Environmental and Social Impact Assessment

Project Number: 47929
October 2014

Gulpur Hydropower Project
(Pakistan)

Prepared by Mira Power Limited

This is an updated version of the draft originally posted in September 2013 available on http://www.adb.org/projects/47929-001/documents.

Environmental and Social Impact Assessment of

Gulpur Hydropower Project

October 12, 2014

HBP Ref: R4V08GHP

Final Report

Mira Power Limited (MPL) Islamabad

Hagler Bailly Pakistan

water matters

Hagler Bailly Pakistan

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Acronyms

AEP	Annual Exceedence Probability
AIS	Alien Invasive Species
AJK	Azad Jammu & Kashmir
AJKFWD	AJK Fisheries and Wildlife Department
Al	Aluminum
ARI	Average Recurrence Interval
BAP	Implementation of Biodiversity Action Plan
BAU	Business as Usual
BHUs	Basic Health Units
BID	Background Information Document
CBD	Convention on Biological Diversity
CCGTs	Combined Cycle Gas Turbines
Cd	Cadmium
CEO	Chief Executive Officer
CGD	concrete gravity dam
CGD	Concrete Gravity Dam
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMP	Construction Management Plan
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CO	Carbon Monoxide
Cr	Chromium
CSR	Corporate Social Responsibility
DHQ	District Headquarter
DRIFT	Downstream Response to Imposed Flow Transformations
EFlow	Environmental Flow
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EPC	Engineering, Procurement, and Construction
ESIA	Environment Social Impact Assessment
ESMS	Environmental and Social Management System
ESMS	Environmental and Social Management System
Fe	Iron
GAI	Geomorphological Assessment Index
GCM	Global Climate Models
GFPs	Grievance Focal Points
GHG	greenhouse gas
GIIP	Good International Industry Practice
GPO	General Post Office
GRC	Grievance Redress Committee

GT	Grand Trunk
HDPE	High Density Polyethylene
HEB	Hydroelectric Board
HPP	Hydropower Project
HWF	Himalayan Wildlife Foundation
IAK	Indian Administered Kashmir
ICIW	India Commission for Indus Waters
ICP	Informed Consultation and Participation
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IO	Implementing Organization
IP	Indigenous Peoples
IPCC	Intergovernmental Panel Climate Change
IPP	Independent Power Producer
IR	Involuntary Resettlement
IUCN	International Union for Conservation of Nature
IWD	irrigation water demand
KSA	Saudi Arabia
LARP	Land Acquisition and Resettlement Plan
LDL	Lowest Detection Limit
LMM	Liverpool Malaria Model
LOC	Line of Control
LPG	Liquefied Petroleum Gas
MBT	Main Boundary Thrust
ND	No dam
NEQS	National Environmental Quality Standards
NGO	Non-governmental Organization
NHA	National Highway Authority
NO_2	Nitrogen Dioxide
NOL	Normal Operating Level
NRMP	Northern Resource Management Project
NS	Not Specified
NSDW	National Standards for Drinking Water
NTDCL	National Transmission and Dispatch Company Ltd.
OM	Operations Manual
OR	Operating Rule
P&DD	Planning & Development Department
Pb	Lead
PCE	Passenger Car Equivalent
PCIW	Pakistan Commission for Indus Waters
PCP	Public Communications Policy
PCU	Public Complaints Unit
PES	Present Ecological State
P	Phosphorous

PM10	Particulate Matter
PMD	Pakistan Meteorological Department
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PPE	Personal Protective Equipment
Pro	Protection’
SEA	Strategic Environment Assessment
SO_4	Sulfate
SPD	the Survey of Pakistan Datum
SPF	Snow Leopard Foundation
SPS	Safeguard Policy Statement
SR	Safeguards Requirement
SWHP	Surface Water Hydrology Project
TBT	Tool Box Talks
TDS	Total Dissolved Solids
TKN	Nitrogen
UAE	United Arab Emirates
VIC	Variable Infiltration Capacity
VU	Vulnerable
WAPDA	Water and Power Development Authority
WHC	Convention Concerning the Protection of the World Cultural and Natural Heritage
WHO	World Health Organization
WWF	World Wildlife Fund

1. Executive Summary

1. Mira Power Limited ('MPL' or the 'Company') is an Independent Power Producer (the IPP) which is planning to develop Gulpur Hydropower Project (the 'Project') in the Azad Jammu & Kashmir (the 'AJK'). The Project will utilize the flow of Poonch River, the full length of which within AJK has been notified as a national park by the AJK Wildlife and Fisheries Department in 2010. MPL engaged Hagler Bailly Pakistan to conduct an assessment of potential impacts from the Project and to identify mitigation and management measures to address potential impacts.

1.1 Project Setting

2. The map in **Figure 1–1** illustrates the general setting of the area of interest for this ESIA. The Poonch River originates in the western foothills of the Pir Panjal Range, and the steep slopes of the Pir Panjal form the upper catchment of the river. The river is narrow and descends steeply until it reaches the foothill areas where the gradient flattens out and the river widens as it is joined by several tributaries. The valley narrows again near the Line of Control (LOC) and the gradient is steeper (6.9-8.3 m/km) to Kotli, but eases off (3.7 m/km) after that. The river flows into the Mangla Lake that is the reservoir of Mangla Dam, situated at the confluence of the Poonch and Jhelum Rivers. Flows in the Poonch River are highest in the summer months driven first by snow melt and then by the monsoon rains. Summer water temperatures in the lower Poonch approach 30°C.

1.2 Narrative Description of the Course of Poonch River

3. This narrative description covers the Poonch River from the Madarpur near Line of Control (LoC) to the Mangla reservoir and provides an overview of the landscape and land use in the Poonch River Valley (**Figure 1–2**).

Segment A - Line of Control (LoC) to Tata Pani (25 km, Average Elevation 1,000 m)

4. The Poonch River crosses the LoC and enters in from Indian controlled territory into Pakistan controlled territory about 4 km upstream of village of Madarpur. The river is about 100 m wide at full flow and has series of pools and riffles. The river also has strong rapids and exposed rocks on the bank and slopes rising to about 1,500 m above the river. Snow Trout ***Schizothorax plagiostomus*** occurs in Poonch River in this segment, especially during winters when it migrates downstream from colder upstream waters. Snow trout is not endangered but has economic value as a food fish for communities both upstream and downstream of LoC. Other common species in this stretch are ***Crossocheilus latius***, ***Garra gotyla***, ***Labeo dyocheilus***, and Mahaseer ***Tor putitora***. Illegal sand mining is extensive in this area, particularly near Kallar Bridge. There is a crossing point to Indian Administered Kashmir at Titri Note. This segment of Poonch River is also rich in fish and illegal fishing using of dynamite, electrocution, and poisons is common. The land in this area is fertile and agricultural fields are very common.

Figure 1–1: Project Setting

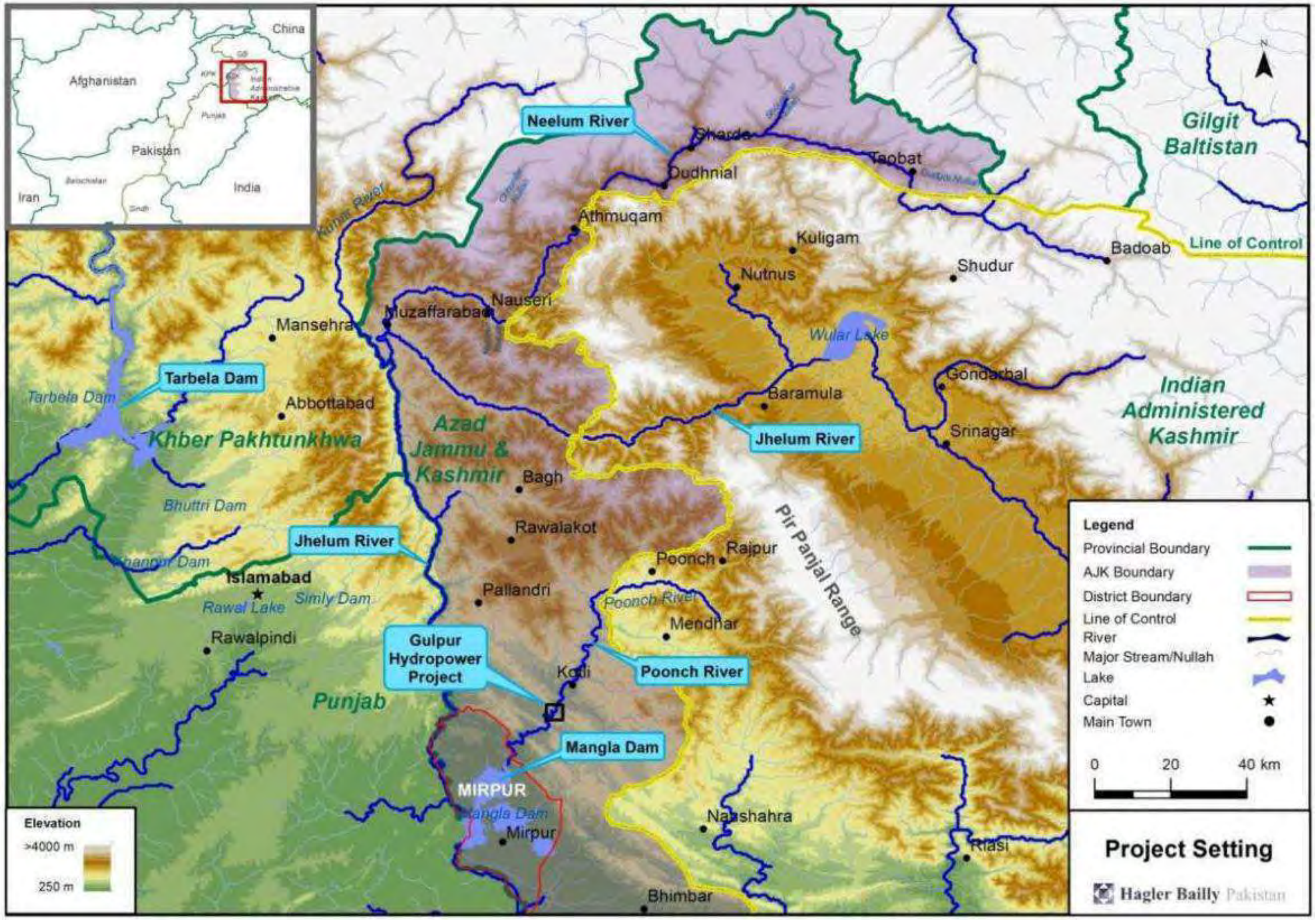
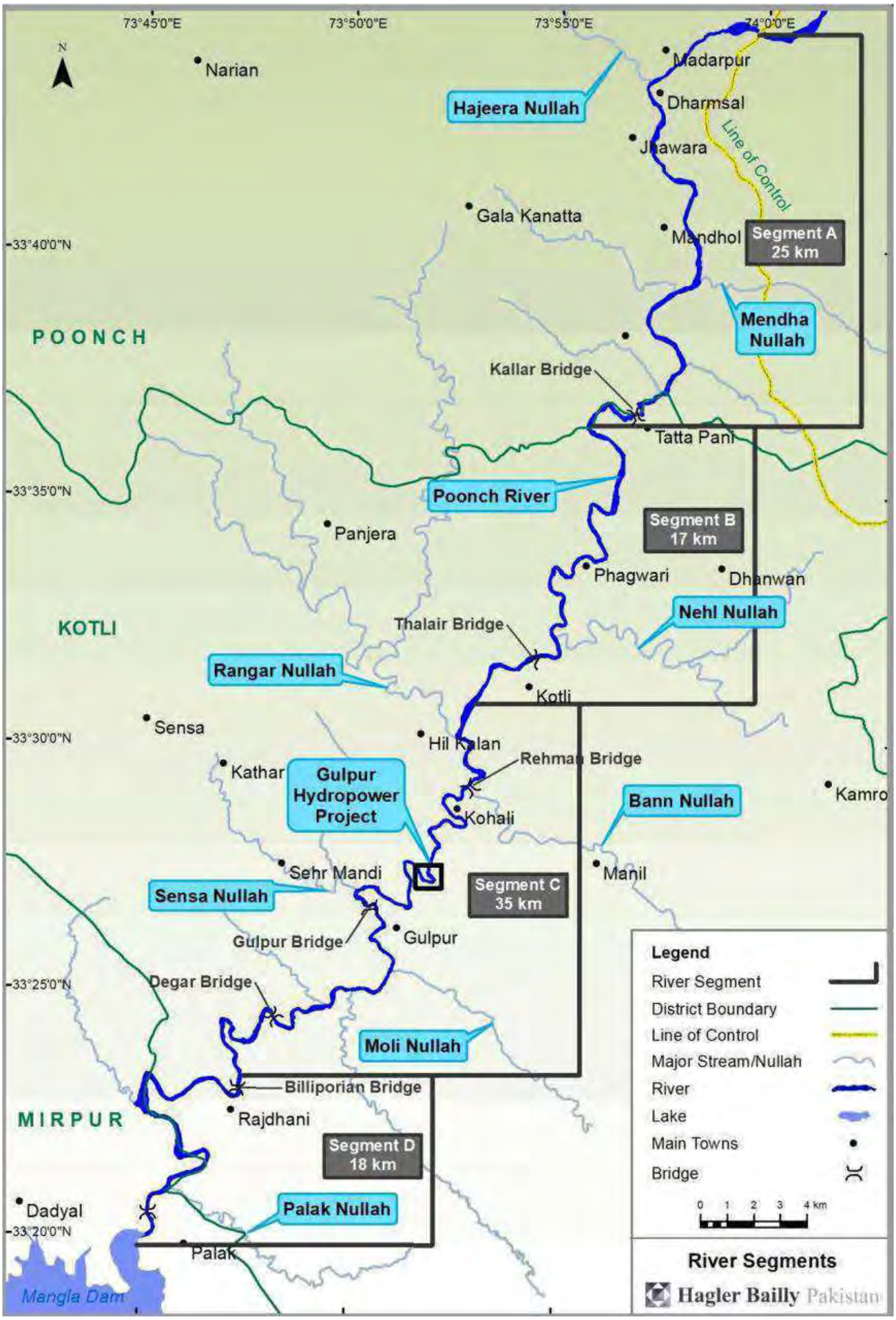


Figure 1–2: Designated River Segments along Poonch River



Segment B – Tata Pani to Kotli (17 km, Average Elevation 800 m)

5. The valley in Segment B is wider relative to Segment A and the longitudinal gradient is shallower. Braided channels are common in this stretch of the river. Mahaseer ***Tor putitora*** and Pakistani Labeo ***Labeo dyocheilus, Botia rostrata, Crossocheilus latius,*** and ***Glyptothorax cavia*** fish are commonly found in this segment. The villages are mainly located on the left bank, which has low topographic relief, while there is a thick cover of mixed vegetation and on the steeper left bank . This stretch of Poonch River has one major urban center, Kotli Town, and one major village, Phagwari. Kotli is the major urban hub of Poonch valley with all the main commercial activity and government offices centered in this city. Approximate population of Kotli is 113,000 with 17,660 households. Sand mining is very common along this stretch of the river.

Segment C – Kotli to Rajdhani (35 km, Average Elevation 500 m)

6. The river continues to flow through a steep narrow valley, which widens near Gulpur. Near Rehman Bridge a Water and Power Development Authority (WAPDA) hydrological monitoring station and a slaughter house are located. There is also a waste dumping area where vultures feed. The Rangar Nullah and the Bann Nullah join the Poonch River upstream of Rehman Bridge). These tributaries are breeding areas for the Mahaseer ***Tor putitota.*** Common fish fauna found in this stretch of river is ***Tor putitota, Botia rostrata, Clupisoma garua, Crossocheilus latius, Mastacembelus armatus, Glyptothorax stocki,*** and ***Crossocheilus latius*** which is commonly found in deep pools of the river. The first village in this segment is Hill Killan which has no vehicular access. There are approximately 80 households in Hill Killan with a total population of 480. Due to the demand for construction material from Kotli and Gulpur, extensive sand mining is carried out in this segment as well**.** A major village called Gulpur is located on this stretch which acts as a center for the surrounding small villages. Gulpur, after Kotli, is the second biggest town in Poonch valley. Approximate population of Gulpur is 6,400 with 800 households.

Segment D – Rajdhani to Mangla Reservoir (18 km, Average Elevation 450 m)

7. The valley is relatively wide and the longitudinal gradient is low Deep pools and large flood plains are common in this segment, with the river flowing in a single channel. The river concludes and drains into the Mangla reservoir. Common fish in this segment are ***Tor putitora, Botia rostrata, Clupisoma garua, Crossocheilus latius, Mastacembelus armatus, Glyptothorax stocki*** and ***Crossocheilus latius***, ***Parambassis ranga, Chanda nama.*** The diversity of fish species is higher closer to the Mangla reservoir where both the river and lake dwelling species occur. Rajdhani is a major village located in this stretch of Poonch River**.** Sand mining is actively practiced due to demand for construction materials from Rajdhani.

1.3 Regulatory and Institutional Framework

8. The applicable regulations and guidelines for this ESIA include laws in AJK including those that have been enacted in Pakistan but have been adopted by the AJK Legislature, international conventions, and ADB and IFC Guidelines. The ***Azad Jammu and Kashmir Environmental Protection Act, 2000*** is the principal legislative tool used for regulating environmental protection in the state of Azad Jammu and Kashmir. This legislation provides for two types of environmental assessments: IEEs and EIAs. EIAs are carried out for projects that have a potentially 'significant' environmental impact, and IEEs are conducted for relatively smaller projects with a relatively less significant impact.

An EIA was prepared and submitted to the AJK Environmental Protection Agency (AJK EPA) for the Gulpur Hydropower Project under this legislation. The AJK EPA reviewed the EIA and granted an approval for construction of the Project.

9. The Pakistan Environmental Protection Agency has published a set of environmental guidelines for conducting environmental assessments and environmental management of projects, which have been adopted by the AJK EPA. The relevant guidelines are:

- Guidelines for the Preparation and Review of Environmental Reports, Pakistan Environmental Protection Agency, 1997
- Guidelines for Public Consultation, Pakistan Environmental Protection Agency, May, 1997
- Guidelines for Sensitive and Critical Areas, Pakistan Environmental Protection Agency, October, 1997

10. The National Environmental Quality Standards (NEQs) specify the following standards:

- Maximum allowable contamination of pollutants (32 parameters) in emission and liquid industrial effluents discharged to inland water.
- Maximum allowable concentration of pollutant (16 parameters) in gaseous emission from sources other than vehicles.
- Maximum allowable concentration of pollutants in gaseous emissions from vehicle exhaust and noise emission from vehicles.
- Maximum allowable noise level from vehicles.
- Ambient noise standards
- Ambient air quality standards.

11. Other environmental laws applicable to Project construction and operation include the following.

12. ***The AJK Wildlife (Protection, Preservation and Management) Ordinance 2013:*** This legislation endeavors to promote social, economic, cultural and ecological well-being of local communities in conformity with the concerns of the international communities. The Ordinance also provides for the declaration of various categories of protected areas: wildlife sanctuaries, wildlife refuge, national parks, game reserves, biosphere reserves, biodiversity reserve, and national natural heritage sites. The Project is located in the Poonch River Mahaseer National Park notified in 2010 and aims to achieve net gain for biodiversity consistent with Safeguards Requirement (SR) 1 of ADB's SPS[1] and IFC Guidelines[2] and will therefore achieve betterment of the national park. Consistent with the legislation which allows the government to permit activities that are for the betterment of the park, MPL filed a written request to the AJK Wildlife and Fisheries Department (Department) for permission to construct and operate the Project.

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1 Asian Development Bank, 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment

2 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

The Department granted permission to MPL subject to preparation and approval of a Biodiversity Action Plan for the Project. MPL has shared the draft version of the BAP with the Department and will request approval form the Department following clearance by ADB and IFC.

13. ***The Land Acquisition Act, 1894:*** The law deals with the matters related with acquisition of private land and other immovable properties existing on the land required for the project. The Land Acquisition and Resettlement Plan (LARP) prepared for the project conforms to this legislation.

14. ***Jammu and Kashmir Forest Regulation 1930:*** Forests of Azad Jammu and Kashmir are managed according to the guidelines provided by ***Jammu and Kashmir Forest Regulations of 1930*** (including amendments), generally known as Forest Law Manual. This regulation lays down the rules and regulations for both demarcated and un-demarcated forests, collection of drift and stranded wood as well as penalties and procedures for not abiding by these regulations. MPL has shared the ESIA with the Forest Department and made provisions for a plantation plan in the watershed following advice from the department.

15. ***Fisheries Act 1897:*** The ***Fisheries Act 1897*** regulates fishing in the waters of Pakistan. However, as the Poonch River is located in a national park, the provisions of wildlife legislation supersede those under this legislation.

16. ***The Factories Act, 1934:*** The pertinent clauses of the Act are those that deal with health, safety and welfare of the workers, disposal of solid waste and effluent, and damage to private and public property. It also deals with the regulations for handling and disposing of toxic and hazardous materials.

17. ***The Explosives Act, 1884:*** It provides regulations for handling, transportation and use of explosives. The contractors have to abide by the regulation during quarrying, blasting and for other purposes.

18. ***Laws Regulating Flow Releases for Hydropower Projects:*** Guidelines for Preparation and Review of Environmental Reports which were prepared by the Government of Pakistan in 1997 and have been adopted by the Government of AJK contain the only reference to environmental flow. (**Section 3.5**) requires that the environmental assessment shall consider direct and indirect impacts. In the examples of the indirect impact given in the guidelines, one example is "environmental degradation of a river mouth resulting from dam building high in the catchment, and the resulting reduction in environmental flows". It can be concluded that the environmental law considers the reduction in flow as an impact and requires that its subsequent impacts shall be taken into consideration in the EIA.

1.3.1 International Conventions and Obligations

19. The Azad Jammu and Kashmir Environmental Protection Act, 2000 recognizes that it is necessary to fulfill the obligations envisaged under the biodiversity related Multilateral Environmental Agreements ratified by the Government of Pakistan. A list of international conventions that focus on biodiversity issues is given in **Table 1–1**.

Table 1–1: International Agreements on Biodiversity and Pakistan's Status

Convention	Date of Treaty	Entry into Force in Pakistan
Convention on Biological Diversity (CBD)	1993	26 Jul 1994
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1975	19 Jul 1976
Convention on Conservation of Migratory Species (CMS)	1979	01 Dec 1987
Convention on Wetlands of International Importance especially as Waterfowl Habitat	1971	23 Nov 1976
Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC)	1972	08 Dec 2011
Indus Water Treaty	1960	12 Jan1961

1.3.2 IFC's Performance Standards and Guidelines

20. International Finance Corporation applies the Performance Standards 2012 to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, the eight Performance Standards establish standards that the client is required to meet throughout the life by IFC or other relevant financial institution.

21. Performance Standard 6, Biodiversity Conservation and Sustainable Management of Living Natural Resources, recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The PS 6 outlines the definition of a Critical Habitat and specifies the conditions in which the client will not implement any activities if Project is located in a Critical habitat.

22. The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). Components of The General EHS Guidelines include Environment, Occupational Health and Safety, Community Health and Safety, and Construction and Decommissioning.

1.3.3 ADB Guidelines

23. The following ADB policies and guidelines are applicable to the proposed Project:

- ADB Policies, Strategies and Operations Manuals including but not limited to:
  - ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment, SR2 on Involuntary Resettlement (IR), and SR 3 on Indigenous Peoples (IP)
  - ADB Social Protection Strategy (2001);
  - ADB Gender and Development Policy (1998);
  - Public Communications Policy (2011); and
  - Relevant ADB Operations Manual (OM) such as OMF1 for Safeguards Policy Statement, OML3 for Public Communications, OMD10 for Non-

sovereign Operations, OMC3 for Incorporation of Social Dimensions into ADB Operations, OMC2 for Gender and Development; [3]

1.4 Project Description

24. The Gulpur Hydropower Project with design capacity of 100 MW will use the water resources of the Poonch River for power generation. The Project site is located in Kotli District, Azad Jammu and Kashmir about 9 km South of Kotli Town. **Figure 1–3** illustrates the proposed Project facilities.

25. The Project's major components include dam, intake structure and power house. All the project structures will be located near Barali village on the Poonch River about 11 km downstream of Kotli Town and about 6 km downstream of the confluence of Bann Nullah with the river. The intake structure and intake portal of the power tunnel will be located on west bank of the Poonch River, 150 meter upstream of weir structure on the eastern face of a ridge. The power house and outlet will be located on right bank Poonch River about 700 m downstream of the dam structure. Private land constitutes about 7.3 percent of the total area to be occupied by the Project. About 93% (292 hectares) of the land required for the proposed Project is expected to be utilized for the reservoir. In total, the proposed project will require 314 hectares of land; out of which 93% is government owned.

26. The dam will be a concrete gravity dam (CGD) with height of 66 m, length of 205m, and width of 80 m. A100-year frequency flood (13,334 cumec) has been applied to the spillway overflow section. The discharge capacity of the spillway has been designed to maintain the normal operation level (El.534 m) in case of the 100-year frequency flood. The power house will be operated in a non-peaking mode to avoid stress on the river ecology downstream of the power house. Diversion of river flows during construction is required at the dam structure. A single-stage river diversion plan has been proposed for the construction of the dam. The diversion will be manipulated within the river section by constructing a cofferdam.

27. The Project would take about 48 months for its completion and commissioning. The materials used for the construction of the proposed project include coarse aggregates, fine aggregates (sand), rock for stone pitching and riprap, earth, water, cement and steel. The Project will generate about 1.0 million cubic meters of rock material (mostly sandstone and siltstone) from excavation. Excavation for dam will generate a quantity of about 0.56 million cubic meters, power tunnel 0.21 million cubic meters and power house 0.20 million cubic meters. Depending upon the quality of the excavated stone material, some quantity will be used to meet the requirement of aggregate, rock fill at cofferdams and stone pitching. However, bulk of the excavated material be deposited in the spoil tip area located at the Project site (**Figure 1–3**).

28. Impact of varying levels of environmental flow (EFlow) on project economics and ecosystem integrity were assessed in this ESIA. MPL discussed these impacts with key stakeholders to select an EFlow regime that achieves a balance between the benefits to the ecosystem and the financial loss to the owner and economy. An EFlow of 4 cumec was proposed to achieve a balance between environment and development, and approved by the Wildlife and Fisheries Department, the AJK EPA, and the Himalayan Wildlife Foundation (HWF), a key stakeholder engaged in protection of biodiversity of the Poonch River. HWF was instrumental in motivating the government of AJK in notifying

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[3] Available from http://www.adb.org/Documents/Manuals/Operations/default.asp

the entire length of Poonch River as a Poonch River Mahaseer National Park in 2010. Following the notification, HWF prepared an ecological baseline of the Poonch River which provided the basis for development of management strategies for the national park, and mobilized resources for protection of the biodiversity of the river.

1.5 Description of the Environment

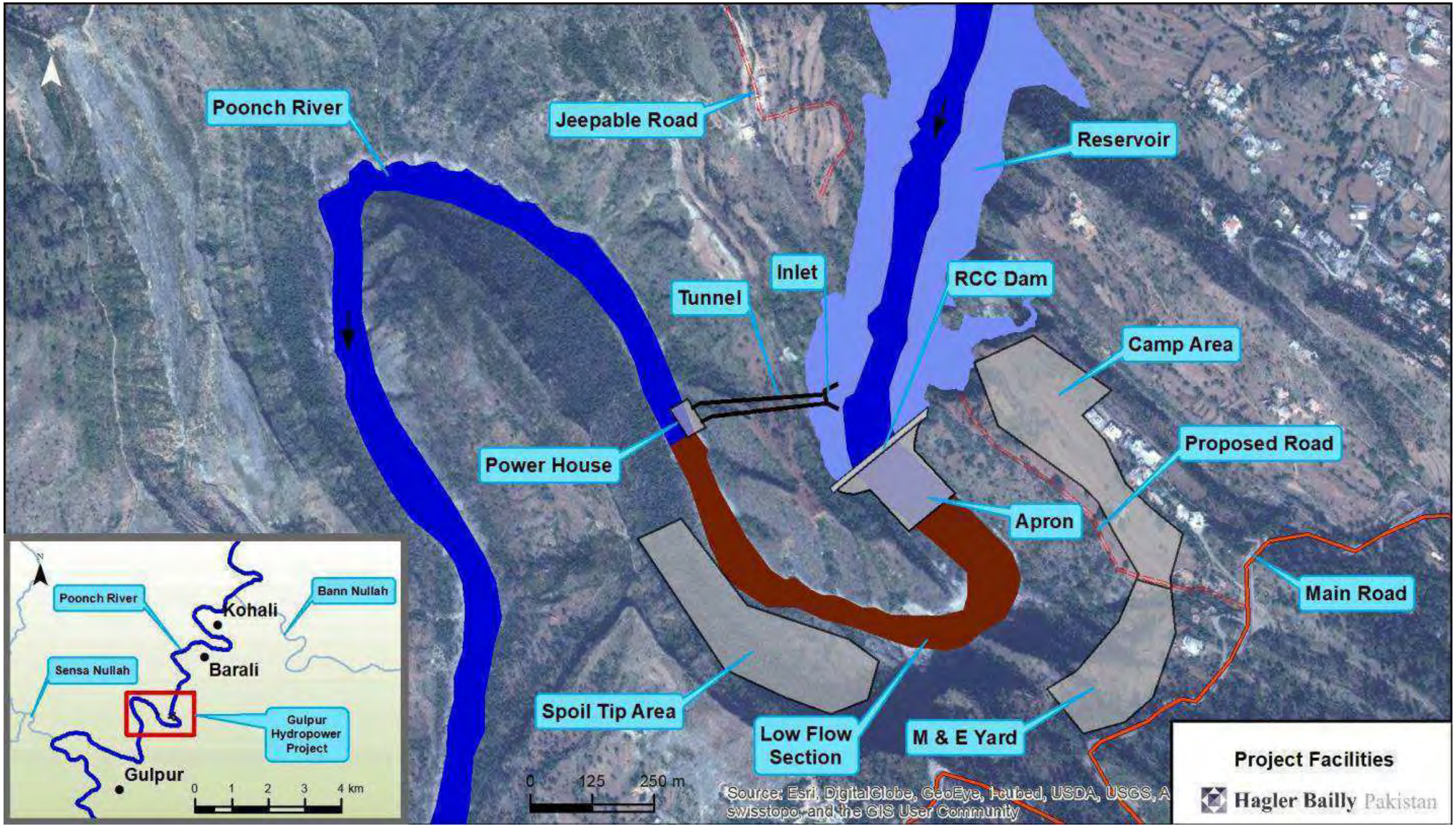
1.5.1 Description of Physical Environment

29. ***Geology:*** The Project area is a part of land formations developed at the foothills of Himalayan Ranges through tectonic events subsequent to those that caused building of the Himalayas. The Project area contains middle Siwalik formations developed from the sedimentary deposits contributed by a number of drainage channels from the uprising Himalayan Range. The rock formations include extremely folded beds, having almost vertical dips, of various types of sandstones, clay-stones and siltstones. The Poonch River and nullahs generally pass through deep and narrow gorges having steep slopes. Occasionally, relatively wide valleys are also encountered which are being used for settlements and agricultural activities. Mostly the mountains are covered with primary soils, except along the river and nullahs where the beds are almost devoid of soil material either for steep slopes or for the scouring action of the river/nullahs flows. Within the flood plains where slopes are milder to nearly level, deposits of secondary soils exist.

30. ***Soils:*** The texture of the primary soils varies from moderately fine to moderately coarse depending upon the rock type from which these have developed. However, the secondary soils are mostly moderately coarse textured. The soils of the raised terraces in floodplains are generally devoid of the stony material. The soils of lower terraces generally contain varied quantities of pebbles, cobbles and boulders.

31. ***Air Quality and Noise:*** In general there are no major sources of air pollution, i.e., no industries, exist in the project area except road traffic in the valleys of Poonch River and nullahs (tributary streams). Measured concentrations of carbon monoxide, nitrogen dioxide, and sulfur dioxide in ambient air were found to be within NEQS and IFC limits. The ambient particulate matter PM_{10} was also found to be within NEQS and IFC guideline. Noise monitoring was conducted at two settlements near the location of Project facilities, one near the proposed dam site and one near proposed power house location. The noise level was found in range of 45-56 (dBA), generally within limits specified by NEQS and IFC, except at one location where the noise from rapids in the river added to the background noise level. The nighttime noise levels generally exceeded the NEQS and IFC limits due to the noise form the river turbulence.

Figure 1–3: Project Facilities



32. ***Climate and Meteorology:*** Generally, the project area falls in sub-humid and sub-tropical zone. It has moderate summer and cold winter. The climate is greatly influenced by monsoon in the months of July and August and snowcapped mountains of Pir Panjal Range. Average annual precipitation in the area is 1,237 mm. However, there is a great seasonal variation. The maximum rainfall occurs during the months of July and August when the average precipitation is 266 mm and 271 mm, respectively. Minimum rainfall is experienced in November with the average of 24 mm. Average monthly mean maximum temperature varies from 17.6 ^{o}C in January to 38.4 ^{o}C in June, whereas monthly mean minimum temperature ranges between 4.8 ^{o}C in January and 24.9 ^{o}C in June. Because of the physiographic features of the project area, wind direction is East/Westerly at the proposed powerhouse and camp site, whereas, wind direction is predominantly North/Easterly at the proposed weir and batching plant site.

33. ***Land Use Type and Vegetation:*** In a zone extending 3 km from the river bank, aagriculture accounts for about 27% and 40% of the land use in Segment A and Segment B (**Figure 1-2**), respectively. In Segment C, where the valley widens, about 50% of the land is used for agriculture; whereas only 28% of land is used for agriculture in Segment D. Forest is the second main land cover. About 64% of land in Segment A is under pine forests. In Segments B, C and D, only 30–40% of land is under pine forests. Segment B and Segment D have a high proportion of scrub forests, 23% and 29% respectively whereas Segments A and C have below 10% of scrub forests. Residential area accounts for less than 5% of the land use; houses are generally compact and located within agricultural areas.

34. ***Land Ownership:*** The land on the hills generally belongs to the Forest Department. The land on the high benches within hilly areas is used for cultivation and settlements. The river and nullah (stream) beds along with the adjacent slopes are owned by the government. As such, the proposed Project components, viz., dam, intake structure including intake portal of the power tunnel and powerhouse including penstocks will be located on the government land. The land for construction camps and colony is proposed to be acquired from the land available on the raised benches near the proposed structures.

35. ***Water Resources:*** The main surface water resource of the project area is the Poonch River, which flows along Kotli- Mirpur Road and drains into Mangla reservoir. Poonch River is a main tributary of Jhelum River. The total catchment area of the river at the Project dam site is about 3,800 km^2. The water quality of the river is appropriate for irrigation and other non–consumptive purposes., The river water is not suitable for drinking and cooking as it is contaminated by the wastewater effluent from towns, villages and settlements established along the river as well as located in the river drainage area. This particularly implies for the Kotli Town. The project area in Kotli District is devoid of any large aquifer. This is because of the stony formation of the area and steep slopes of the mountains. The rainwater seeps into the grounds at the mountains oozes out at places in the form of springs. However, limited quantity of groundwater is available in Kotli Valley that is exploited for supply of potable water to the town. The consumptive requirement of the communities at other places is generally met from the spring water.

36. ***Hydrology:*** WAPDA has maintained a stream gauging station on Poonch River at Rehman Bridge since 1960. Measurements include stream flows and suspended sediment concentrations. Rehman Bridge Gauging Station is located just downstream of Bann Nullah about 5 km south east of Kotli Town. Stream flow record of Poonch River at Rehman Bridge for the period 1960 to 2011 available in the form of mean daily flows has

been used to present inflow time series. Mean monthly discharges computed from the mean daily flows show a minimum value of 12 cumec observed in January 1966 and maximum value of 830 cumec in September 1992. Mean monthly flows vary between 41 m^3/s (cumec) in November to 279 cumec in August.

37. ***Sediment Loads:*** The 1960 to 2011 observed suspended sediment loads at the Rehman Bridge gauge station on the Poonch River near Kotli were obtained from the Surface Water Hydrology Project of the Water and Power Development Authority (WAPDA) for use in this study. The mean suspended sediment load of the Poonch River is c. 10.87 million tonnes per annum. Although cobble and boulder beds are extensive morphological features on the river bed and banks, the sand fraction represents a large portion of the river bank deposits. Based on observed sediment fraction distributions, sand accounts for approximately 10% and silt and clay 90% of the total suspended sediment load under present day conditions.

38. ***Traffic:*** For assessment of impacts on traffic during the construction of the Project facilities, traffic count surveys were carried out at two critical junctions, Gulpur Junction and Palak Junction. Gulpur Junction also represents the level of traffic that will be experienced at the point near Project site where the access road for the project connects to the main road. Traffic counts survey was carried out for traffic from Mirpur/Rawalpindi towards Kotli and from Kotli to Mirpur/Rawalpindi. Generally, the traffic volume was low with the number of vehicles passing well below the recommended usage limits. Cars and motorcycles were dominant in the vehicular traffic.

1.5.2 Description of Ecological Environment

Aquatic Ecology

Fish

39. Poonch River is a warm water river and the water temperature approaches almost 30° C during the summer months. A total of 37 fish species have been recorded from the Poonch River. The diversity (richness) is higher in the area where the River Poonch makes its confluence with Mangla reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer. The reason is the topography and water temperature of the River Poonch. The Poonch flows relatively gently in a valley which provides numerous breeding grounds for the reproduction of fish. Of the fish species recorded from the Poonch River, 16 species are species of special importance (Biodiversity Baseline, Final Report, June 2014 Gulpur Hydropower Project).

40. Six fish species observed in the study area are listed in IUCN Red List. Kashmir Catfish ***Glyptothorax kashmirensis*** is listed as Critically Endangered in IUCN Red List. Mahseer ***Tor putitora*** is listed as Endangered while Pabdah Catfish ***Ompok pabda*** and Butter Catfish ***Ompok bimaculatus*** are listed as Near Threatened. Moreover, Common Carp ***Cyprinus carpio*** and Twin-banded Loach ***Botia rostrata*** are listed as Vulnerable. The endemic fish species in the Study Area include Pakistani Baril ***Barilius pakistanicus***, Punjab Loach ***Schistura punjabensis*** and Nazir's Catfish ***Glyptothorax naziri***. It was determined that the aquatic habitat in the study area is important for survival of Kashmir Catfish ***Glyptothorax kashmirensis*** listed as Critically Endangered and Mahaseer ***Tor putitora*** listed as Endangered in IUCN Red List.

Macro-invertebrates

41. Abundant macro-invertebrate taxa reported from the Project site and vicinity includes Chironimidae, and ***Choroterpes sp.*** and ***Stenonema sp***. A total of 37 macro-invertebrate taxa were identified in the Study Area during the October 2013 survey. The average abundance of macro-invertebrates was generally higher in the tributaries. Similar to abundance, diversity of macro-invertebrates observed was higher in the tributaries compared to the river due to lower water volume and velocity in the nullahs.

Otters

42. Otters are the only water mammals associated with the Poonch River. The species found is the Common Otter ***lutra lutra***. The Otter lives in a wide variety of aquatic habitats, including highland and lowland lakes, rivers, streams, marshes, and swamps. This species is considered to be Near Threatened in the IUCN Red List 2013. Otters were found to be active (based on the observation of foot-prints and droppings) in the vicinity of deep and long pools in the river containing wintering fish species.

Terrestrial Ecology

43. The Ecological Study Area is mostly composed of hilly areas and riparian area along the Poonch River and tributaries. A total of 32 plant species have been observed or reported from the area. The vegetation of the riparian areas is mainly dominated by ***Dalbergia sissoo, Parthenium hysterophorus, Xanthium strumarium*** and ***Ricinus communis.*** The vegetation at high altitude is mainly dominated by ***Pinus roxburghii.*** The vegetation at the lower altitude is scrub forest dominated by ***Dalbergia sissoo, Ziziphus mauritiana, Dodonaea viscosa*** and ***Carissa opaca***.

44. A comprehensive account of the mammals found in the Poonch River basin is not available. Sixteen (16) mammalian species have been reported in literature from the Pir Lasura National Park in Kotli District that is located approximately 12 km away from the Project site. Mammal species observed or reported from the Ecological Study Area include the Rhesus Monkey ***Macaca mulatta***, Indian Grey Mongoose ***Herpestes edwardsii,*** Asiatic Jackal ***Canis aureus,*** Indian Crested Porcupine ***Hystrix indica,*** Common Leopard ***Panthera pardus,*** Common Red Fox ***Vulpes vulpes*** and a cat species ***Felis sp***. The only terrestrial mammal included in the IUCN Red List [4] is the Common Leopard ***Panthera pardus*** that is listed as Near Threatened. Small mammals reported from the Study Area include House Mouse ***Mus Musculus***, Indian Field Mouse ***Mus Booduga***, House Shrew ***Suncus Murinus***, and House Rat ***Rattus rattus***.

45. A total of 35 amphibian and reptiles have been reported from the Ecological Study Area [5]. These include Skittering Frog ***Euphlyctis cyanophlyctis***, Rohtas Fort Gecko ***Cyrtopodion rohtasfortai,*** Asian Grass Frog ***Fejervarya limnocharis,*** Agror Valley Agama ***Laudakia agrorensis,*** Swat Green Toad ***Pseudepidalea p. pseudoraddei*** and Indian Burrowing Frog ***Sphaerotheca breviceps.***

46. A total of 45 species have been reported from the Ecological Study Area. Abundant bird species include Jungle Babbler ***Turdoides striata***, House Sparrow ***Passer domesticus***, Common Myna ***Acridotheres tristis***, Jungle Crow ***Corvus macrorhynchos***

[4] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 11 October 2013

[5] Khan, W.A. 2013. A preliminary baseline report on amphibians and reptiles of Gulpur Hydroelectric Power, Kotli, Azad Jammu and Kashmir, 7 pp.

and Himalayan Bulbul ***Pycnonotus leucogenys.*** Two of the bird species recorded from the Study Area are included in the IUCN Red List 2013. These are the White-backed Vulture ***Gyps bengalensis*** and Egyptian Vulture ***Neophron percnopterus*** listed as Critically Endangered and Endangered in the IUCN Red List 2013

Poonch River Mahaseer National Park

47. The entire stretch of the Poonch River along with 10-15 km downstream segments of its tributaries was declared a national park (Poonch River Mahaseer National Park) in a letter from the AJK Secretariat Forest/AKLASC/Fisheries (ref no: SF/AV 11358-7/2010 dated 15 December 2010). The Poonch River was declared as a national park due to its high fish diversity and importance of supporting fish of both conservation and economic importance particularly the Endangered fish species (IUCN Red List 2013) Mahaseer ***Tor putitora*** that is important both from the conservation and recreational/economic viewpoint. By the ESIA process and the need to conform to the 'net gain' principle under the IFC and ADB requirements , the profile of the national park, its conservation importance, and threats to its ecological resources have been highlighted and brought to public notice.

Critical Habitat Assessment

48. The Project site has been designated as a Critical Habitat in view of its location in a National Park (Poonch River Mahaseer National Park) as well as the presence of two fish species of conservation importance: Mahaseer ***Tor putitora*** and Kashmir Catfish ***Glyptothorax kashmirensis*** listed as Endangered and Critically Endangered respectively in the IUCN Red List respectively. Mira Power Ltd has therefore made a commitment to achieve net gain for biodiversity in the Poonch River basin, (where the proposed Project is located) to meet these requirements of IFC's Performance Standard 6 and Safeguards Requirement (SR) 1 of ADB's SPS.

1.5.3 Description of Socio-Economic Environment

49. Settlements located at a distance of less than two km from the Poonch River were included in the Socioeconomic Study Area which covered a 65 km length of the river. Communities in the Socioeconomic Study Area have direct access to the river and are more likely to be impacted by the construction and operation of the Project. Settlement and household level surveys were conducted in February 2014. The key respondents were male members who either held important leadership positions in the community or had insight on the settlement due to age or nature of work. Household survey respondents were mostly men. However women, especially those who did not have any male members in the household, were surveyed, where possible.

50. Eleven rural settlements and Kotli urban area were surveyed, which were 25% of the total settlements in the Socioeconomic Study Area. The size of the surveyed rural settlements varied, ranging from 15 households in the smallest settlement with a population of 125 to 4,000 households in the largest settlement with a population of 24,000. Urban population constitutes 74% share in the total population surveyed in the Socioeconomic Study Area; while the remaining 26% belongs to rural areas. On the average, there are 573 households and 3,645 persons per rural settlement. The average household size in Kotli District is 7.3, almost equal to estimated household size of 7.0 for the surveyed settlements.

51. The age structure shows a relatively large number of children of ages between 10 and 20 years, accounting for approximately 25% of the population. The median age of the surveyed population was 22 years. Population above 60 years was found to be only 5%, which suggests a lower life expectancy in the rural households of the Socioeconomic Study Area. The dependency ratio was estimated at 51% in rural settlements and 50% for Kotli, which indicates the presence of adequate labor–force to provide for the economically dependent. The sex ratio of the surveyed population was 115, compared to 101 for AJK as a whole, which shows the presence of a larger male population as compared to females. Data collected from the field also shows a higher tendency towards in-migration than out-migration in the Socioeconomic Study Area, especially in Kotli. The migrants are mainly from Nakyal, Poonch, Bhimber, Baloch and Indian Administered Kashmir.

52. About 99% of the population of Kotli is Muslim (which includes a 2% Shia). The other 1% population is Christian. The influence of spiritual leaders is widespread. Ten castes were reported. The largest caste in Kotli is the Butt or Kashmiri caste, which form 40% of Kotli's population. In rural settlements, trend varies from village to village. The main languages spoken in Kotli District are Urdu and Pahari. The area is generally peaceful. Ethnic/sectarian violence does not exist in the area. In the rural areas, the village ***Panchayat*** and the spiritual leaders hold influence in resolving conflicts and maintaining peace.

53. Kotli has relatively well developed infrastructure in comparison to the other settlements in the Socioeconomic Study Area. In rural settlements, the roads are narrow and usually unpaved. Internet access is available in the entire socioeconomic area.

54. Eighty-four percent of the surveyed rural households are masonry and adobe houses account for 16% of the dwellings. About 43% households have access to tap water, 42% use water from mountain springs and 16% rely on groundwater wells. Due to lack of proper drainage infrastructure and storm water management system, rainwater was seen to have accumulated on roads. There is no effluent disposal and treatment system reported in the surveyed settlements. Pit latrine systems exist in most rural areas and septic tank facility was reported in some villages.

55. Microbiological analysis of drinking water samples collected in the project area show that nearly every sample has some biological contamination. There were four samples with lead concentration above acceptable limits and two samples with arsenic concentration above acceptable limits.

56. The three major energy sources in Socioeconomic Study Area include electricity, firewood and liquefied petroleum gas (LPG). All settlements in the Socioeconomic Study Area are connected to the national grid. Almost all of the population in rural settlements uses firewood for cooking and water heating purposes and electricity for lighting. Average monthly bill is PKR 1,700 (USD 17) for electricity, PKR 2,300 (USD 23) for firewood and PKR 2,100 (USD 21) for LPG. Piped natural gas is not available in AJK.

57. There is one District Headquarter (DHQ) hospital in Kotli. There is a dispensary in Barali village; and Basic Health Units (BHUs) exist in villages of Rajdhani and Gulpur. Common health problems identified in the rural households are flu and diarrhea reported among all age groups and gender. Some cases of stomach illnesses were reported for all age groups. Respiratory illnesses including allergies were noted in adult women.

58. The observed literacy rate in surveyed rural population was 85% in males and 61% in females. In Kotli, the literacy rate was 88% for men and 79% for women in Kotli.

The literacy rate among women was higher in the city due to better living standards and conveniently located educational institutions. Nearly 80% of the educated population in rural settlements was enrolled in primary and secondary schools, while only 7% in higher levels[6] compared to 20% in Kotli, which indicates a high dropout at primary and middle education levels in rural areas. Number of boys enrolled at primary and middle level is higher as compared to girls in the overall Socioeconomic Study Area.

59. Overseas employment constitutes 29% and daily wage labor forms 23% of all occupations in the rural settlements of Socioeconomic Study Area. In Kotli, businesses and shop owners dominate the market. Women have limited opportunities to work outside their homes, and the share of women in the employed workforce is negligible. Linkages of the people's livelihoods to the Poonch River were limited to river-based sand and gravel mining and fishing. Mean (arithmetic average) household income in rural areas was PKR 24,500 (USD 245) per month and in urban areas was PKR 32,000 (USD 320) per month. The highest monthly income was for overseas individuals at PKR. 40,500 (USD 405). A relatively higher wage profile was observed in Kotli compared to the rural settlements.

60. Out of 421 households interviewed in 11 villages, 28 reported engagement in sediment mining as a business. Total quantity of sediment extracted in the stretch of the river downstream of the LoC to the Mangla reservoir is estimated at 434,400 m^3. Average rate of sand sold by vendors in the market is approximately PKR 2,500/100cuft (PKR 882/m^3) and of gravel is PKR 2,700/100 cuft (PKR 953/m^3).

61. Fish consumption was observed throughout the Socioeconomic Study Area. Out of 421 households interviewed, 259 reported fish consumption from Poonch River. The most common fish consumed include Pakistan Labeo (70% of total consumption) and Mahaseer (30% of total consumption). Total quantity of fish caught from Poonch River consumed in the stretch of the river downstream of the LoC to the Mangla reservoir is estimated at 25,000 kg per year. Market rate for fish caught from the river is PKR 300/kg (USD 3/kg). The total value of the fish caught per year in entire stretch of Poonch River downstream of the LoC to the Mangla reservoir is estimated at PKR 7.5 million (USD 75,000).

62. Seventy-five percent of surveyed population responded that there will be no significant impact on their recreational activities due to changing river flow in Poonch River, while 23% people said the decrease in flow will have a negative impact including loss of recreational activities especially swimming and bathing. Forty percent respondents said that their dependence on the river is in the range of 0% to 25% and is mostly limited to recreational activities and livestock. Eight percent people reported more than 75% reliance on river in terms of livestock and recreation.

1.6 Environmetal Flow Assessment

63. Hagler Bailly Pakistan appointed Southern Waters to assist with an Environmental Flow (EFlow) assessment for the Poonch River upstream and downstream of the proposed Gulpur HPP in AJK. The objectives of the EFlow assessment were:

- To evaluate the present day condition (i.e. the present structure and functioning) of the Poonch River from upstream of Gulpur HPP to Mangla Dam;

6 Grade 12 and above is categorized as Higher Level studies in this report.

- To evaluate how the condition of the river could change under different operational scenarios for the proposed Gulpur HPP.

1.6.1 The EFlow Assessment Process

64. DRIFT (Downstream Response to Imposed Flow Transformations) which is a holistic EFlow assessment approach and has previously been extensively elsewhere in the world and in the Himalayan rivers in AJK was applied. The objective was to describe the present condition of the river ecosystem and then, through scenarios, to predict how this could change with different design and operation of the Gulpur HPP.

65. The Gulpur HPP assessment concentrated on three EFlow sites (EF Sites) on the Poonch River one of which was upstream of Gulpur HPP, on in the low flow section downstream of the dam, and one downstream of the tailrace outlet. The sites were selected on the basis of a catchment delineation exercise specifically considering geomorphologically different river reaches, biological variations along the length of the river, different social uses of the river, different types and levels of impacts likely to be incurred as a result of Project operation, and access and safety for site surveys. The categories used to describe the Poonch River's present ecological condition were based on modification from the natural, with the natural condition seen as the reference condition **(Table 1–2)**.

Table 1–2: Definitions of the Present Ecological State (PES) Categories

Ecological category	Description of the habitat
A	Unmodified. Still in a natural condition.
B	Slightly modified. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically / Extremely modified. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

66. The Present Ecological Status of the sites is provided in **Table 1–3**. In summary, the Present Ecological State of the Poonch within the study area is mostly Category C (moderately modified from natural condition).

Table 1–3: Sites for Gulpur EFlow Assessment

EF Site No.	*Site*	*Description*	*Present Ecological State*
EF 1	Kallar Bridge	Situated upstream of the full supply level of the reservoir	C
EF 2	Borali Bridge	Situated between the weir and the tailrace	C
EF 3	Gulpur Bridge	Situated c. 7 km downstream of the tailrace	C

67. The flow regimes at the EF sites will be affected by the Project in three main ways.

- EF Site 1 flow regime will not be affected, but the river ecosystem at this point will be affected by the barrier effect of Gulpur dam. This will stop or reduce the movement of plants and animals along the river, as explained further below.
- EF Site 2 will be affected by a decrease in river flow as a result of the upstream diversion of water into a tunnel to the power house. It will also be affected by the barrier effect of Gulpur dam, which will have consequences as mentioned above and will also alter the thermal, sediment and physicochemical regimes along the river downstream of the dam.
- EF Site 3 will be affected by releases from the Gulpur tailrace and by the barrier effect of Gulpur dam. This site was used to predict any anticipated recovery of the river ecosystem from the peaking flow releases from the tunnel.

1.6.2 Indicators Used

68. In the DRIFT process, the hydrological simulations form the foundation upon which the biophysical and social predictions of change are built. The EFlow team chose a range of hydrological indicators, and biophysical indicators that they believe respond to flow changes shown in **Table 1–4**.

Table 1–4: Discipline Indicators Used in the DSS

Discipline	Indicators
Hydrology	Mean annual runoff
	Median annual runoff
	Dry season onset
	Dry season minimum 5-day discharge
	Dry season duration
	Wet season onset
	Wet season peak 5-day discharge
	Wet season duration
Hydraulics	Minimum 5-day dry season fish breeding habitat[7]
	Depth
	Minimum 5-day average velocity (across the cross-section)
Geomorphology	Active channel width
	Area of silt/mixed bars (regardless of level of inundation)
	Area of cobble bars (regardless of level of inundation)
	Median bed sediment size (armouring)
	Depth of pools
	Area of secondary channels and backwaters
	Suspended sediment load.

[7] Fish breeding habitat was the number of meters of the cross-section where depth is between 0.25 and 0.5 m, and velocity is between 0 and 0.5 m^3s^{-1}.

Discipline	Indicators
Water quality	Nutrient concentration
	Temperature
Riparian vegetation	Dry bank trees and shrubs
Algae	Periphyton biomass
Macroinvertebrates	Simuliidae
	EPT biomass
Fish	Pakistani Labeo ***Labeo dyocheilus***
	Mahaseer ***Tor putitora***
	Twin-banded Loach ***Botia rostrata***
	Kashmir Catfish ***Glyptothorax kashmirensis***
	Garua Bachwaa ***Clupisoma garua***
	Snow Trout ***Schizothorax plagiostomus (richardsonii)***
Wildlife	Fish-eating wildlife (Otter ***Lutra lutra*** , Common Leopard ***Panthera pardus***)
	Wildlife that drink from the main river (Barking deer ***Muntiacus muntjak***)
	Riverine insectivores (White-capped redstart ***Chaimarromis leucocephalus***)
Management issues (non-flow related)	Selective fishing pressure
	Non-selective fishing pressure
	Mining – sand and gravel
	Mining – cobble and boulder
	Water quality

69. Response curves were then compiled that described the relationships between the driving (flow) and responding (biophysical) indicators. The full system of links between driver and responding indicators forms a complex web of response curves within the DRIFT decision support system (DSS). Each response curve describes the expected impact of a single type of flow or other driving change on the abundance of a single responding biophysical indicator, on a response scale of 0 (no response) to 5 (critically high response). In total, about 106 response curves were created per site for the project and housed in the custom-built Poonch River DSS.

1.6.3 Scenarios Evaluated

70. Scenarios were constructed to assess the impact of the following independent variables:

- Flow: Varying levels of EFlow release from the dam to maintain flow in the segment of the river between the dam and tailrace where the flow is reduced due to diversion of the river into the tunnels leading to the power house. EFlow releases from 4 to 16 cumec were simulated in view of the level of release at which the Project is likely to lose viability.
- Management: Varying levels of protection of the river to improve the integrity of the ecosystem by reducing threats such as illegal fishing and unregulated mining of sand, gravel and boulders from the river bed. Three protection levels were used:

  - Business as usual (BAU) or Poor Protection = increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years. Based on a literature based review of long term regional trends in fish richness and abundance in absence of protection and with anthropogenic pressures, fish populations over a fifty year period are expected to reach a fraction of Present Day levels with Mahaseer population declining to about 10% of Present Day level (90% decline).[8]
  - Protection Level 1 (Pro 1) or Moderate Protection = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time. This level of protection corresponds to protection with limited resources and intermittent availability of funds that the AJKFWD is presently achieving with assistance from the Himalayan Wildlife Foundation. Experience from the past five years from this level of protection indicates that the fish richness and abundance has remained practically stagnant, conservation efforts notwithstanding. In other words, the conservation efforts are only effective to the extent of arresting the decline that would have been experienced under the BAU scenario.
  - Protection Level 2 (Pro 2) or Enhanced Protection = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over time. The increase in fish abundance under this scenario will be of the order of 50%[9] over a 50 year period. The protection measures and the human and financial resources required to achieve this level of protection from the basis of the Biodiversity Action Plan prepared as a part of this ESIA.
- Peaking: One scenario was assumed where the plant was operated in a peaking mode where the turbines are shutown for an extended period in a day to store water the in the dam, and then released through the turbines to generate power in the peak power demand period in the evening.
- Turbine Configurations and Operating Rules: Varying the type, number, and capacity of turbines and associated operating rules to account for EFlow and technical limitations of turbines in terms of minimum operating capacity of a turbine.

71. The EFlow assessment was conducted in the following two phases:

- **Initial Scenarios:** Ten scenarios with varying levels of EFlows were simulated in the initial phase assuming three Francis turbines with a flow range of 33-66 m^3/s (cumec). A constant flow through the turbines on a given day to avoid

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[8] The predicted decrease in abundance of individual fish species over Present Day levels will vary above and below 90%. The reason for this is the predator-prey relationships, resistance to pollution, and differential impact of anthropogenic factors on individual species. For example, the decline will be higher in fish that have a food or recreational value.

[9] The predicted increase in abundance of individual fish species over Present Day levels will vary somewhat above and below 50%. The reason for this is the predator-prey relationships, where increase in abundance of predator fish may lead to decline in that of the prey fish.

peaking was assumed for nine scenarios. A peaking[10] scenario was simulated to assess the impact of a peaking operation on river ecology.

- **Additional Scenarios:** The preparation for the initial EFlow scenarios raised concerns as to whether or not constant EFlow releases were realistic given the design of Gulpur HPP as they would result in sub-optimal efficiencies that would put a strain on the turbines. Ten additional scenarios with varying levels of EFlows were simulated assuming a non-peaking operation. A modified turbine configuration with two Kaplan turbines having a flow range of 20- 100 cumec and corresponding operating rules were adopted to reduce impact on power generation associated with EFlow release.

72. The minimum releases in each scenario were constant releases through the year. In addition, it was assumed that floods that cannot be harnessed by the dam will spill into the downstream river during the wet season. With the current design parameters, discharges greater than 198 cumec will result in spills from the dam. The results of the following combination of initial and additional scenarios were used for the EFlow assessment:

73. **Results used from Initial Scenarios:** These included No-Dam scenarios, scenarios related to EF Site 1, and a peaking scenario. The No-Dam DRIFT simulations were identical for the initial and additional scenarios as changing the turbine design and configuration does not apply in the No-Dam situation. The DRIFT simulations for EF Site 1 were also identical under the initial and additional scenarios as the changing the operating rule associated with turbine design has no impact on the conditions upstream of the dam. In case of peaking scenario, the impacts were so significant that it was considered unnecessary to repeat the scenario with an altered turbine design. The following scenarios from the initial set of scenarios were therefore retained for the EFlow assessment.

1. ND[11]Pro1: No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level 1
2. NDBAU: No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level BAU
3. NDPro2: No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level 2
4. G8PeakBAU An 8.0 cumec minimum release from the Gulpur weir and PEAKING-power releases at the tailrace Protection level BAU.

74. **Results used from Additional Scenarios:** EFlow levels of 4, 6, 8, 12, and 16 cumec were simulated for BAU and Pro 2 protection levels. The following scenarios from the additional set of scenarios were retained for the EFlow assessment.

1. G4OR[12]BAU: A 4 cumec minimum release from the Gulpur weir. Protection level BAU.

[10] In a peaking operation the flow through the turbines is stopped during on a daily basis in the low flow months to accumulate water in the reservoir, and then released for a limited period in the day to generate power to match the period of peak demand which typically occurs in the early evening.

[11] ND = No dam; Pro 1, 2 and BAU refer to protection levels

[12] OR = Operating Rule assumed for the design configuration of two Kaplan turbines.

2. G4ORPro2: A 4 cumec minimum release from the Gulpur weir. Protection Level 2.
3. G6ORBAU: A 6 cumec minimum release from the Gulpur weir. Protection level BAU.
4. G6ORPro2: A 6 cumec minimum release from the Gulpur weir. Protection Level 2.
5. G8ORBAU: An 8 cumec minimum release from the Gulpur weir. Protection level BAU.
6. G8ORPro2: An 8 cumec minimum release from the Gulpur weir. Protection Level 2.
7. G12ORBAU: A 12 cumec minimum release from the Gulpur weir. Protection level BAU.
8. G12ORPro2: A 12 cumec minimum release from the Gulpur weir. Protection Level 2.
9. G16ORBAU: A 16 cumec minimum release from the Gulpur weir. Protection level BAU.
10. G16ORPro2: A 16 cumec minimum release from the Gulpur weir. Protection Level 2.

75. To keep the number of scenarios to manageable level, Protection Level 1 was not run for the release scenarios.

1.6.4 Conclusions of EFlow Assessment

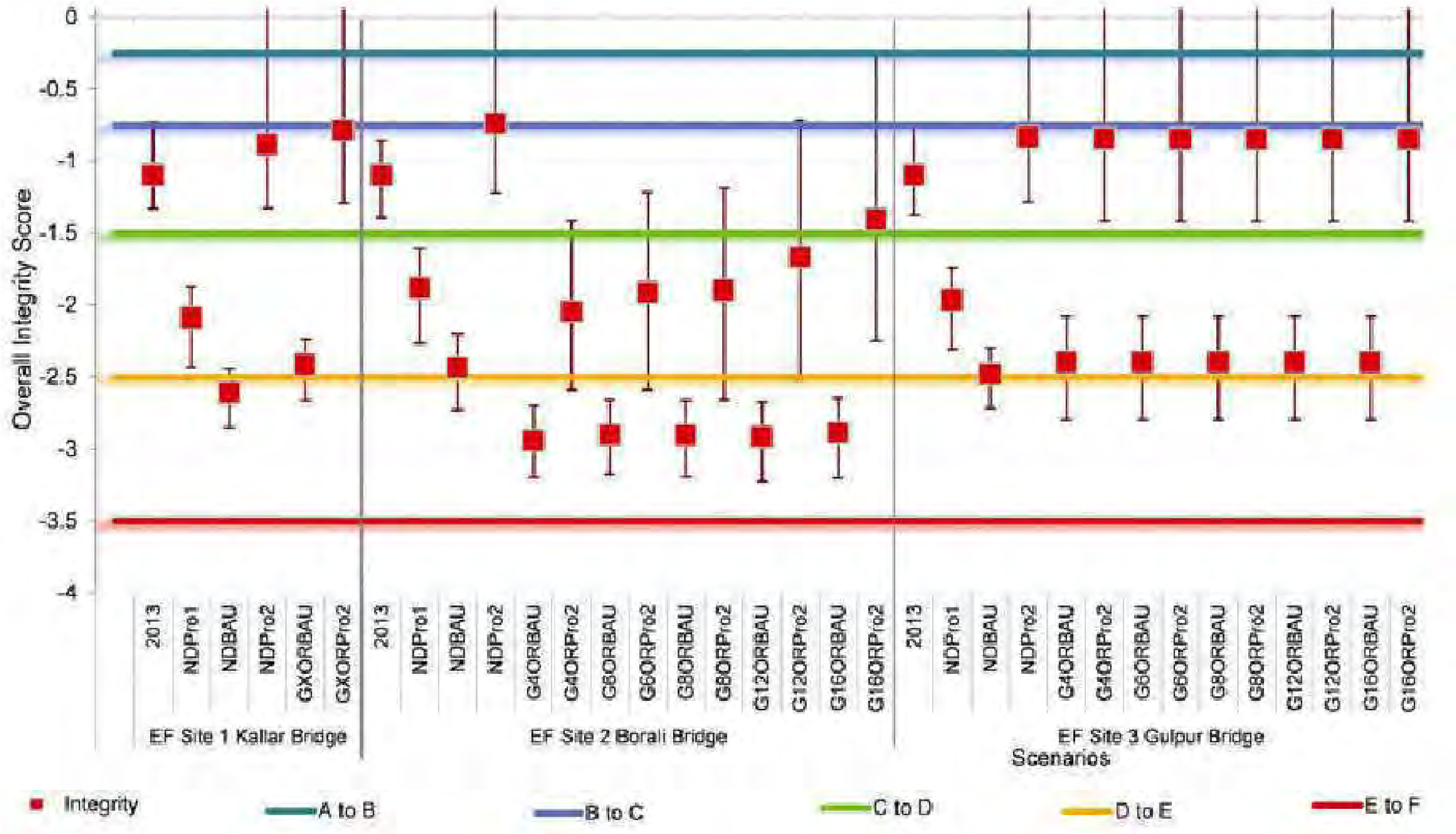
Ecological Integrity

76. **Figure 1–4** summarizes ecological integrity under the scenarios studied.

77. **Without Dam in Place:** With Poor Protection or Business as Usual (BAU) case, the ecosystem integrity of the river which is presently Mid Category C will deteriorate to a Low Category D over the next 52 years at all EF Sites. With Moderate Protection (Pro 1), the river will still deteriorate to a Mid Category D. An enhanced level of protection (Pro 2) will lead to an improvement of about 0.5 in ecological integrity score resulting in Low Category B river. The conditions are expected to change uniformly at all the sites evaluated upstream and downstream the dam.

Figure 1–4: Overall Integrity scores for all Sites and all Scenarios

Baseline (2013) integrity is labelled 2013



78. At EF Site 2, just downstream of the dam:

- The flows will be reduced in the segment of the river downstream of the dam and above the powerhouse due to diversion of the river water into tunnels. The river will deteriorate to a Mid Category E under all BAU scenarios with Poor Protection. In other words, the impact of Poor Protection will be far higher than that of the reduced flows, and increasing minimum flow release from 4 cumec to 16 cumec with Poor Protection will not result in any noticeable improvement in the ecological condition of the river.
- Under Pro 2 or Enhanced Protection, the conditions will improve from Mid Category D with an EFlow in the range of 4-8 cumec to Low Category C with an EFlow of 16 cumec. The improvement is discernible the above 8 cumec.

79. At EF Site 3, downstream of the power station:

- A peaking operation will result in deterioration to a Mid Category E river similar to that at EF Site 2 where the flows are reduced.
- Under BAU or Poor Protection, the river will deteriorate to a low Category D under all minimum release scenarios, for reason similar to those indicated for EF Site 2.
- Under Pro 2 or Enhanced Protection, the conditions will improve to border line between Category B and C, similar to those at EF Site 1 upstream of the dam. In other words, the contribution of Enhanced Protection measures will more than compensate for harm done by the dam.

1.6.5 Impacts on Indicator Fish Species

80. The EFlow assessment covered a study of impact of varying EFlow on indicators listed in **Table 1–4**. **Table 1–5** summarizes the impacts on the indicator fish species under the scenarios evaluated. The discussion in this summary is limited to that on the indicator fish species for two reasons: Fish populations depend on the condition of habitat and directly and indirectly reflect changes in all the other classes of indicators such as hydrology, geomorphology, and macroinvertebrates. The indicator fish species include an Endangered (Mahaseer) and a Critically Endangered (Kashmir Catfish) species. Impacts of the Project on these two species at different assessment sites and under varying flow scenarios are described in this section. The impacts on these two species are indicative of the range of impacts on other species present in the river. The larger Mahaseer feeds in the riffles in and breeds mainly in the shallow tributaries, and takes refuge in river pools in winter. This fish migrates in the seasons as temperature of the water through the length of the river changes. The smaller Kashmir Catfish is sedentary, feeds and breeds in riffles in the main river, and takes refuge in winter in crevices in boulders in shallow waters.

Table 1–5: Impact on Indicator Fish Species under Scenarios Studied

Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.

	NDPro 1	NDBAU	NDPro 2	*G8PeakBAU*	G4ORBAU	G4ORPro 2	G6ORBAU	G6ORPro 2	G8ORBAU	G8ORPro 2	G12ORBAU	G12ORPro 2	G16ORBAU	G16ORPro 2
Mahaseer														
EF Site 1	–60	–96	47		–80	80			–80	80			–80	80
EF Site 2	-55	-92	51		-100	-93	-100	-91	-100	-87	-100	-61	-100	-42
EF Site 3	-59	-94	51	-100	-100	-8	-100	-8	-100	-8	-100	-8	-100	-8
Pakistan Labeo														
EF Site 1	–64	–86	62		–79	69			–79	69			–79	69
EF Site 2	-59	-77	58		-100	-26	-99	-5	-99	-2	-99	5	-98	11
EF Site 3	-59	-87	60	-100	-89	61	-89	61	-89	61	-89	61	-89	61
Kashmir Catfish														
EF Site 1	–3	–62	31		–80	21			–80	21			–80	21
EF Site 2	-8	-62	15		-100	-91	-100	-89	-100	-86	-100	-71	-98	-45
EF Site 3	-8	-62	20	-100	-46	57	-46	57	-46	57	-46	57	-46	57
Twin–Banded Loach														
EF Site 1	4	–64	34	23	–83	23				–83			–83	23
EF Site 2	-1	-54	47		-100	-90	-100	-83	-100	-78	-99	-50	-91	-14
EF Site 3	-1	-53	48	-100	-7	89	-7	89	-7	89	-7	89	-6.9	89
Garua Bachwaa														
EF Site 1	-66	–99	73	8	–100	8				–100			–100	8
EF Site 2	-60	-94	86		-95	-89	-95	-89	-95	-88	-95	-53	-95	-9
EF Site 3	-60	-96	80	-100	-99	64	-99	64	-99	64	-99	64	-99	64
Snow Trout														
EF Site 1	–24	–40	19	29	–25	29				–25			–25	29

Mahaseer

81. **With no dam in place**, at all EFflow Sites upstream and downstream of the dam the population of Mahaseer is predicted to decline by about 95% in the next 52 years if the protection is poor under BAU Scenario. It is predicted to decline by about 58% under Pro 1 or Moderate Protection scenario, and improve by about 50% under Pro 2 Enhanced Protection scenario. The results show that a meaningful and effective protection system is essential for recovery of this specie in the river and limited or half way efforts will not be useful in the long term.

82. **At EF Site 1 with dam in place**, the population of Mahaseer is predicted to decline by about 80% with Poor Protection under BAU Scenario. With Enhanced Protection under Pro 2 Scenario, the population is predicted to improve by about 80%. The dam will benefit the population of Mahaseer at EF Site 1 upstream of the dam, mainly because the two important breeding areas for this fish namely Rangar and Bann Nullahs are located upstream of the dam. The dam will act as a barrier to movement of fish downstream, and will retain the fish hatched in the nullahs. The impact of the barrier effect of the dam upstream of the dam, however, will be small in comparison to the impact of protection measures or lack thereof.

83. **At EF Site 2 with dam in place**, Mahaseer will practically be eliminated under the Poor Protection or BAU Scenario. Assuming Enhanced Protection as in Project design, a minimum release of 4 cumec from the dam is predicted to improve the conditions only marginally, with 7% of the fish surviving (decline of 93%), while a release of 8cumec will improve the survival to 9% (91% decline). However, an increase of minimum release to16 cumec from the dam could improve the survival of fish to 59% (decline of 41%). **It is important to note that these survival rates at EF Site 2 apply to stretch of 700m under Project design where the dam and power house are located in close proximity of each other with a short length of power tunnel**.

84. At EF Site 3 with dam in place:

- Mahaseer will again practically be eliminated under the Poor Protection or BAU Scenario. The principle reason for this is that in addition to impact of Poor Protection which is a dominant factor (decline of over 90% with Poor Protection or BAU under No-Dam scenario), the main breeding areas of Mahaseer including Bann and Rangar Nullahs are located upstream of the dam. The barrier effect of the dam combined with Poor Protection will result in elimination of Mahaseer fish from the river.
- With Enhanced Protection under Pro 2 Scenario, the decline of Mahaseer will be restricted to 8% of present day. Additional mitigation measures such as stocking of Mahaseer from the hatchery located in Mirpur adjacent to Mangla reservoir (not included in DRIFT modelling) are proposed as a mitigation (**Section 12**, Environmental Management and Monitoring Plan) to maintain the population of Mahaseer to at least present day levels.

Kashmir Catfish

85. **With no dam in place,** Kashmir Catfish population is expected to decrease by around 60% under Poor Protection or BAU Scenario. However, the population is predicted to increase by about 20% under Pro 2 Scenario. The highest increase in population is expected at EF Site 1, followed by Site 3 and 2, the differences being

attributable to habitat conditions prevailing at the sites. Its population will remain relatively unaffected under present level of protection or Pro 1 scenario.

86. **At EF Site 1 with dam in place,** the population is expected to decrease significantly by around 80% under the BAU Scenario. However, under Pro 2 Scenario, the fish population is predicted to increase by about 21%. The Kashmir Catfish does not benefit from Enhanced Protection as much as the Mahaseer and Pakistan Labeo as it is not a target of subsistence or recreational fishing, and can take refuge in the crevices in the boulders where it is less likely to be captured by netting.

87. **At EF Site 2 with dam in place**, Kashmir Catfish fish will practically be eliminated under the Poor Protection or BAU Scenario. Under the Pro 2 Scenario, a minimum release of 4 cumec from the dam is predicted to improve the conditions only marginally, with 9% of the fish surviving (91% decline), while a release of 8 cumec will improve the survival to 14% (86% decline). However, an increase of minimum release to 16 cumec from the dam could improve the survival of fish to 55% (decline of 45%). Being smaller in size, this fish benefits more from low flows due to increase in habitat availability. It also benefits from absence of bigger predators such as Mahaseer which do not benefit as much from increasing flows.

88. **At EF Site 3 with dam in place,** the decline in fish population is expected to be 46% with Poor Protection under the BAU Scenario. This affect is relatively lower in comparison to that on the Mahaseer because at EF Site 3 the fish benefits from the lower predation associated with decline in population of Mahaseer. Under Pro 2 Scenario, the fish population is expected to rise by 57% which is a significant increase. The fish will be eliminated under the Peaking Scenario due to instability in the flows and daily reduction in habitat.

1.7 Assessment of Impacts

1.7.1 Assessment of Impacts on Physical Environment

89. The key physical environmental aspects that may be affected by the Project activities are the following:

- Noise and dust associated with construction
- Generation of waste by the Project activities during construction
- Use of water for Project activities during construction
- Traffic congestion during construction phase.

90. The baseline conditions for each physical aspect were analyzed and the impact on the environment due to construction and operation of the Project was estimated. The significance, time-scale and spatial-scale of the impact expected were predicted and adequate mitigation measures to be taken were provided. To ensure the implementation of the mitigation measures, monitoring measures have been provided.

91. Impact due to waste disposal during construction is critical because it is expected that approximate 400 people will reside on the construction site. The camping area around Project will generate wastewater and solid waste. Also, the construction waste generated is of concern and an assessment of the impact on physical environment was carried out. The current particulate matter concentration near the Project facilities is below the NEQS limits but the risk of impact due to dust from construction activities such as material movement and batching plant operation is important. Other impacts such as

noise nuisance and traffic congestion are of concern due to movement of large number of construction vehicles in the area.

92. Measures included in the EMP to manage the impacts include control of soil erosion, treatment of wastewater from camp and office facilities, proper disposal of excavated material that cannot be used in construction, solid waste, control of dust through regular sprinkling, limiting operations that generate noise disturbance to day time, sourcing of water from the river, and springs where the access of community to potable water is not affected, and management of traffic to avoid congestion on the public roads. In addition, regular contact will be maintained with the local community to ensure that their grievance are recorded and addressed promptly.

1.7.2 Assessment of Impacts on Terrestrial Ecological Resources

93. Site clearance and construction of Project infrastructure and the area submerged due to creation of the reservoir (**Segment C in Figure 1.2)** will result in immediate and direct modification of land and a loss of terrestrial habitat (Area of Habitat Loss) leading to loss of plants and animals in this area**.** The Area of Habitat Loss is estimated at 313 hectares consisting largely of riparian habitat and scrub forest. No threatened flora or fauna species were found or reported from this Area of Habitat Loss. Signs of the Otter ***Lutra lutra*** (Near Threatened in IUCN Red List) have not been observed in this area. Moreover, no critical habitat, threatened or unique ecosystem was identified in this area. The habitats found in this Area of Habitat Loss are homogenous and widespread. They hold no significance for the survival of endemic or restricted range species. Therefore, the magnitude of impact of habitat loss and associated loss of flora and fauna is considered minor. Recommended mitigation measures include minimizing vegetation removal and re-vegetating cleared areas not occupied by Project infrastructure.

94. Construction of Project infrastructure will result in disturbance to the floral and faunal species around the Project facilities due to blasting, noise, vibrations, illumination, air pollution and dust. The Zone of Impact for Terrestrial Ecological Resources (**Segment C in Figure 1.2**) consists of the Project facilities and a 1 km potential impact zone around these facilities to account for an area in which the ecological resources may be impacted by Project related disturbances. Habitat loss, habitat fragmentation, sensory disturbances may result in a decrease in species abundance and possibly change species diversity within this zone and the habitat types found in this Zone of Impact will be affected. However, no terrestrial critical habitat or threatened or unique ecosystem was identified in the Zone of Impact. Moreover, the habitats in this Zone are homogenous and widespread. They hold no significance for the survival of endemic or restricted range species. Therefore, the decrease in biodiversity and ecological function caused by construction related disturbances is of minor magnitude. Mitigation measures include following the measures outlined in the Construction Management Plan.

95. Influx of Project staff and contractors during the construction and operations phase of the Project may increase encroachment into pristine areas, increase the incidence of Project staff and contractors in hunting activities and wildlife trade. Mitigation measures include regulations for Project staff and contractors to avoid illegal poaching and providing awareness to the workers on relevant government laws.

96. The operation of the hydropower plant will result in some potential disturbances to species, which may exacerbate the effects of habitat loss and decreased species abundance. These disturbances include noise and light. However, considering the fact that no threatened ecosystem or species has been reported from the Zone of Impact, the

magnitude of this impact is considered minor. Mitigation measures include implementation of the Biodiversity Action Plan to preserve the ecological integrity of the Poonch River Basin.

1.7.3 Socio-Economic Impacts

97. MPL has produced a Land Acquisition and Resettlement Plan (LARP) which will address all issues related to land acquisition, resettlement and related impacts. Therefore, land ownership and resettlement impacts are not covered in this report. The potential socioeconomic impacts of the Project can be categorized into the following three impact groups:

- **Macroeconomic:** Impacts related to the national economy;
- **Local Livelihoods and Wellbeing**: Economic benefits to the community residing in the vicinity of the Project; and
- **Socio-cultural:** Social and cultural impacts on the local communities due to the Project.

Macroeconomic

- The gap between supply and demand has crossed 5,000 MW. The proposed Project will supply the much needed power to reduce the current gap.
- The Project will invest in equipment, construction materials, infrastructure and human resources. This investment and the return generated from the Project will be circulated within the AJK economy.
- Government revenues collected during the operational phase of the project in the form of taxes and royalties will benefit the national economy

Local Livelihoods and Wellbeing

- Direct, indirect and induced employment at the domestic and local levels, resulting in increased prosperity and wellbeing due to higher and stable incomes of people
- Increase in the stock of skilled human capital due to transfer of knowledge and skill under the Project resulting in enhanced productivity
- Increase in local incomes and wellbeing due to increase in catch of fish following protection and creation of favorable habitats for the fish in the Poonch River
- Loss of income from sand and gravel mining due to change in pattern of sediment deposition following construction of the dam.

Sociocultural

- Increase in population due to in-migration of job seekers (in-migrants) leading to pressure on existing infrastructure and services
- Disputes over distribution of Project benefits within local community and between local community and the in-migrants, resulting in social unrest

- Potential social unrest in the Project area due to conflicting socio-cultural norms amongst the local community and in-migrants
- In-migration of job seekers leading to cultural and ethnic diversity, promoting tolerance and awareness in the Project area
- Increase in opportunities for recreational fishing due to increase in population of fish.

98. A number of measures to enhance the positive benefits of the Project have been included in the Environmental Management and Monitoring Plan (EMMP) for the Project. A Sediment Mining and Management Plan will be prepared and implemented along the Poonch River. Scope and Terms of Reference for this plan have been provided in the ESIA. The plan will ensure that a balance is achieved between meeting community needs for sand and gravel and integrity of aquatic habitat in River Poonch such that the habitat is not excessively damaged due to uncontrolled mining activities on the river bed. MPL will produce an annual Corporate Social Responsibility (CSR) plan, which will provide detailed information on method, roles and responsibilities of interaction with the local community, mitigation of socio-cultural impacts such as social ills, socio-cultural conflicts and enhancement of positive impacts such as recreational opportunities due to increased fish catch in the area.

1.7.4 Climate Change and Green House Gas Emissions

99. This is a renewable energy project, which is expected to have a net positive impact by offsetting energy sourced from fossil fuel power projects. A climate change study was conducted to evaluate climate change impacts on issues that are relevant to the operation of the hydropower plant. The climate change study included a risk screening, analysis of downscaled Global Climate Models (GCM) results, analysis of hydrological changes, estimates of reservoir sedimentation, projected climate change impacts on water supply, greenhouse gas (GHG) emissions from the Gulpur HPP reservoir, and evaluation of disease risks.

100. It is indicated that the amount of GHG emissions released from the reservoir changes over time due to a variety of factors that include climate, water flow through the reservoir, and decomposition (i.e., carbon content) of the submerged biological matter. Of the studies presented, the range of annual emissions of a HPP similar in size and location to the Gulpur HPP could be between 1,407 tons and 27 million tons. However based on terrain, dry weather and limited organic matter (7% coverage largely scrub vegetation), it is likely that reservoir's GHG emissions will fall on the lower end of the spectrum and will be outweighed from the carbon reduction emissions generated. To validate this, an estimation of CO2-eq was carried out; an expected 278,000 tons CO2-eq[13] will be generated due to inundation of existing vegetation. The estimated construction related GHG emissions are 110,000 tons CO2-eq. These emissions will be outweighed by the carbon reduction emissions due to displacement of fossil fuels presently being used for power generation in the country.

101. The central tendency of 16 statistically downscaled models, in the context of Annex I of the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5), over the project area suggests little overall change in temperature, consistent with the regional analysis. In terms of central tendency, the models suggest

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[13] Based on an estimated dry biomass per unit area for shrub and grasses of 0.75 kg/m^2 in the reservoir submerged area and complete decomposition by methanogenic bacteria.

that the project area will likely experience an air temperature increase of around 1° C by the 2020s and more than 2°C by the 2050s, while average annual precipitation changes are likely to be small. Nevertheless, multiple models and studies suggest that there might be an increase in the extreme precipitation in the region.

102. The overall scale of the Gulpur HPP, the Project can be considered to be at medium risk from climate change. As the Gulpur HPP is currently designed, there is no provision for adding spillway capacity in the future. The dam is designed to withstand current PMF (i.e. design flood), which is a highly conservative design parameter. If a flood were to be larger than the design flood in the future, one would expect overtopping. Analysis performed by the Project engineers suggests that even in the case of catastrophic failure of the dam, downstream water flows would not reach inhabited locations. Furthermore, because this is a run-of-the river Project, with limited water storage, it allows some resiliency through changing operational criteria to adapt to future flow conditions that differ from historical patterns. Therefore the design and operation will provide some resilience to climate change.

103. Besides the flooding, the hydrologic analysis also considered changes in streamflow quantities and timing which are influenced by changing precipitation patterns (including the monsoon) and snowmelt timing. The change in the timing and seasonality of the discharge is of much greater consequence to the future operation of the dam in comparison to the potential human demands upstream which constitute about 5% of the discharge and analysis shows the Gulpur HPP watershed itself is not a major user of irrigation water and irrigation demand change upstream is unlikely to reduce inflows into reservoir. Evaporation changes in the Gulpur HPP basin may occur as a result of climate change, even in the absence of irrigation demand. Flows in February and March are higher and flows in May and June are lower, both as a result of earlier snowmelt. This change is an important consideration for future hydropower operations, because some of the peak electricity demand months in May and June also correspond to lower flows.

104. The changes in monthly suspended sediment loads display a non-uniform seasonal pattern. Future projections are larger than baseline values in March, April, and August but generally smaller in May and June. The 2040 and 2070 climatologies generally display increased variability relative to the baseline period. At the yearly level of aggregation, the baseline and 2040 climatologies display a very similar distribution, but the variability of the data is increased in 2070 climatology with more instances of large annual loads relative to the baseline and 2040 periods. However, in light of existing plans to flush sediment build-up every eight years, it appears that the risks of substantial increases in reservoir sedimentation rate due to climate change are small.

1.7.5 Cumulative Impact Assessment

105. The following areas and aspects were covered in the cumulative impact assessment carried out for the Project:

- The Strategic Environment Assessment (SEA) perspective for development of hydropower in the AJK
- Hydropower projects planned in Poonch River basin
- Ecosystem services of concern:
  - Mining of sand, gravel, and boulders from the river bed by the communities
  - Subsistence and recreational fishing

106. An SEA for the development of hydropower potential in the AJK was prepared by the IUCN in 2014. The findings of the SEA suggest that the hydropower potential in the Jhelum and Neelum rivers which is substantial (about 7,000 MW) could be developed at a comparatively lower cost to environment, and caution needs to be exercised while developing the potential in Poonch River in view of its high environmental value and a relatively smaller contribution it can make to the national economy (about 470 MW). However, the country is presently facing a shortage of capital due to its risk rating, and the projects proposed in Jhelum and Neelum rivers will take much longer to develop as they are larger in size and require significantly larger capital outlay. Given these constraints and shortage of power in the country, the Project is considered to be an acceptable option amongst currently available alternatives.

107. There are four hydropower projects planned on the Poonch River in AJK, each with a capacity of about 100 MW, while one project of 37 MW is being implemented in the Indian Administered Kashmir. If all the proposed projects are constructed and assuming a non–peaking operation, the hydrology of the river will be impacted[14] in all but three short segments of combined length of 12 km or 8% of the total length of the river of 148 km from the Parnai dam to the Mangla reservoir. After construction of four hydropower projects as planned in AJK, the ecology of the entire length of the river in the basin in AJK will be impacted significantly and altered irreversibly. With sequential changes in the hydrology of the river and the barriers that will be constructed, the ecology will not be able to stabilize and new reservoir based ecosystems will not get time to get established. There will be no river left in practical terms, and stretch of the river in AJK will consist of a series of lakes and low flow sections. Otter will be eliminated from the original course of Poonch River. Residual biota will survive in the tributaries, where it will be at high risk from hunting and other anthropogenic disturbances such as sand and gravel extraction. The ecosystem of Poonch River will be permanently degraded and all essential functions of the original ecosystem will be lost.

108. The Endangered Mahaseer will survive mainly in the segment upstream of the Sehra dam and in between Gulpur and Kotli dams where it can breed in the Bann and Rangar Nullahs (tributary streams). It will be highly vulnerable to exploitation in these tributaries as the streams tend to be highly accessible and additional efforts will be required to maintain protection. The Critically Endangered Kashmir Catfish requires a river habitat for survival; it will therefore not survive in the reservoirs created by the HPPs. The conditions for this fish will not be any better in the low flow sections downstream of the dams, where survival rates which would normally be of the order of 10 – 25% for a single project on the river will drop to 0–5% due to habitat partitioning. This fish will therefore most likely be exterminated form Poonch River if all the five projects are built.

109. Communities depend on the Poonch River for supply of construction materials, and mining of sand and gravel is spread over the entire stretch of the Poonch River in AJK, and in downstream segments of three main tributaries, the Bann, Rangar, and Hajeera Nullahs. Following the construction of planned hydropower projects, the pattern of sediment deposits will become less uniform through the length of the river, with higher level of deposits occurring at the mouth of the reservoirs and just downstream of the dams. A sustainable Sediment Mining and Management Plan is proposed in this ESIA that will minimize the impact on the river ecology while meeting the requirements of the

[14] The reservoirs of the RoR projects have a limited storage capacity. However, some variations in flow may occur as the levels in the reservoirs fluctuate over one to two day period.

community. For this approach to work where multiple dams on a river are envisaged, it is important that it be followed in all the dams in the basin.

110. Cumulative impact on recreational and subsistence fishing will be in proportion to that on the population of Mahaseer fish. Both recreational and subsistence fishing are likely to cease once the fish populations drop below 40% of the present day. This condition will exist in over 80% of the river downstream of the LoC if all the planned projects are built, and will extend across the LoC as well if the Parnai HPP is operated in a peaking mode. Thus, with all five HPPs in place, recreational fishing is expected to cease and subsistence fishing will be confined to a few sections of the river where it is likely to cease as well due to overfishing.

111. The AJK Fisheries and Wildlife Department (AJKFWD) granted permission for construction of the Project in the Poonch River National Park on the condition that a Biodiversity Action Plan (BAP) be developed that will achieve betterment of the national park. In addition, the Department has taken a principled position in writing that hydropower projects on Poonch River will be allowed only if they can demonstrate betterment of the park or net gain and for subsequent projects the implemented BAP for the Gulpur project will be considered as a baseline. A policy framework for management of cumulative impacts of hydropower projects in Poonch River is therefore in place. Tracking of status and design of projects proposed on the Poonch River has been included in the BAP prepared for the Project.

1.8 Analysis of Alternatives

112. The following alternatives were analyzed from the economic and environmental perspectives:

1. No project option
2. Alternative options for power generation
3. Options for project location and layout
4. Peaking vs non-peaking operation
5. Non-Flow or management alternatives
6. Balance between environmental degradation and economic benefit
7. Options for transportation of equipment to project site

113. In view of the current power shortages in the country, the no-project option will have a negative impact on the economy. The Project avoids fossil fuel based power generation which has comparatively higher impact on air quality and climate change.

114. A literature review of long term regional trends in fish richness and abundance in absence of protection and with anthropogenic factors fish populations over a fifty year period are expected to reach a fraction of present day levels. The present level of protection corresponds to protection with limited resources and intermittent availability of funds that the AJKFWD is presently managing with assistance from the Himalayan Wildlife Foundation. Experience from the past five years from this level of protection indicates that the fish richness and abundance has remained practically stagnant. In absence of the Project and without a sustainable resource base for protection as envisioned under the Project through the implementation of the Biodiversity Action Plan, the ecology of the Poonch River runs a high risk of decline. The Project aims to achieve

'net gain' for biodiversity consistent with ADB and IFC guidelines through implementation of a Biodiversity Action Plan which will benefit the environment in the Poonch River.

115. The alternatives to the proposed Project include power generation from LNG/imported natural gas based combined cycle gas turbines (CCGTs), and fuel oil based diesel engines. In addition, green field thermal projects and other options such as nuclear, run-of-the-river hydropower, or wind and solar based renewable energy power plants at other suitable locations could also be considered as the project alternatives. Given the higher life cycle cost of other options, constraints in development of power capacity in the country, and shortage of power in the country, the Project is an acceptable option amongst currently available alternatives.

116. The following were the principal options considered for the location and layout of the Gulpur Hydropower Project. Option 2 which was an intermediate configuration in terms of the location of the dam and the tunnel compared to other options considered was found to be technically not feasible and did not offer any significant socioeconomic or economic advantage over Option 1 and was therefore dropped early in the analysis.

- Option 1: Dam located just downstream of the confluence of Bann Nallah and Poonch River, and a 3.1 km diversion tunnel located in Bann Nallah
- Option 3: Dam located about 6 km downstream of the location proposed under Option 1and upstream of the power house in Option 1, with two or three 180 m diversion tunnels connecting to the power house.

117. Option 3 was selected in preference to Option 1 as a basis for the design of the Project for the following reasons:

- The Poonch River provides habitat for 37 fish species, several species of macro-invertebrates and algal flora species. At least 12 of the fish species are species of special concern as they are endemic to Pakistan, are included in the IUCN Red List 2013[15] or have importance as being commercially important food fish. One fish species Mahaseer ***Tor putitora*** is listed as Endangered in the IUCN Red List 2013 while the Kashmir Catfish ***Glyptothorax kashmirensis*** is listed as Critically Endangered. Recognizing the aquatic biodiversity and the prevailing threats to it, Poonch River was notified as a national park by the government of AJK in 2010. For these reasons, Poonch River was classified as a Critical Habitat as defined by the IFC's PS6 and ADB SPS, requiring the Project to achieve 'net gain' in biodiversity. IFC and ADB as well as the AJKFWD emphasized the need to design the project to minimize the ecological impacts of the project and development of a robust strategy to achieve the net gain in biodiversity.
- Under Option 1, approximately 6.1 km of the River will experience low flows due to operation of the Project (6% of the Poonch River length from LoC to Mangla reservoir) while in Option 3, only 0.7 km of the River will be affected by these low flows (0.7% of the Poonch River length from LoC to Mangla reservoir). From an ecological standpoint, the negative impact on the ecological resources of the Poonch River will be less for Option 3 compared to Option 1 as the impacted length of the river is less for Option 3.

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[15] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 26 October 2013.

- During the breeding season, Mahaseer ***Tor putitora*** migrates into the tributaries (nullahs) of the Poonch River for spawning including the Bann Nullah and Rangar Nullah (**Figure 1-2**). The construction of a dam, as envisaged in Option 1, at the confluence of Poonch River and the Ban Nullah would disrupt this breeding migration and negatively impact the population of the Mahaseer ***Tor putitora.*** Under Option 3, the Project facilities will be located about 6 km downstream of Option 1 location. The breeding grounds of Mahaseer ***Tor putitora*** particularly in the Ban Nullah will not be directly affected by Project operations under Option 3.
- The total submerged area (including the present river) will be approximately 320 hectares for Option 1 and 292 hectares for Option 3. For Option 3, comparatively less terrestrial habitat will be submerged and consequently there will be a lower negative impact on the terrestrial ecology.
- Resettlement under Option 3 will be minor in comparison to that for Option 1.
- For Option 1, a new road approximately 1.5 km long was planned to be built from the existing blacktop road to the inlet of the power tunnel in relatively undisturbed pine and scrub forest. For this, vegetation would have to be cleared, and trees cut. For Option 3, a shorter road of 650m length is required.

118. The powerhouse can be operated in either a peaking or a non-peaking mode in the winter season when the flows into the reservoir drop much below the capacity of the power house. With a peaking operation low flows are extended downstream of the power house in the period the power house is shut down to accumulate water in the reservoir upstream. The river ecology which is adapted to normal daily and seasonal variations in flows is severely impacted by the daily long dry spells. A peaking operation will result in deterioration starting from a Mid Category C river (Moderately Modified), under which loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged to a Mid-Category E river (Seriously Modified) under which the loss of natural habitat, biota and basic ecosystem functions is extensive. There will therefore be no possibility of achieving net gain under a peaking operation. A non-peaking operation of the powerhouse was therefore adopted for the Project.

119. Under the management options, three protection levels were studied:

- Business as usual (BAU) or Poor Protection
- Protection Level 1 (Pro 1) or Moderate Protection
- Protection Level 2 (Pro 2) or Enhanced Protection

120. Achievement of net gain at basin level as required under ADB and IFC Guidelines will be possible only if good protection levels as envisaged under Pro2 scenario are put in place. Preparation and successful implementation of a Biodiversity Actin Plan (BAP) that makes this possible was therefore considered essential for compliance with ADB and IFC Guidelines and made a part of this project.

121. To compare the economic impact and ecological benefit expected by increasing the minimum environmental flow, loss in power generation was carried out for varying levels of EFlows and compared with decline in populations of Mahaseer and Kashmir Catfish in view of their conservation importance. This analysis was conducted for the 700m low flow section downstream of the dam only, as the population of the fish and integrity of the ecosystem will improve overall both upstream of the dam and

downstream of the power house after implementation of the BAP. The results of combined ecological and economic analysis show that when minimum flow is increased from 4 cumecs to 8 cumecs, the benefit to Mahaseer and Kashmir Catfish is not significant. However, when the minimum flow is increased from 8 cumecs to 16 cumecs, a noticeable benefit to their survival in the low flow segment of the river downstream of the weir area is predicted. The financial impacts however increase on a linear scale as the EFlow is increased. Loss in power generation is estimated at 4.0%, 7.8%, and 14.8%, for EFlows of 4, 8 and 16 cumecs respectively. Since only a small segment of the river 700 m in length is impacted and the Project aims to achieve net gain biodiversity through the length of Poonch River in AJK through implementation of the BAP, an EFlow of 4 cumec for the Project where the financial return of the project are not severely impacted was agreed upon with the concerned stakeholders including the AJKFWD.

1.9 Consultations

122. As part of the Environmental Impact Assessment process, consultations were undertaken with communities and institutions that may have interest in the proposed project or may be affected by it. A basin wide study approach was used for the ESIA of Gulpur Hydropower therefore 11 rural communities were consulted along the Poonch River. In addition to the Potentially Affected Communities, local government and local NGO officials were also consulted. Consultations with the Project stakeholders were undertaken during the third and fourth week of February 2014. The main document for distribution to stakeholders during the consultations was the Background Information Document (BID) that informed the stakeholders about the ESIA process and provided a background about the Project. The BID was made available in English and Urdu to suit the language preferences of different stakeholders. The feedback from the communities was recorded and the detailed log of consultations with the attendees list was prepared. Separate meetings with institutional stakeholders were arranged in Kotli, Islamabad and Muzaffarabad. The following is a summary of the concerns raised by the stakeholders:

123. Resettlement and Related:

- Adequate compensation should be provided in case of loss of land/property due to the inundation by the reservoir or construction of project facilities such as camping site.

124. Related to Physical Environment:

- There may be noise and disturbance during construction and blasting. Contractors should ensure that blasting activities are avoided at night and controlled blasting is carried out
- Construction activities may increase dust in the area and the local people may get sick

125. Social and Other Issues:

- The Project authorities will not follow mitigation measures proposed for the project.
- Villagers should be given employment opportunities in the project
- The project management of the power plant should ensure that the health and livelihoods of the locals are not be affected by the project.

- Local villages should get uninterrupted supply of electricity at subsidized rates. The power produced from the Gulpur Hydropower Project should first attend to the local power demand.
- Construction of reservoir and changes in flow may result in limited availability of sand mining sites. Alternate sites should be provided to the locals dependent upon sand mining for livelihood.
- In most of the villages, the stakeholders mentioned problems due to lack of development. The amenities that were demanded included link roads, school, teachers in school, clean drinking water, health facilities, sewerage system, rehabilitation of disabled people, and improvements of housing.

126. Wildlife and Biodiversity Issues:

- Reduced flow downstream of the dam will result in lesser habitat available for the fish
- Reduced flow downstream may increase the concentration of contaminants in river water

127. The concerns of the stakeholders were addressed in the ESIA, except for resettlement related issues which will be addressed in LARP to be prepared by MPL.

1.10 Grievance Redress Mechanism

128. The grievance redress mechanism proposed for the Project will meet the compliance requirements laid out under the relevant national legislation and will be in accordance with the environmental and social safeguards laid out by the lenders and Pakistan Environment Protection Act 1997. Under the Project the following will be established or appointed to ensure timely and effective handling of grievances:

- A Public Complaints Unit (PCU), which will be responsible to receive, log, and resolve complaints; and,
- A Grievance Redress Committee (GRC), responsible to oversee the functioning of the PCU as well as the final non-judicial authority on resolving grievances that cannot be resolved by PCU;
- Grievance Focal Points (GFPs), which will be educated people from each community that can be approached by the community members for their grievances against the Project. The GFPs will be provided training by the Project in facilitating grievance redress.

129. The stakeholders will be informed of the establishment of the PCU through a short and intensive awareness campaign.

1.11 Environmental Management and Monitoring Plan

130. The Environmental Management and Monitoring Plan (EMMP) for the ESIA of this Project summarizes the organizational requirements, management and monitoring plans to ensure that the necessary measures are taken by MPL to avoid potentially adverse effects and maximize potential benefits of the Project as identified in preceding section of the ESIA and to operate in conformance with applicable laws and regulations of AJK, as well as the policies of international financial organizations such as ADB and IFC.

131. A framework for an Environmental and Social Management System (ESMS) has been provided. Specific frameworks and management plans developed for the Project include the following:

- Construction Management
- Air Pollution Control
- Waste Management
- Muck Disposal
- Spill Contingency
- Construction Labor Management
- Traffic Management
- Health and Safety
- Emergency Preparedness

Biodiversity Action Plan

132. The Biodiversity Action Plan is a critical element of the Gulpur Hydropower Project. It has been formulated to address regional biodiversity concerns and to achieve net gain under IFC's Performance Standard 6 and Safeguards Requirement (SR) 1 of ADB's SPS. It addresses the implementation of the Protection Level 2 to conserve, protect and restore the biological resources of the Poonch River Basin. The Draft BAP was shared with the relevant stakeholders particularly the AJK Fisheries and Wildlife Department (AJKFWD), the NGOs working in the area and relevant communities for their comments and suggestions. It has now been accepted and agreed upon by all the stakeholders. The strategy for implementation of the BAP includes:

- A framework Agreement between government of AJK and MPL defining the roles and responsibilities of the two parties in implementation of the BAP and the specific responsibilities to be assigned to AJKFWD for implementation.
- Putting in place a protection system, consisting of an effective watch and ward for the national park and adjacent areas, to fill the gaps in the existing system
- Establishment of two wildlife management offices along the Poonch River to provide a base for the watch and ward staff to operate
- Advice and support for Mahaseer hatchery to be developed by the AJKFWD for stocking of fish downstream of the Project powerhouse
- Implementation by an independent Implementation Organization selected by MPL in consultation with the AJKFWD.
- Active leadership and support from the AJKFWD by making available existing staff for protection, assistance in coordination with other government line departments such as police and district administration
- Commitment by AJKFWD to provide legal authority to the staff of the Independent Organization for exercising powers under wildlife legislation
- Regular oversight and monitoring by a Management Committee set up for implementation of the BAP

- Monitoring on a long term basis by an independent Monitoring and Evaluation Consultant

CSR Plan and Socioeconomic Management Plan

133. MPL will produce an annual Corporate Social Responsibility (CSR) Plan, which will provide detailed information on method, roles and responsibilities of interaction with the local community, mitigation of socio-cultural impacts such as social ills, socio-cultural conflicts and enhancement of positive impacts such as recreational opportunities due to increased fish catch and cultural diversity in the area. MPL will prepare a Stakeholder Engagement Plan as a part of the ESMS for the Project. The proposed Social Augmentation Plan will include the following social augmentation/enhancement measures:

- Providing water supply facility
- Skills Training and Capacity Building Activities
- Health Care Facilities
- Implementation and Operation

Monitoring Program

134. The proposed monitoring program includes regular monitoring of construction and commissioning activities for their compliance with the environmental requirements as per relevant standards, specifications and EMMP. The purpose of monitoring will be to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction. The BAP includes a comprehensive monitoring and evaluation program to assess the effectiveness of implementation of the BAP and achievement of targets for net gain in biodiversity at the basin level.

Environmental Training

135. Personnel, including contractors' personnel, working for or on behalf of the Project will be informed of potential significant environmental impacts and risks associated with the Project by means of awareness training. Visitors to Project sites will also receive awareness training as part of site induction training.

Cost Estimates

136. Cost estimates were prepared for all the mitigation and monitoring measures proposed in the EMMP. The cost represented in **Table 1–6** is indicative only. This budget has been calculated for a 48 month construction phase. Staff cost for monitoring of physical environment during the construction and operation period has not been included as this function will be performed by the designated staff of MPL and will be accounted for in the Project cost. The operational cost shall be calculated before the completion of construction phase after consultation with stakeholders and regulatory authorities. The cost for land acquisition and resettlement related activities are not included in this ESIA.

Table 1–6: Indicative Budget for Mitigation and Monitoring

No	Activity	Amount, USD
Capital and One Time Costs		
1	Implementation of Biodiversity Action Plan (BAP)	186,941
2	Setting up the Monitoring and Reporting System for BAP	43,200
3	Equipment for Monitoring of Impacts on Physical Environment[16]	7,353
	Total, USD	**273,494**
Annual Recurring Costs		
1	Implementation of BAP	74,955
	Monitoring and Evaluation of BAP	69,400
	Total, USD	**144,355**

[16] Equipment for monitoring of noise and dust fall.

2. Introduction

137. Mira Power Limited (the 'MPL' or the 'Company') is an Independent Power Producer (the 'IPP') which is planning to develop Gulpur Hydropower Project (Project) in the Azad Jammu & Kashmir (the 'AJK'). The Project will utilize the flow of Poonch River, the full length of which within AJK has been notified as a national park by the AJK Wildlife and Fisheries Department. MPL engaged Hagler Bailly Pakistan to conduct an assessment of potential impacts on environment from the Project and to identify mitigation and management measures to address potential impacts from the Project. This ESIA is an updated version of the ESIA submitted to EPA (Environmental Protection Agency), ADB and IFC and addresses the comments of the stakeholders and lenders. Information from the previous document has been incorporated where necessary.

2.1.1 Objectives of the ESIA

138. The objective of the study is to assess the environmental, ecological and social impacts associated with the construction and operation of the Gulpur Hydropower Project (hereafter described simply as the Project).

139. The objectives of this ESIA were to:

- Assess the existing environmental conditions in the project area, including the identification of environmentally sensitive areas.
- Assess the proposed activities to identify their potential impacts, evaluate the impacts, and determine their significance.
- Assess cumulative impacts of proposed hydropower projects on Poonch river.
- Assess effects on aquatic ecology of environmental flow.
- Propose appropriate mitigation and monitoring measures that can be incorporated into the design of the proposed activities to minimize any damaging effects or any lasting negative consequences identified by the assessment.
- Assess the proposed activities and determine whether they comply with the relevant environmental regulations in Pakistan and requirements of project lenders including ADB and IFC.
- Prepare an ESIA report for submittal to the Azad Jammu & Kashmir Environmental Protection Agency (AJK EPA), Asian Development Bank (ADB) and International Finance Corporation (IFC).

2.1.2 Approach and Methodology

140. The ESIA was performed in four main phases, which are described below.

Scoping

141. The key activities of this phase included:

142. ***Project Data Compilation:*** A generic description of the proposed activities relevant to environmental assessment was compiled with the help of the proponent.

143. ***Published Literature Review:*** Secondary data on weather, soil, water resources, wildlife, and vegetation were reviewed and compiled.

144. ***Legislative Review:*** Information on relevant legislation, regulations, guidelines, and standards was reviewed and compiled.

145. ***Identification of Potential Impacts:*** The information collected in the previous steps was reviewed and potential environmental issues identified.

Baseline Data Collection

146. No considerable amount of baseline information on the project area was available from existing literature. Therefore, a detailed field visit was conducted to collect primary data on the proposed site.

Impact Assessment

147. The environmental, socio-economic, and project information collected was used to assess the potential impacts of the proposed activities. The issues studied included potential project impacts on:

- Land Resource and Geomorphology
- Groundwater and surface water quality
- Ambient air quality, greenhouse gas emissions and ambient noise levels
- The ecology of the area, including flora and fauna especially the aquatic ecosystem
- Local communities

148. Wherever possible and applicable, the discussion covers the following aspects:

- The present baseline conditions
- The potential change in environmental parameters likely to be effected by project related activities
- The identification of potential impacts
- The evaluation of the likelihood and significance of potential impacts
- The defining of mitigation measures to reduce impacts to as low as practicable
- The prediction of any residual impacts, including all long-term and short-term, direct and indirect, and beneficial and adverse impacts
- The monitoring of residual impacts

2.2 Project Setting

149. The map included in **Figure 2–2** illustrates the general setting of the area of interest for this Study. A map showing the major Project facilities is shown in **Figure 2–2.** The Poonch River originates in the western foothills of the Pir Panjal Range, and the steep slopes of the Pir Panjal form the upper catchment of the river. The river is narrow and descends steeply until it reaches the foothill areas where the gradient flattens out and the river widens as it is joined by several tributaries. The valley narrows again near the Line of Control (LOC) and the gradient is steep (6.9-8.3 m/km) to Kotli, but is less

steep (3.7m/km) after that. The river flows into the Mangla Lake that is the reservoir of Mangla Dam, situated at the confluence of the Poonch and Jhelum Rivers. Flows in the Poonch River are highest in the summer months driven first by snow melt and then by the monsoon rains. Summer water temperatures in the lower Poonch approach 30°C.

150. The Poonch River and tributaries was declared a national park in a letter from the AJK Secretariat Forest/AKLASC/Fisheries (ref no: SF/AV 11358-7/2010 dated 15 December 2010). (**Figure 2–3**). However, a number of activities such as illegal and unregulated sand and gravel mining and fishing are still taking place in the national park. The AJK Fisheries and Wildlife Department (AJKFWD) in collaboration with Himalayan Wildlife Foundation (HWF) is building up management and protection systems and engaging the communities in protection of the national park. HWF is an NGO registered as a non-profit organization with the Security and Exchange Commission of Pakistan (SECP) under the Companies Ordinance, 1984. It has been active in establishment and development of national parks in Pakistan since 1993, and works with the local communities and the government to devise and implement strategies for protection of biodiversity in areas where species and ecosystems are critically threatened. HWF was instrumental in motivating the government of AJK in notifying the entire length of Poonch River as a national park in 2010. Following the notification, HWF prepared an ecological baseline of the Poonch River which provided the basis for development of management strategies for the national park, and mobilized resources for protection of the biodiversity of the river.

151. The HWF has been intermittently funding 4-6 wildlife guards and providing management and logistics support to the AJKFWD inclusive of coordination with the communities and local authorities. The wildlife guards provided by HWF generally operate under the authority provided to them by the AJKFWD as honorary game watchers. The process of building up management and protection systems will take time as communities are presently dependent on these resources. The long term framework will consist of sustainable management of resources with community participation where livelihoods are involved, as allowed under the AJK wildlife legislation (**Section 3.2.2**, The AJK Wildlife (Protection, Preservation and Management) Ordinance ***2013***). By the ESIA process, the profile of the national park, its conservation importance, and threats to its ecological resources have been highlighted and brought to public notice.

2.3 Narrative Description of the Course of Poonch River

152. The purpose of this section is to provide an overview of the landscape and land use in the Valley of Poonch River. The locations along the river for the purpose of this narrative description are indicated in **Figure 2–4**. Photographs of the river are included in **Figure 2–5** through **Figure 2–12**. Stretches of the river described in this section broadly correspond to river lengths between the major towns along the river. A formal delineation of the river based on the physical, biological, and ecological parameters is presented in further sections of this report. This narrative description covers the Poonch River from the Madarpur near Line of Control (LoC) to the Mangla Reservoir.

2.3.1 Segment A - Line of Control (LoC) to Tatta Pani (25 km, Average Elevation 1,000 m)

Physical Environment

153. Photographs of this stretch of the Poonch River are included in **Figure 2–5**. The Poonch River crosses the LoC about 4 km upstream of Madarpur. The river is about

100 m wide at full flow and has series of pools and riffles (**Figure 2–5 a**). The river also has rapids (**Figure 2–5 b**), and exposed rocks on the river bank (**Figure 2–5 c**), and slopes rising to about 1,500 m above the river. Snow Trout ***Schizothorax plagiostomus*** occurs in Poonch River in this segment, especially during winters when it migrates downstream from colder upstream waters. Other common species in this stretch are ***Crossocheilus latius***, ***Garra gotyla***, ***Labeo dyocheilus***, and ***Tor putitora***. Extensive sand mining (**Figure 2–5 f**) is carried out in this area, particularly near Kallar Bridge (**Figure 2–5 e**).

Figure 2–1: Project Setting

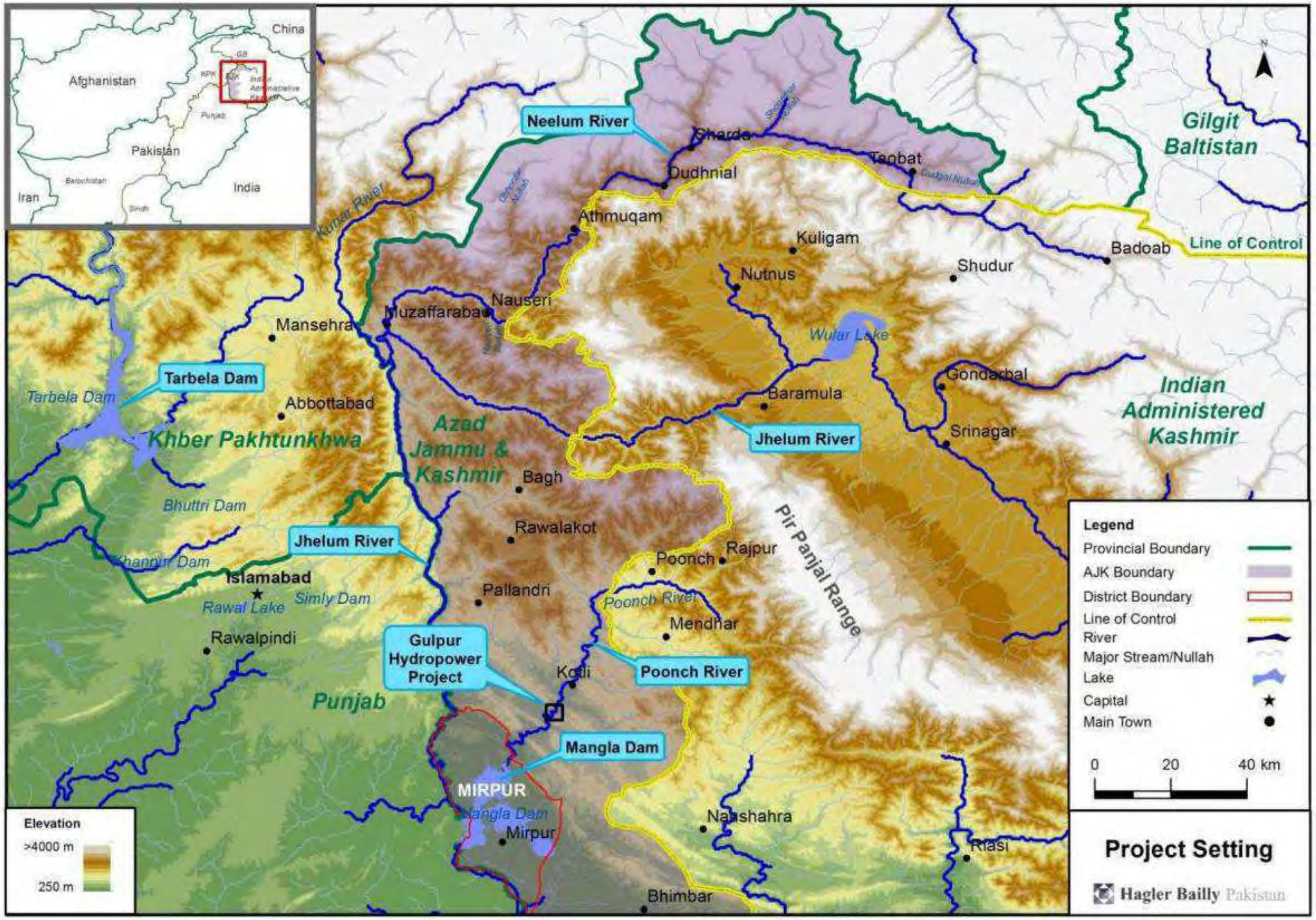


Figure 2–2: Project Facilities

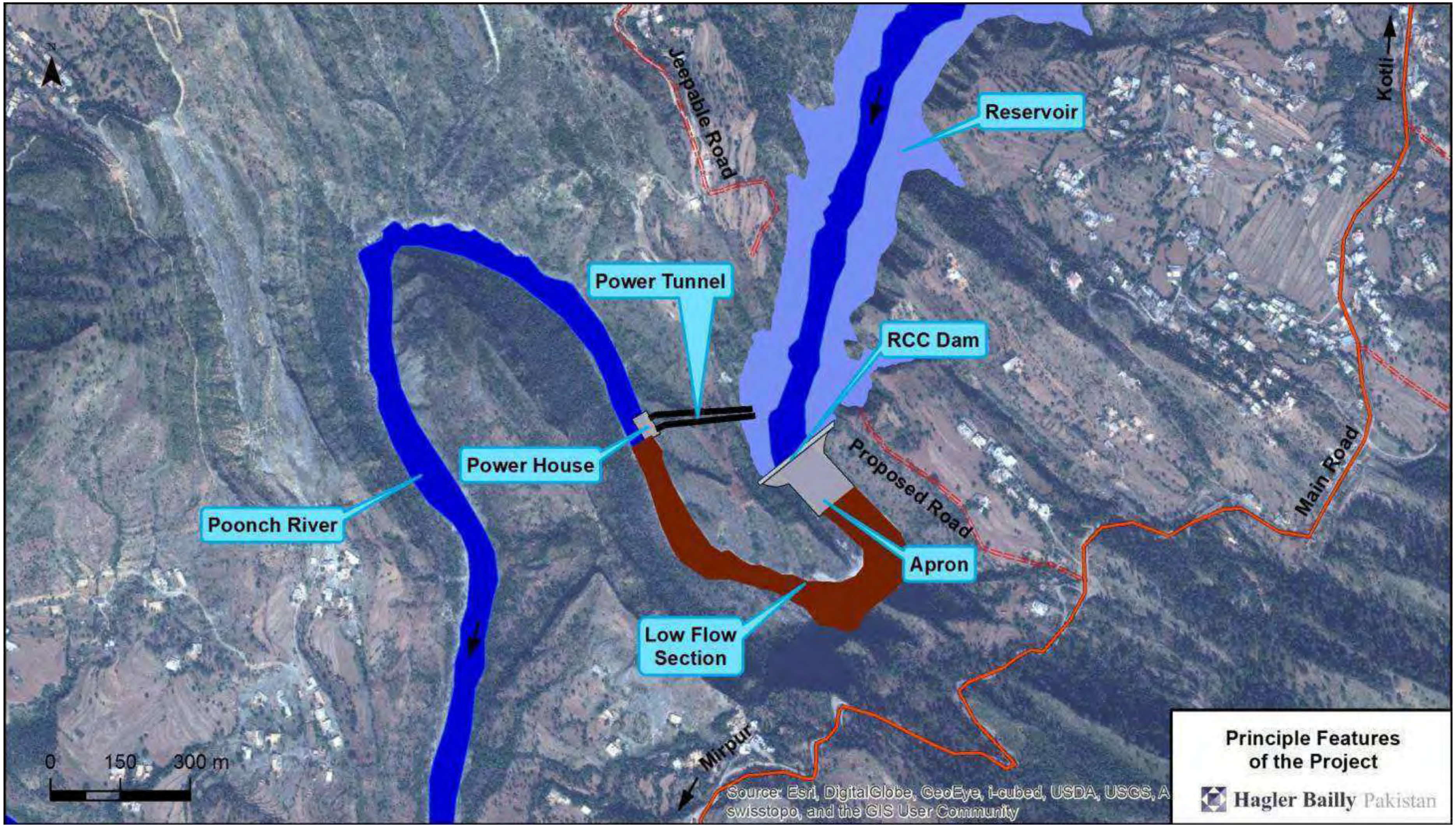


Figure 2–3: Poonch River Mahaseer National Park

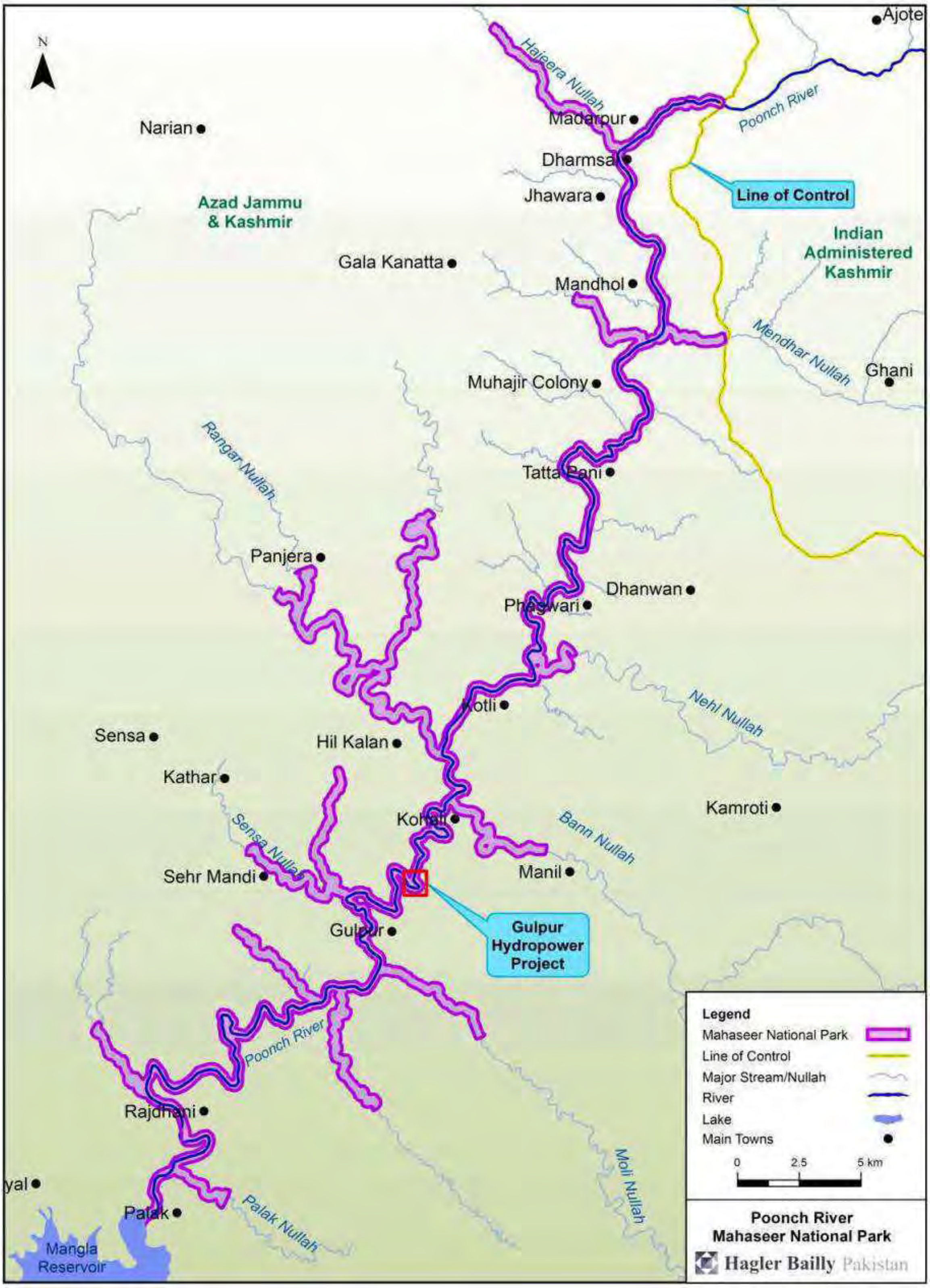


Figure 2–4: River Segments along Poonch River for Narrative Description

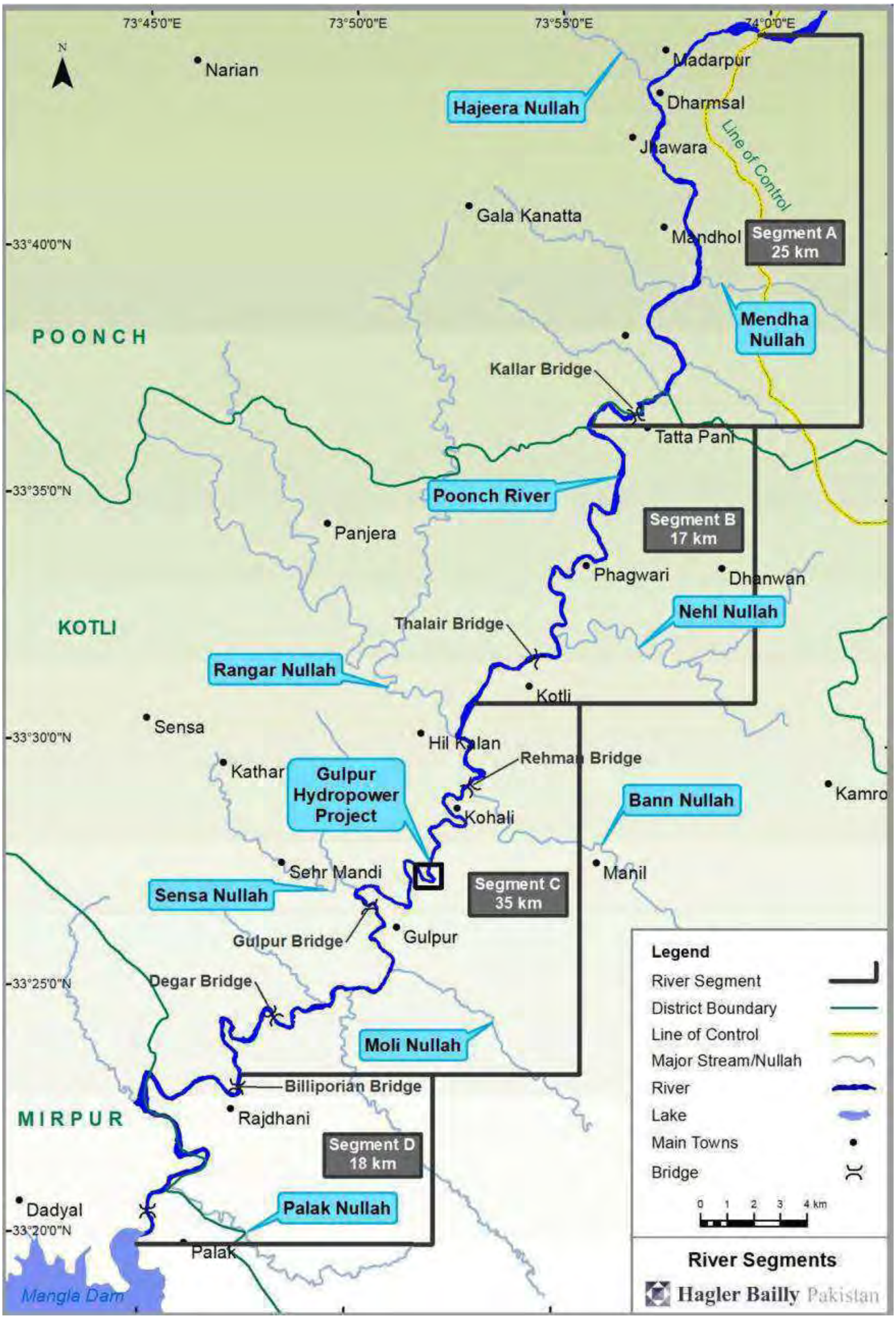


Figure 2–5: Photographs of Poonch River – LoC to Tata Pani

a. Upstream of Kallar Bridge

b. Rapids downstream of Kallar Bridge

c. Pool downstream of Kallar Bridge

d. Rapids downstream of Kallar Bridge

e. Kallar Bridge

f. Sand Mining

Social Environment

154. Photographs of this stretch are shown in **Figure 2–6**. Poonch River flows into Pakistan from India and Segment A is on the Line of Control that separates the Indian Administered Kashmir from the AJK. There is a crossing point to the Indian Administered Kashmir in this segment at Titri Note shown in **Figure 2–6 a.** This crossing point also acts as a trade link between India and Pakistan as the gates are opened twice a week for trade goods to be exchanged. There is also Trade Facilitation Centre with storage facilities for the traders shown in **Figure 2–6 b. Figure 2–6 c** shows the village of Madarpur, the first village after crossing the border with India (Line of Control). **Figure 2–6 d** shows the Indian side of Pir Panjal range, from where the Poonch River originates. **Figure 2–6 e-f** show extensive sand mining practiced in the area. This segment of Poonch River is also rich in fish and illegal fishing is being carried out

extensively in this segment. The Himalayan Wildlife Foundation (HWF), an NGO, is supporting the Fisheries in Wildlife Department in control of illegal fishing activities and their staff has confiscated numerous items such as nets, electrocution rods and poison shown in **Figure 2–6 g-h**. The land in this area is fertile and agricultural fields are very common shown as in **Figure 2–6 j.**

Figure 2–6: Photographs of social environment – LoC to Tata Pani

a. Titri note crossing point to India

b. Trade Facilitation Centre at the border

c. Madarpur village

d. Pir Panjal range in Indian Occupied Kashmir

e. Sand collection near the bank of the river

f. Sand mining at the bed of Poonch River

g. Fishing equipment confiscated by HWF

h. Confiscated nets by wildlife game watcher

i. Tatta Pani market

j. Agricultural fields

2.3.2 Segment B – Tatta Pani to Kotli (17 km, Average Elevation 800 m)

Physical Environment

155. Photographs of this stretch of the Poonch River are included in **Figure 2–7 a, c, d.** The valley in Segment B is wider relative to Segment A and the longitudinal gradient is shallower (**Section 4**). Braided channels are common in this stretch of the river. Mahaseer ***Tor putitora*** and Pakistani Labeo ***Labeo dyocheilus, Botia rostrata, Crossocheilus latius,*** and ***Glyptothorax cavia*** fish are commonly found in this segment.The villages (**Figure 2–7 d**) are mainly located on the left bank, which has low topographic relief, while there is a thick cover of mixed vegetation and on the steeper left bank (**Figure 2–7 c**).

Figure 2–7: Photographs of Poonch River – Tatta Pani to Kotli

a. Poonch River at Kotli

b. View of Kotli city

c. Rapids on Poonch River

d. Village along the course of Poonch River

Social Environment

156. This stretch of Poonch River has one major urban centre Kotli and one major village Phagwari. **Figure 2–8 a-b** show agricultural fields around Phagwari and Phagwari market. Sand mining is also very actively being carried out along this stretch of the river as shown in. **Figure 2–8 c**. At the end of Segment B, the biggest town in terms of population on Poonch River is located namely Kotli. Due to the extensive demand of sand for construction and development in Kotli, the bed of Poonch River in this segment is highly disturbed as shown in **Figure 2–8 d-e.** A newly constructed reinforced concrete bridge connects the left and right bank of Poonch River called Thalair Bridge in **Figure 2–8 f.** Kotli is known as the 'City of Mosques', a famous Gol Masjid in Kotli is shown in **Figure 2–8 h.**

Figure 2–8: Photographs of Social Environment – Tata Pani to Kotli

a. Agricultural fields at Phagwari village

b. Market in Phagwari village

c. Sand mining near Phagwari

d. Sand mining near Kotli Town

e. Sand mining near Kotli Town

f. Thalair Bridge

g. Punjab College in Kotli

h. Gol Mosque in Kotli

2.3.3 Segment C – Kotli to Rajdhani (35 km, Average Elevation 500 m)

Physical Environment

157. Photographs of the Poonch River in this stretch are included in **Figure 2–9**. The river continues to flow through a steep narrow valley, which widens near Gulpur (**Figure 2–9 b**). Near Rehman Bridge a Water and Power Development Authority (WAPDA) hydrological monitoring station (**Figure 2–9 e**) and a slaughter house are located (**Figure 2–9 f**). There is also a waste dumping area where vultures feed (**Figure 2–9 c**). The Rangar Nullah and the Bann Nullah join the Poonch River upstream of Rehman Bridge (**Figure 2–9 d**). These tributaries are breeding areas for the famous local fish Mahaseer ***Tor putitota*** which is commonly found in deep pools of Poonch river (**Figure 2–9 a**). Common fish fauna found in this stretch of river is ***Tor putitota, Botia rostrata, Clupisoma garua, Crossocheilus latius, Mastacembelus armatus, Glyptothorax stocki*** and ***Crossocheilus latius*** which are commonly found in deep pools of the river.

Figure 2–9: Photographs of Poonch River – Kotli to Rajdhani

a. Wide valley and deep pools of Poonch River

b. Riffles near Gulpur Bridge

c. Waste dumping area and Egyptian vultures near Rehman Bridge

d. Confluence of Bann Nullah with Poonch River

e. Location of WAPDA monitoring station

f. Slaughter House

Social Environment

158. The first village in Segment C is Hill Killan which has no vehicular access. **Figure 2–10 a** shows a track that is used to access the village. Due to the demands from Kotli and Gulpur, extensive sand mining is carried out in this segment of Poonch River as shown in **Figure 2–10 b.** A major village called Gulpur is located on this stretch which acts as town centre for the surrounding small villages. Adjacent to the village is Muhajir colony where the refugees from Indian Occupied Kashmir are given refuge shown in **Figure 2–10 c**. Agricultural fields and sand mining (**Figure 2–10 e-f)** are common in this area due to the demands triggering from the population living in Gulpur.

Figure 2–10: Photographs of social environment– Kotli to Rajdhani

a. Track towards Hill Killan village

b. Flood plain near Hill Killan

c. Muhajir Colony near Gulpur

d. Mosque in Gulpur

e. Agricultural fields near Gulpur

f. Sand mining on Poonch River near Gulpur

2.3.4 Segment D – Rajdhani to Mangla Reservoir (18 km, Average Elevation 450 m)

Physical Environment

159. Photographs of the Poonch River from this stretch are shown in **Figure 2–11.** The valley is relatively wide and the longitudinal gradient is low. Deep pools (**Figure 2–11 a)** and large flood plains (**Figure 2–11 b**) are common in this Segment, with the river flowing in a single channel. The river concludes and drains into the Mangla reservoir (**Figure 2–11 c**). Common fishes in the area are ***Tor putitota, Botia rostrata, Clupisoma garua, Crossocheilus latius, Mastacembelus armatus, Glyptothorax stocki*** and ***Crossocheilus latius***, ***Parambassis ranga, Chanda nama.***

Figure 2–11: Photographs of Poonch River – Rajdhani to Mangla Reservoir

a. Deep pools and flood plain upstream Billiporian bridge

b. Wide valley and riffles in Poonch River

c. Mangla Reservoir

d. Billiporian Bridge

Social Environment

160. A major village is located along this stretch of Poonch River called Rajdhani shown in **Figure 2**–**12 a.** Sand mining is actively practiced in this segment to meet the demand from construction materials in Rajdhani. This segment of the river flows into the Mangla Reservoir adjacent to Mirpur city (**Figure 2–10 d)**. Wildlife and Fisheries Department, AJK owns a fish hatchery near Mangla Reservoir shown in **Figure 2–10 e,** which is presently out of operation. **Figure 2–10 f** shows the Mangla Dam spillway located along the road which connects Mirpur to the Grand Trunk Road at Dina.

Figure 2–12: Photographs of social environment – Rajdhani to Mangla Reservoir

a. Rajdhani village

b. Sand mining near Mangla reservoir

c. Sand being transported to Rajdhani

d. Mirpur Town near Mangla Dam

e. Wildlife Department fish hatchery

f. Mangla Dam spillway

2.4 Team

161. The team for preparing the Biodiversity Impact Assessment of the Gulpur Hydropower Project consists of the following team members.

Name	Organization	Position on team
Mr Vaqar Zakaria	Hagler Bailly Pakistan	Project Director
Dr Cate Brown	Southern Waters	EF Task Leader
Dr Alison Joubert	Southern Waters	DRIFT DSS
Dr Mehr Ali Shah	NESPAK	Hydrology

Name	Organization	Position on team
Dr Andrew Birkhead	Streamflow Solutions	Hydraulic and scenario modeling
Dr Mohammed Rafique	Hagler Bailly Pakistan[1]	Fish ecology
Mr Mark Rountree	Fluvius Consultants	Geomorphology
Ms Fareeha Irfan Ovais	Hagler Bailly Pakistan	Manager
Mr Bilal Khan	Hagler Bailly Pakistan	Manager
Mishkatullah	Sub Hagler Bailly Pakistan[1]	Macroinvertebrates
Mr Hussain Ali	Hagler Bailly Pakistan	Field work and data collation
Dr Jackie King	Water Matters	Quality control

2.5 Organization of the Report

162. This report covers the Regulatory and Institutional Framework applicable to the Project (**Section 3**), Project Description (**Section 4)**, Description of the Environment (**Section 5**), Environmental Flow Assessment (**Section 6**), and Assessment of Impacts on Environment (**Section 7**). Furthermore this report contains Analysis of Alternatives (**Section 8**), Stakeholder Consultations (**Section 9)**, Grievance Redressal Mechanism **(Section 10)** and Environmental Management Plan **(Section 11)** for the Gulpur Hydropower Project.

[1] Subconsultant to Hagler-Bailly Pakistan

3. Regulatory Framework

163. This section summarizes the regulatory and institutional framework applicable to this Project for protection of the environment with specific focus on hydropower projects. The regulations and guidelines discussed in this section include applicable laws in AJK, international conventions, and ADB and IFC Guidelines.

3.1 Enabling Environmental Law

164. This section summarizes the laws and regulations applicable to Project construction and operations. It includes the laws and regulations that have been enacted by the AJK Government as well as those that have been enacted in Pakistan but have been adopted by the AJK Legislature.

3.1.1 Azad Jammu and Kashmir Environmental Protection Act 2000

165. The ***Azad Jammu and Kashmir Environmental Protection Act, 2000*** is the principal legislative tool used for regulating environmental protection in the state of Azad Jammu and Kashmir. The Act is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, and noise pollution, handling of hazardous wastes and biodiversity protection. The responsibility to implement the provisions of the 2000 Act lies with the Azad Jammu and Kashmir Environmental Protection Agency (the 'Agency' or 'AJK-EPA'). Considering that the Project is a run of the river (RoR) hydropower project with anticipated environmental impacts, the Act is applicable to the Project in both construction and operation phases.

3.1.2 Environmental Guidelines

166. The Pakistan Environmental Protection Agency has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development projects. These guidelines have been adopted by the AJK-EPA for use in its jurisdiction. Under Regulation 6(2) of the IEE-EIA Regulations 2009, the "EIA shall be prepared, to the extent practicable, in accordance therewith and the proponent shall justify in the EIA and departure therefrom". The relevant guidelines are:

Policy and Procedures for Filing, Review and Approval of Environmental Assessments, Pakistan Environmental Protection Agency, September 1997[1].

167. These guidelines define the policy context and the administrative procedures that will govern the environmental assessment process, from the project pre-feasibility stage, to the approval of the environmental report. The section on administrative procedures has been superseded by the. The EIA developed for the Gulpur Hydropower Project has been prepared in accordance with this Policy as well as the IEE-EIA Regulations, 2000

Guidelines for the Preparation and Review of Environmental Reports, Pakistan Environmental Protection Agency, 1997

168. These guidelines target the project proponents and specify:

[1] Also adopted by the EPA-AJK

- The nature of the information to be included in environmental reports.
- The minimum qualifications of the EIA conductors appointed.
- The need to incorporate suitable mitigation measures at every stage of project implementation.
- The need to specify monitoring procedures.

169. The terms of reference for the reports are to be prepared by the project proponents themselves. The report must contain baseline data on the project area, detailed assessment thereof, and mitigation measures. The EIA developed for the Gulpur Hydropower Project has been prepared in accordance with these guidelines.

Guidelines for Public Consultation, Pakistan Environmental Protection Agency, May, 1997

170. These guidelines support the two guidelines mentioned earlier. It deals with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in any impact assessment study. The community and institutional stakeholder plan and subsequent consultations for the ESIA of the Project (**Section 9**, Consultations) were carried out keeping these guidelines in view.

Guidelines for Sensitive and Critical Areas, Pakistan Environmental Protection Agency, October, 1997

171. The guidelines on sensitive areas are more specific in that they identify the officially notified protected areas in Pakistan, including critical ecosystems, archeological sites, etc., and present checklists for environmental assessment procedures to be carried out inside or in the vicinity of such sites. Environmentally sensitive areas include, among others, archeological sites, biosphere reserves and natural parks, and wildlife sanctuaries and preserves. The guidelines state that the approach recommended in the document should extend to areas in the vicinity of such sensitive and critical sites, although the term ‘vicinity’ is not explicitly defined.

172. Since the guideline treat ‘sensitive and critical areas’ as synonymous to protected areas (areas protected under the wildlife laws or archaeology laws), the Gulpur Hydropower Project lies in a sensitive and critical area in view of its location in a national park.

173. The guidelines recommend that the concerned Project a) demonstrate that a balance between protection of species and meeting human needs will be established; b) demonstrate through a verifiable process of communication that the provincial department (in this case, AJK Fisheries and Wildlife Department) has been engaged and their consent has been obtained; and c) in case of discovery of new species the Wildlife Department is notified. The Environmental Flow Assessment (**Section 6**) and the Biodiversity Action Plan (**Section 11**) that has been developed for the Gulpur Hydropower Project ensures that these requirements are met.

3.1.3 National Environmental Quality Standards (NEQS)

174. The National Environmental Quality Standards (NEQs) specify the following standards:

- Maximum allowable contamination of pollutants (32 parameters) in emission and liquid industrial effluents discharged to inland water.
- Maximum allowable concentration of pollutant (16 parameters) in gaseous emission from sources other than vehicles.
- Maximum allowable concentration of pollutants in gaseous emissions from vehicle exhaust and noise emission from vehicles.
- Maximum allowable noise level from vehicles.
- Ambient noise standards
- Ambient air quality standards.

175. These standards apply to gaseous emissions and liquid effluents discharged by batching plants, asphalt plants, campsites, construction machinery, and vehicles. The standards for vehicle, noise wastewater and drinking water will apply during the construction as well as operational phase of the Project.

176. Neither the federal government nor AJK have as yet notified standards for surface water, groundwater, and water for irrigation use. Similarly, standards for solid waste and hazardous and toxic waste have also not been notified as yet.

3.2 Other Environmental Laws

3.2.1 The Land Acquisition Act, 1894

177. The law deals with the matters related with acquisition of private land and other immovable properties existing on the land required for the project. The public purpose, inter alia, includes the construction of development projects including related roads, quarry areas, colonies, etc. For that matter, it may also be applicable at private level provided the public utility of the project is established. As the land is a provincial subject, the proponent has to acquire the land for the project through the provincial governments. The Land Acquisition and Resettlement Plan (LARP) prepared for the project conforms to this legislation.

3.2.2 AJK Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2013

178. The ***AJK Wildlife (Protection, Preservation and Management) Ordinance 2013*** was promulgated by the President of AJK in 2010 with an aim to consolidate the laws relating to protection, preservation, conservation and management of wildlife in Azad Jammu and Kashmir. It also endeavours to promote social, economic, cultural and ecological well-being of local communities in conformity with the concerns of the international communities. It outlines the roles and responsibilities of government organizations and departments primarily the AJK Wildlife and Fisheries Department that has the basic responsibility to ensure enforcement of the Act. The Ordinance also provides for the declaration of various categories of protected areas: wildlife sanctuaries, wildlife refuge, national parks, game reserves, biosphere reserves, biodiversity reserve, national natural heritage site (**Section 36–52**). It prohibits the dealing with any wildlife animal, dead or alive, for domestic or commercial use without a Certificate of Lawful Possession (**Sections 24**). Permits and trade license are necessary for the import, export and trade of wild animals of an endemic or exotic species (**Section 22**). The Ordinance also contains three Schedules listing the following: game animals, which shall

only be hunted under the terms of a game shooting or game capture license; animals, trophies or meat, for the possession, transfer, or export for which a Certificate of Lawful Possession is required; and, protected animals, which shall not be hunted, captured or killed. The Ordinance recognizes that it is necessary to fulfil the obligations envisaged under the biodiversity related Multilateral Environmental Agreements ratified by the Government of Pakistan. The provisions in this Ordinance related to National Park are outlined in **Section 44** of Chapter VI (Protected Areas) and are outlined below:

National Park:

1. With a view to the protection and preservation of landscape, flora, fauna, geological features of special significance and biological diversity in the natural state, the government may, by notification in the official Gazette, declare any area to be a National Park and may demarcate it in such a manner as may be prescribed.
2. A National Park shall be accessible to public for recreation; education and research purposes subject to such restrictions as the government may impose.
3. The provision for access roads to and construction of rest houses, hostels and other, buildings in the national park along with amenities for public may be 50 made, as not to impair the object of the establishment of the National Park.
4. Any facility provided under Sub-Sections (2) and (3) shall be in conformity with the recommendations of the Environmental Impact Assessment or Initial Environmental Examination under AJ&K Environment Protection Act, 2001 and amendments made thereunder.
5. The following acts shall be prohibited in a National Park:
    i. Hunting, shooting, trapping, killing or capturing of any wild animal;
    ii. Carrying of arms, pet animals, livestock, firing any gun or doing any other act which may disturb any wild animal or doing any act which interferes with the serenity and tranquility of the park and breeding places of wild animals;
    iii. Logging, felling, tapping, burning or in any way damaging or destroying, taking collecting or removing any plant or tree;
    iv. Grazing of livestock;
    v. Fishing;
    vi. Clearing or breaking up any land for cultivation; mining or quarrying any stones for any other purpose;
    vii. Polluting or poisoning water flowing in and through the National Park;
    viii. Littering and dumping of waste;
    ix. Writing, in scripting, carving, disfiguring, defacing, painting, chalking, advertising;
    x. Use of vehicular transport except on recognized roads;
    xi. Blowing of pressure horns with in one kilometer radius of park boundary.
    xii. Playing music, radios or making noise.
6. The Department may, however for the research purpose or betterment of the Park or for providing incentives or concessions to the communities for participatory management authorized doing of one or more acts mentioned in

Sub-Section (5) on an explicit written request made to the head of the Department justifying the need for such an action or certifying that it does not impair the objectives of established park, in specific manner.

7. Whoever contravenes or fails to comply with any of the provision of the Section or abets in the commission or furtherance of any such act shall be punishable with imprisonment, which shall not be less than six months and may extend to one year or with fine which shall not be less than ten thousand rupees and may extend to rupees thirty thousands.
8. In case offense is proved to be followed by award of punishment by the court, all animals, tools, implements, carriages, including mechanically propelled vehicles, pack, animal, arms, ammunitions and other equipment and conveyances used in the commission or furtherance of an offence shall stand confiscated in favor of the government, in addition to the punishment awarded under this Section,
9. If a woman, is charged for any of the offense under this Ordinance, the court may, after the reasons to be recorded in writing, dispense with her physical presence before the court while permitting her to appear by an agent duly authorized in writing under the signature or thumb-impression of such accused having woman, attested by a respectable person of the area concerned.

179. The Poonch River and tributaries was declared a national park in a letter from the AJK Secretariat Forest/AKLASC/Fisheries (ref no: SF/AV 11358-7/2010 dated 15 December 2010). Despite the fact that the Poonch River Mahaseer National Park is a designated protected area, extensive sand and gravel mining and illegal fishing continues at several locations in the River, due to shortcomings in protection and management. The AJK Department of Fisheries and Wildlife is working on closing these gaps, and the long term framework will consist of sustainable management of resources with community participation where livelihoods are involved, as allowed under Sub Section (6).

180. The AJK Department of Fisheries and Wildlife in a letter (ref no: 1944 – 48, dated 21 May 2014) granted permission for construction of the 100 MW Gulpur Hydropower Project in the Poonch River Mahaseer National Park on the condition that a Biodiversity Action Plan (BAP) be developed that will achieve betterment of the national park. In addition, the Department has taken a principled position in writing that hydropower projects on Poonch River will be allowed only if they can demonstrate betterment of the park or net gain in biodiversity, and for subsequent projects the implemented ESIA for the Gulpur project will be considered as a baseline.

3.2.3 Jammu and Kashmir Forest Regulation 1930

181. Forests of Azad Jammu and Kashmir are managed according to the guidelines provided by ***Jammu and Kashmir Forest Regulations of 1930*** (including amendments), generally known as Forest Law Manual. This regulation lays down the rules and regulations for both demarcated and un-demarcated forests, collection of drift and stranded wood as well as penalties and procedures for not abiding by these regulations.

182. Subject to finalization of the engineering design of the Project, some land in the ownership of the AJK Forest Department may have to be acquired from the GoAJK for the Project. There are no trees or forests on land owned by the Forest Department located in the Project footprint that is likely to be acquired.

3.2.4 Fisheries Act 1897

183. The ***Fisheries Act 1897*** regulates fishing in the waters of Pakistan. Pakistan waters shall include the sea within a distance of one marine league off the seacoast. The provisions issued in this Act include: the prohibition to use explosives; the prohibition to use toxic and poisonous agents in fishing activities; the dimension and kind of nets used; the offences and relative penalties. Fishing in the Poonch River including use of gill nets, dynamites and poisons is regulated by this Act.

3.2.5 The Antiquities Act, 1986

184. The Act deals with the matters relating to the protection, preservation and conservation of archaeological/ historical sites and monuments. It prohibits construction (or any other damaging) activity within 200 meters of such sites unless prior permission is obtained from the Federal Department of Archaeology and Museums. No archaeological/ historical site is present at the site of the Project footprint or within 200 meters of the Project site.

3.2.6 The Factories Act, 1934

185. The pertinent clauses of the Act are those that deal with health, safety and welfare of the workers, disposal of solid waste and effluent, and damage to private and public property. It also deals with the regulations for handling and disposing of toxic and hazardous materials. As the construction activity has also been classified as an 'industry', the regulations will be applicable to the Contractors.

3.2.7 The Explosives Act, 1884

186. It provides regulations for handling, transportation and use of explosives. The contractors have to abide by the regulation during quarrying, blasting and for other purposes.

3.3 Specific Legal Provisions

3.3.1 Law for Environmental Assessment

187. The Azad Jammu and Kashmir Environmental Protection Act 2000 (AJK Act 2000) provides for two types of environmental assessments: IEEs and EIAs. EIAs are carried out for projects that have a potentially 'significant' environmental impact, and IEEs are conducted for relatively smaller projects with a relatively less significant impact. The term 'EIA' has been defined in PEPA 1997 as "an environmental study comprising collecting data, prediction of qualitative and quantitative impacts, comparison of alternatives, evaluation of preventive, mitigatory and compensatory measures, formulation of environmental management and training plans and monitoring arrangements, and framing of recommendations and such other components as be prescribed".

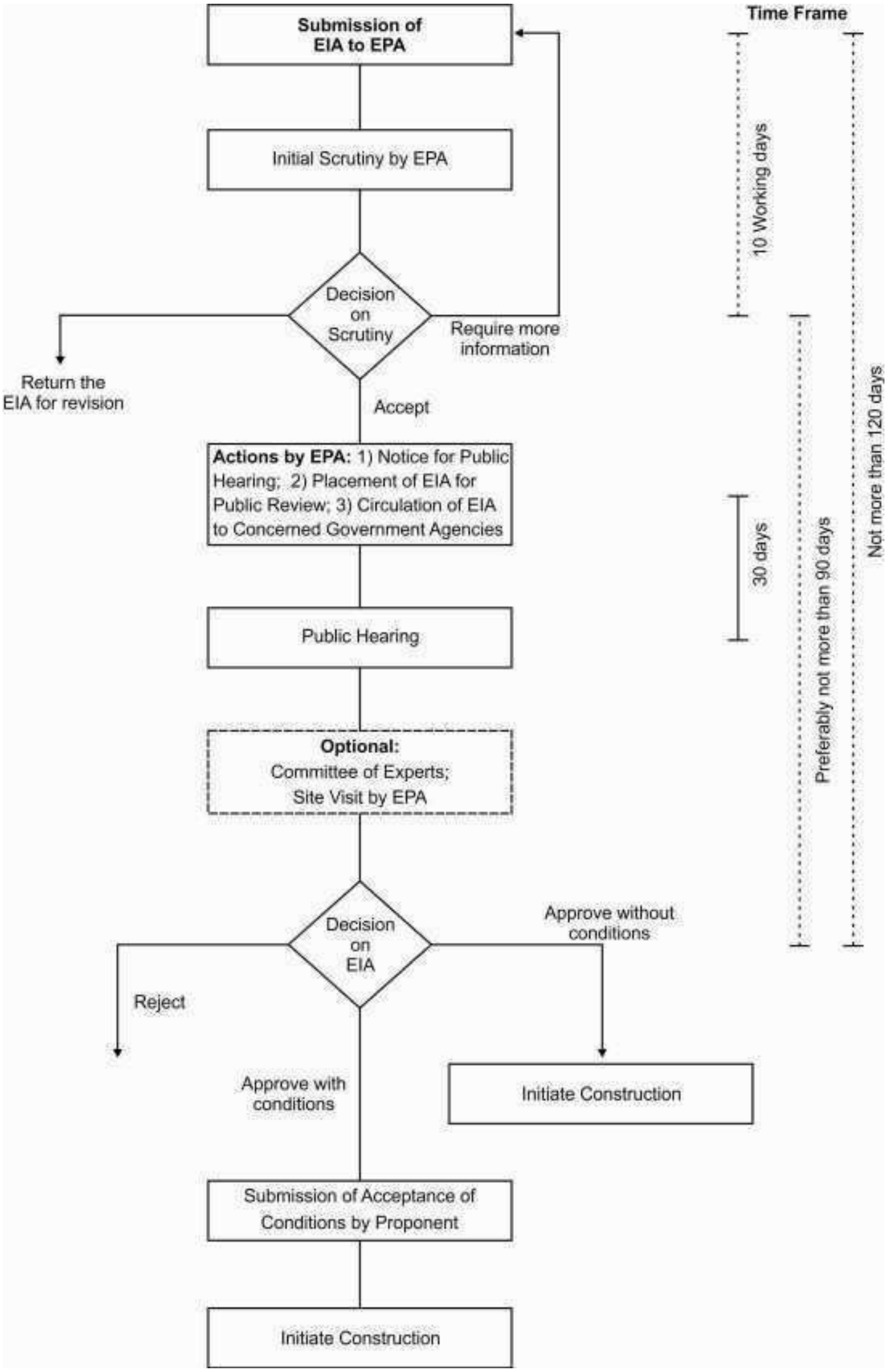
188. **Section 11** of the AJK Act 2000 requires that: "No proponent of a project shall commence construction or operation unless he has filed with the Agency (AJK Environmental Protection Agency), an initial environmental examination or where the project is likely to cause an adverse environmental examination or, here the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Agency approval in respect thereof."

189. The IEE-EIA Regulations 2000 provide the necessary details on the preparation, submission, and review of initial environmental examinations and environmental impact assessments. The IEE and EIA Regulations categorize projects for IEE and EIA. Schedules I and II, attached to the Regulations list the projects that require IEE and EIA, respectively. Hydroelectric power generation over 50 MW is included in Schedule II and hence an EIA is a mandatory requirement for the Gulpur Hydropower Project.

190. Key features of the EIA review and approval process is described below. The process is shown in the form of a flowchart in **Figure 3–1**:.

- A fee, depending on the cost of the project and the type of the report, is submitted along with the document;
- The submittal is also accompanied by an application in the format prescribed in Schedule IV of the Regulations;
- The EPA conducts a preliminary scrutiny and replies within 10 days of the submittal of a report, a) confirming completeness, or b) asking for additional information, if needed, or c) returning the report requiring additional studies, if necessary;
- Section 12(3) of AJK Act 2000 states that every review of an environmental impact assessment shall be carried out with public participation.
- AJK Act 2000 also requires the Agency to communicate its decision within a period of four months from the date the EIA has been files for review [Section 12(4)];
- The EPA is required to make every effort to complete the IEE and EIA review process within 45 and 90 days, respectively, of the issue of confirmation of completeness;
- The AJK-EPA after review may approve the EIA or require the EIA to be re-submitted after modifications as prescribed by the Agency or refuse the project as being contrary to the environmental objectives;
- Before commencing construction of the project, the proponent is required to submit an undertaking accepting the conditions;
- Before commencing operation of the project, the proponent is required to obtain from the EPA a written confirmation of compliance with the approval conditions and requirements of the EIA;
- An EMP for operations is to be submitted with a request for obtaining confirmation of compliance;
- The EPAs are required to issue confirmation of compliance within 15 days of the receipt of request and complete documentation; and
- The EIA approval is valid for three years from the date of accord.

Figure 3–1: Regulatory Review Process for ESIA



3.3.2 Laws Regulating Flow Releases for Hydropower Projects

191. There are laws relating to environmental protection, water resources, and ecology in Azad Jammu and Kashmir, however, there is only one reference to environmental flow in the legal instruments.

192. **Section 11(1)** of the ***Azad Jammu and Kashmir Environmental Protection Act 2000*** requires that environmental assessment of development projects shall be undertaken. Under **Section 32(1)** of the Act, the Government is empowered to make regulations for carrying out the purposes of the Act. This includes "laying down of guidelines for preparation of initial environmental examination and environmental impact assessment and development procedures for their filing, review and approval (**Section 32(2)** (vii)). The Government is promulgated these regulations in the form of the ***Azad Jammu & Kashmir Environmental Protection Agency Review of Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) Regulations 2009***. Regulations 6 of this instrument states that where guidelines have been issued for preparation of environmental assessment the document shall be prepared, to the extent "practicable", in accordance the guideline. Further, it requires that any departure shall be justified.

193. ***Guidelines for Preparation and Review of Environmental Reports*** (**Section 2.12**) which was prepared by the Government of Pakistan in 1997 and has been adopted by the Government of AJK under the Regulation 6 of the Regulations mentioned in the previous paragraph. These guidelines contain the only reference to environmental flow. **Section 3.5** requires that the environmental assessment shall consider direct and indirect impacts. In the examples of the indirect impact given in the guidelines, one example is "environmental degradation of a river mouth resulting from dam building high in the catchment, and the resulting reduction in environmental flows"

194. It can be concluded that the environmental law considers the reduction in flow as an impact and requires that its subsequent impacts shall be taken into consideration in the EIA.

195. Other than this, there is no mention direct or through implication, of environmental flow in the environmental law or other laws such as the ***Azad Jammu and Kashmir, Wildlife (Protection, Preservation, Conservation and Management) Ordinance 2010*** or the ***Canal and Drainage Act (VIII of 1973)***.

3.4 International Conventions and Obligations

196. The Azad Jammu and Kashmir Environmental Protection Act, 2000 recognizes that it is necessary to fulfil the obligations envisaged under the biodiversity related Multilateral Environmental Agreements ratified by the Government of Pakistan.

197. A list of international conventions that focus on biodiversity issues is given in **Table 3–1** with shared goals of conservation and sustainable use of biological resources, the biodiversity-related conventions work to implement actions at the national, regional and international level. In meeting their objectives, the conventions have developed a number of complementary approaches (site, species, genetic resources and/or ecosystem-based) and operational tools (e.g., programs of work, trade permits and certificates, multilateral system for access and benefit-sharing, regional agreements, site listings, funds).

Table 3–1: International Agreements on Biodiversity and Pakistan's Status

Convention	Date of Treaty	Entry into Force in Pakistan
Indus Water Treaty	1960	12 Jan1961
Convention on Biological Diversity (CBD)	1993	26 Jul 1994
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1975	19 Jul 1976
Convention on Conservation of Migratory Species (CMS)	1979	01 Dec 1987
Convention on Wetlands of International Importance especially as Waterfowl Habitat	1971	23 Nov 1976
Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC)	1972	08 Dec 2011

Indus Water Treaty

198. The Indus Waters Treaty is a water sharing treaty between Pakistan and India, brokered by the World Bank (then the International Bank for Reconstruction and Development). The treaty was signed in Karachi on September 19, 1960 by Indian Prime Minister Jawaharlal Nehru and President of Pakistan Ayub Khan (President of Pakistan)[2].

199. The Indus System of Rivers comprises three western rivers the Indus, the Jhelum and Chenab and three eastern rivers - the Sutlej, the Beas and the Ravi. The treaty, under Article 5.1, envisages the sharing of waters of the rivers Ravi, Beas, Sutlej, Jhelum and Chenab which join the Indus River on its left bank (eastern side) in Pakistan. According to this treaty, Ravi, Beas and Sutlej, which constitute the eastern rivers, are allocated for exclusive use by India before they enter Pakistan. However, a transition period of 10 years was permitted in which India was bound to supply water to Pakistan from these rivers until Pakistan was able to build the canal system for utilization of waters of Jhelum, Chenab and the Indus itself, allocated to it under the treaty. Similarly, Pakistan has exclusive use of the western rivers Jhelum, Chenab and Indus but with some stipulations for development of projects on these rivers in India. Pakistan also received one-time financial compensation for the loss of water from the eastern rivers. Since March 31, 1970, after the 10-year moratorium, India has secured full rights for use of the waters of the three rivers allocated to it. The treaty resulted in partitioning of the rivers rather than sharing of their waters[3].

200. In the Final Award in the Permanent Court of Arbitration constituted in accordance with the Indus Waters Treaty 1960 between the Government of India and the Government of Pakistan, the following judgment was given by the court in December 2013 regarding environmental flows for Kishenganga Hydroelectric Power Plant in India and Neelum Jhelum Hydroelectric Power Plant in Pakistan:

201. "The Court acknowledges India's point that the environmental sensitivity that Pakistan urges in these proceedings does not match Pakistan's own historical practices, where the environmental flow has often been set at a low minimum, apparently using a

[2] Text of 'Indus Water Treaty', Ministry of water resources, Govt. of India". Retrieved 2013-02-01.

[3] "Indus Waters Treaty 1960" (pdf). Site Resources; World Bank. pp. 1–24.

"rule of thumb" approach. The Court will address the issue of the balance to be achieved between the environment and other uses of the Kishenganga/ Neelum in subsequent subdivisions. With respect to the information brought to bear on decision-making, however, the Court sees no reason to remain wedded to past practices. On the contrary, more comprehensive and accurate information on the likely impacts of infrastructure projects can only benefit decision-making in both Pakistan and India. The Court urges both Parties to continue or expand their attention to environmental considerations at other projects, including the Neelum Jhelum Hydroelectric Power Project. In the Court's view, such an approach is consistent with the acute need of both Parties for increased production of hydropower. Indeed, the Court's ultimate decision on the minimum flow is informed by a deep awareness of the critical importance (and shortage) of electricity in both India and Pakistan. Meaningful development in this area need not be at odds with careful consideration of environmental effects."

Convention on Biological Diversity (CBD), Rio De Janiero, 1993

202. Convention on Biological Diversity, known informally as the Biodiversity Convention covers ecosystems, species, and genetic resources and the field of biotechnology. The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993.

203. The Convention has three main goals:

- conservation of biological diversity;
- sustainable use of its components; and
- fair and equitable sharing of benefits arising from genetic resources.

204. The objective of the convention is to conserve biological diversity, promote the sustainable use of its components, and encourage equitable sharing of the benefits arising out of the utilization of genetic resources. Such equitable sharing includes appropriate access to genetic resources, as well as appropriate transfer of technology, taking into account existing rights over such resources and such technology. In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity.

205. The Poonch River (**Section 4**) is rich in abundance and diversity of fish and thus it is important to minimize the negative impact of Project on these aquatic biological resources.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington, 1975

206. The convention aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It protects certain endangered species from over-exploitation by means of a system of import/export permits. Through its three appendices, the Convention accords varying degrees of protection to more than 30,000 plant and animal species. Project construction and operation will increase the influx of personnel to Project site and vicinity and could improve access to the natural habitats. This may increase the likelihood of trade in wildlife and wildlife parts.

Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, 1979

207. The Convention on the Conservation of Migratory Species of Wild Animals also known as Bonn Convention aims to conserve terrestrial, marine and avian migratory species throughout their range. Parties to the CMS work together to conserve migratory species and their habitats by providing strict protection for the most endangered migratory species, by concluding regional multilateral agreements for the conservation and management of specific species or categories of species, and by undertaking co-operative research and conservation activities. Migratory birds have been reported from the Project site and vicinity.

Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar, 1971

208. Popularly known as the Ramsar Convention, provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The convention covers all aspects of wetland conservation and wise use, recognizing wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities. There is no declared Ramsar site in the vicinity of the Project.

Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC), Paris, 1972

209. The primary mission of the World Heritage Convention (WHC) is to identify and conserve the world's cultural and natural heritage, by drawing up a list of sites whose outstanding values should be preserved for all humanity and to ensure their protection through a closer co-operation among nations. There is no such site in the vicinity of the Project.

3.5 Institutional Framework

210. The basic responsibility for managing and conserving the wildlife and fisheries of AJK lies with AJK Wildlife and Fisheries Department. This includes protecting and managing the river and river-dependent flora and fauna. The Wildlife and Fisheries Department works in conjunction with the Forest Department to manage the protected areas such as national parks, the terrestrial forests and river-dependent forests.

3.5.1 AJK- EPA

211. AJK Environmental Protection Agency was established in July 1998 under the AJK Environmental Protection Act 2000, to provide for the protection, conservation, rehabilitation and improvement of the environment for the prevention and control of pollution and promotion of sustainable development. Presently AJK-EPA, is headed by the Director General of AJK-EPA, with its Head Office at Muzaffarabad.

212. Environment Unit was established in June 1994 under Northern Resource Management Project (NRMP) in Planning & Development Department (P&DD) headed by an Environmentalist (B-18). This Environmental Unit started its work in July 1994 on following three areas;

- To address and resolve the environmental issues of the State AJK.

- To work out the establishment of Provincial EPAs type State Environmental Protection Agency (AJK-EPA).
- To take initiative the Government for the promulgation of Environmental Protection Ordinance in AJK.

213. The proponent is responsible for preparing the complete environmental documentation required by the AJK-EPA and remain committed for getting clearance from it. Moreover, it is also desirable that once clearance from AJK-EPA is obtained, the proponent should remain committed to the approved project design. No deviation is permitted in design and scope of rehabilitation during project implementation without the prior and explicit permission of the EPAs.

3.5.2 AJK Wildlife and Fisheries Department

214. The AJK Wildlife and Fisheries Department is headed by the Director of Wildlife and Fisheries. The aim of the Department as outlined on their official website[4] is to "***protect, conserve and manage terrestrial and aquatic wild genetic resources to satisfy need of ecosystems and communities, on sustainable basis, through setting of a protected areas network, habitat protection / development, eco-tourism promotion and promotion of public private partnerships***." The objectives of the Department are as follows:

- Promote eco-tourism through development of safaris, trophy hunting, sport hunting and checking illegal hunting.
- Enhancing the technical capabilities of the department by reorganizing and providing the technical staff in each district of AJ&K.
- Identifying more potential areas of biodiversity hotspots and establishing new protected areas for proper conservation and management.
- Preparation of Management Plans for each Protected Area and their effective implementation.
- Setting up of a well-designed monitoring system based on the measurable impact and performance indicators to ensure the sustainability of the biological diversity.
- Identification of the custodian communities dependent on the natural resources of the protected areas, organization them and involve them in the conservation and management practices.
- Reduce the pressure of the custodian communities on the natural resources through the provision of alternate livelihood resources and reduce the poverty by initiating activities of income generation.
- Survey of fish diseases and establishment of diagnostic laboratory.

[4] Official website of AJK Fisheries and Wildlife Department available at: http://forest.ajk.gov.pk/index.php?option=com_content&view=article&id=54&Itemid=85. Accessed on 16 September 2013.

3.5.3 AJK Forest Department

215. The AJK Forest Department is headed by the Chief Conservator Forests. The aim of the Department as outlined on their official website[5] is "***scientific management of forestry resource on sustainable basis, ensuring environmental amelioration, checking*** *sediment inflow into water bodies."* The salient features of present forest management are to:

- Maintain and improve the existing forest for the purpose of soil and water conservation.
- Bring the partially stocked forest to its full capacity by natural as well as artificial regeneration measures.
- Extract the forest according to the principles of forest health.
- Provide the legitimate requirements of local population for grazing and other forest produce.
- Maximize the production without causing permanent damage to the forest crop.
- Improve existing conditions of rangelands and wildlife habitat
- Create a balance between the utilization of forest resource and the conservation of its environment.

3.6 IFC's Requirements

216. IFC applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Other financial institutions electing to apply them to projects in emerging markets may also apply the Performance Standards. Together, the eight Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC or other relevant financial institution:

3.6.1 IFC's Performance Standards on Social and Environmental Sustainability

217. International Finance Corporation applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, the eight Performance Standards (Performance Standards and Guidance Notes 2012 edition) establish standards throughout the life by IFC or other relevant financial institution.

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security

[5] Official website of AJK Forest Department available at : http://forest.ajk.gov.pk/index.php?option=com_content&view=article&id=54&Itemid=85 Accessed on 16 September 2013

- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

218. The Performance Standard 7 and 8 are not relevant for this project as there are no indigenous people present in the project area, and no sites of cultural significance will be impacted by the project.

219. ***PS 1 Assessment and Management of Environmental and Social Risks and Impacts*** – It establishes the importance of (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project.

220. ***PS 2 Labor and working conditions*** - requires that worker-management relationship is established and maintained, compliance with national labor and employment laws and safe and healthy working conditions are ensured for the workers.

221. ***PS 3 Resource Efficiency and Pollution Prevention*** - outlines approach to pollution prevention and abatement in line with Internationally disseminated technologies and practices with objectives to a)To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities b) To promote more sustainable use of resources, including energy and water, c) To reduce project-related GHG emissions.

222. ***PS 4 Community health, safety and security*** - recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. The objective is to a) anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances b) To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.

223. ***PS 5 Land Acquisition and Involuntary Resettlement*** - This standard requires that project does not result in involuntary resettlement or at least if unavoidable it is minimized by exploring alternative project designs. In addition, the project will ensure that social and economic impacts from land acquisition or restrictions on affected persons' use of land are mitigated.

224. ***PS 6 Biodiversity Conservation and Sustainable Natural Resource Management*** - It recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The objectives are a) to protect and conserve biodiversity b) to maintain the benefits from ecosystem services c) To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

225. The PS 6 defines a Critical Habitat as outlined below.

226. Critical Habitat is designated by the International Finance Corporation (IFC) Performance Standards 6[6] and is described as having a high biodiversity value, as defined by:

- Habitat of significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted-range species;
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

227. The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision will be evaluated on a case-by-case basis. Examples are as follows:

- Areas required for the reintroduction of CR and EN species and refuge sites for these species (habitat used during periods of stress (e.g., flood, drought or fire)).
- Ecosystems of known special significance to EN or CR species for climate adaptation purposes.
- Concentrations of Vulnerable (VU) species in cases where there is uncertainty regarding the listing, and the actual status of the species may be EN or CR.
- Areas of primary/old-growth/pristine forests and/or other areas with especially high levels of species diversity.
- Landscape and ecological processes (e.g., water catchments, areas critical to erosion control, disturbance regimes (e.g., fire, flood)) required for maintaining critical habitat.
- Habitat necessary for the survival of keystone species.
- Areas of high scientific value such as those containing concentrations of species new and/or little known to science.

228. In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;12

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6 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

229. In such cases where a client is able to meet the requirements defined in paragraph, the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains15 of those biodiversity values for which the critical habitat was designated.

230. In instances where biodiversity offsets are proposed as part of the mitigation strategy, the client must demonstrate through an assessment that the project's significant residual impacts on biodiversity will be adequately mitigated to meet the requirements of paragraph 17.

231. The Project site for Gulpur Hydropower Project has been designated as a Critical Habitat[7] in view of its location in a National Park (Poonch River Mahaseer National Park) as well as the presence of two fish species of conservation importance: Mahaseer ***Tor putitora*** and Kashmir Catfish ***Glyptothorax kashmirensis*** listed as Endangered and Critically Endangered respectively in the IUCN Red List. [8] Mira Power Ltd has therefore made a commitment to achieve net gain for biodiversity in the Poonch River basin, (where the proposed Project is located) to meet these requirements of IFC's Performance Standard 6 by development of a Biodiversity Action Plan (**Section 11**).

232. GHPP will have to follow all the Performance Standards of IFC for this project and should ensure that the contractors / subcontracts (subcontractors of the contracts) appointed by MPL all follow the IFC performance standards on Environmental and Social Sustainability.

3.6.2 Environmental, Health and Safety General Guidelines

233. The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project based on the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The General EHS Guidelines consist of the following components.

234. ***Environmental:*** This guideline applies to facilities or projects that generate emissions to air at any stage of the project life cycle. They also look into aspects of energy conservation, wastewater and ambient water quality, water conservation, hazardous materials management, waste management, noise and contaminated land.

235. ***Occupational Health and Safety:*** This section provides guidance and examples of reasonable precautions to implement in managing principal risks to occupational health and safety. Although the focus is placed on the operational phase of projects, much of the guidance also applies to construction and decommissioning activities. This incorporates general facility design and operation, communication and training, physical

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7 Hagler Bailly Pakistan (January 2014), Critical Habitat Assessment of Gulpur Hydropower Project. Prepared for Mira Power Ltd.

8 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

hazards, chemical hazards, biological hazards, radioactive hazards, Personal Protective Equipment (PPE), special hazard environment and monitoring.

236. ***Community Health and Safety:*** This guidance complements the above two guidelines by specifically addressing aspects of project activities which fall outside the traditional project boundaries but which are related to the project operations as and when they occur.

237. ***Construction and Decommissioning:*** This section provides an additional and specific guidance to the prevention and control of community health and safety impacts that may occur during new project development, at the end of the project life cycle or due to expansion or modification of existing project facilities.

3.7 ADB Guidelines

238. The following ADB policies and guidelines shall be applicable to the proposed project:

- ADB Policies, Strategies and Operations Manuals including but not limited to:
  - ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment, SR2 on Involuntary Resettlement (IR), and SR 3 on Indigenous Peoples (IP);
  - ADB Social Protection Strategy (2001);
  - ADB Gender and Development Policy (1998);
  - Public Communications Policy (2011); and
  - Relevant ADB Operations Manual (OM) such as OMF1 for Safeguards Policy Statement, OML3 for Public Communications, OMD10 for Non-sovereign Operations, OMC3 for Incorporation of Social Dimensions into ADB Operations, OMC2 for Gender and Development;[9]

239. The ADB's environmental policy is grounded in its Poverty Reduction Strategy and its Long-Terms Strategic Framework. To ensure the reduction of poverty through environmentally sustainable development, the ADB's Environment Policy contains five main elements: (i) promoting environment and natural resource management interventions to reduce poverty directly, (ii) assisting developing member countries to mainstream environmental considerations in economic growth, (iii) helping maintain global and regional life support systems that underpin future development prospects, (iv) building partnerships to maximize the impact of ADB lending and non-lending activities, and (v) integrating environmental considerations across all ADB operations.

240. Under the last element, the ADB pledges to address the environmental aspects of its operations through the systematic application of procedures for (i) environmental analysis for country strategy and programming; (ii) environmental assessment of project loans, program loans, sector loans, loans involving financial intermediaries, and private sector loans; (iii) monitoring and evaluation of compliance with environmental requirements of loans; and (iv) implementation of procedures for environmentally responsible procurement. In the context of policy-based lending and policy dialogue, the ADB will identify opportunities to introduce policy reforms that provide incentives to

9 Available from http://www.adb.org/Documents/Manuals/Operations/default.asp

improve environmental quality and enhance the sustainability of natural resource management.

241. ADB classifies projects into category A (with potentially significant environmental impact); category B (with potentially less significant environmental impact); or, category C (unlikely to have significant environmental impact).[10] An IEE is required for category B projects and an ESIA, requiring greater depth of analysis, for category A projects. No environmental assessment is required for category C projects although their environmental implications nevertheless need to be reviewed. The proposed project has been classified as a category A project for environment.

242. The ADB's requirements for environmental assessment are specified in its Environmental Assessment Guidelines[11]. The ADB requires that an environmental assessment report and a summary ESIA report be prepared for a Category A project. Important considerations in preparing the environmental assessment include assessing induced, indirect, and cumulative impact, examining alternatives, achieving environmental standards, designing least-cost mitigation measures, developing appropriate environmental management plans and monitoring requirements, formulating institutional arrangements, and ensuring meaningful public consultation. The format of the environment assessment report for program loans is flexible, but includes a matrix describing the environmental consequences and mitigation measures for the policy actions underpinning the program loan.

243. The ADB requires public consultation and access to information in the environment assessment process. For a Category A project, it is required that the groups affected by the proposed project and local NGOs be consulted at least twice: (i) once during the early stages of ESIA field work; and (ii) once when the draft ESIA report is available, and prior to loan appraisal by the ADB. The public consultation process needs to be described in the ESIA and summary ESIA reports.

244. The EMMP is a key component of the ESIA. The ADB places strong emphasis on the preparation of EMMPs during project processing. The EMMP sets out conditions and targets to be met during project implementation. It is also required to develop procedures and plans to ensure that the mitigation measures and monitoring requirements approved during the environmental compliance review will actually be carried out in subsequent stages of the project.

245. The ADB, however, recognizes that the specific construction and operational activities may not be defined well enough at the feasibility stage of the project cycle to provide the details required for an effective EMMP. The ADB therefore requires that the Borrower ensure that a revised EMMP be prepared at the beginning of the implementation stage. The Company will be the project proponent and will be responsible for preparing the revised EMMP.

3.7.1 ADB's Safeguard Policy Statement 2009

246. Built upon the three previous safeguard policies on the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998) and the Environment Policy (2002), the Safeguard Policy Statement was approved in 2009. The safeguard policies

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[10] A fourth category, FI (credit line for subprojects through a financial intermediary, or equity investment in a financial intermediary), requires that an appropriate environmental management system should be developed and assessment carried out.

[11] ADB. 2003. Environmental Assessment Guidelines. Manila: ADB.

are operational policies that seek to avoid, minimize or mitigate adverse environmental and social impacts including protecting the rights of those likely to be affected or marginalized by the developmental process.

247. According to **Section 8**, Biodiversity Conservation and Sustainable Natural Resource Management of ADB's Safeguard Policy Statement 2009, "the borrower/client will assess the significance of project impacts and risks on biodiversity and natural resources as an integral part of the environmental assessment process. The assessment will focus on the major threats to biodiversity, which include destruction of habitat and introduction of invasive alien species, and on the use of natural resources in an unsustainable manner. The borrower/client will need to identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity."

248. Critical Habitat is defined by ADB's SPS 2009 as follows: Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities. Critical habitats include those areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.

249. No project activity will be implemented in areas of critical habitat unless the following requirements are met:

- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.
- The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
- Any lesser impacts are mitigated in accordance with para. 27 (Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous. Peoples or traditional communities, and compensation to direct users of biodiversity.

250. When the project involves activities in a critical habitat, the borrower/client will retain qualified and experienced external experts to assist in conducting the assessment.

251. ADB's safeguard policy framework consists of three operational policies on the environment, indigenous peoples and involuntary resettlement. A brief detail of all three operational policies has been mentioned below:

252. ***Environmental Safeguard:*** This safeguard is meant to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process.

253. ***Involuntary Resettlement Safeguard:*** This safeguard has been placed in order to avoid involuntary resettlement whenever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre- project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.

254. ***Indigenous Peoples Safeguard:*** This safeguard looks at designing and implementing projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems and cultural uniqueness as defined by the Indigenous Peoples themselves so that they receive culturally appropriate social and economic benefits; do not suffer adverse impacts as a result of projects; and participate actively in projects that affect them.

255. ***Information, Consultation and Disclosure:*** Consultation and participation are essential in achieving the safeguard policy objectives. This implies that there is a need for prior and informed consultation with affected persons and communities in the context of safeguard planning and for continued consultation during project implementation to identify and help address safeguard issues that may arise. The consultation process begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle. It provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people and is undertaken in an atmosphere free of intimidation or coercion. In addition, it is gender inclusive and responsive and tailored to the needs of disadvantaged and vulnerable groups and enables the incorporation of all relevant views of affected people and other stakeholders into decision making. ADB requires the borrowers/clients to engage with communities, groups or people affected by proposed projects and with civil society through information disclosure, consultation and informed participation in a manner commensurate with the risks to and impacts on affected communities. For projects with significant adverse environmental, involuntary resettlement or Indigenous Peoples impacts, ADB project teams will participate in consultation activities to understand the concerns of affected people and ensure that such concerns are addressed in project design and safeguard plans.

3.7.2 Social Protection Requirements

256. ADB's Social Protection Strategy (2001 SPS) requires the Borrower to comply with applicable labor laws in relation to the Project, and take the following measures to comply with the core labor standards[12] for the ADB financed portion of the Project:

- carry out its activities consistent with the intent of ensuring legally permissible equal opportunity, fair treatment and non-discrimination in relation to recruitment and hiring, compensation, working conditions and terms of employment for its workers (including prohibiting any form of discrimination against women during hiring and providing equal work for equal pay for men and women engaged by the Borrower);

[12] the core labor standards are the elimination of all forms of forced or compulsory labor; the abolition of child labor; elimination of discrimination in respect of employment and occupation; and freedom of association and the effective recognition of the right to collective bargaining, as per the relevant conventions of the International Labor Organization;

- not restrict its workers from developing a legally permissible means of expressing their grievances and protecting their rights regarding working conditions and terms of employment;
- engage contractors and other providers of goods and services:
- who do not employ child labor[13] or forced labor[14];
- who have appropriate management systems that will allow them to operate in a manner which is consistent with the intent of (A) ensuring legally permissible equal opportunity and fair treatment and non-discrimination for their workers, and (B) not restricting their workers from developing a legally permissible means of expressing their grievances and protecting their rights regarding working conditions and terms of employment; and
- whose subcontracts contain provisions which are consistent with paragraphs (i) and (ii) above.

3.7.3 Public Communications Policy 2011

257. The Public Communications Policy (PCP) of ADB, originally formulated in 2005 and revised in 2011, is aimed at promoting improved access to information about ADB's operations related to funded projects. It endorses greater transparency and accountability to stakeholders involved in a project. The PCP establishes the disclosure requirements for documents and information related to projects. It mandates project-related documents normally produced during the project cycle to be posted on the web.

3.7.4 Gender and Development Policy 1998

258. ADB's Gender and Development Policy (1998) adopts gender mainstreaming as a key strategy for promoting gender equity, and for ensuring that women participate in and that their needs are explicitly addressed in the decision-making process for development activities. The key elements of ADBs gender policy are: (i) Gender sensitivity, to observe how the project affects women and men differently and to take account of their different needs and perspectives in resettlement planning; (ii) Gender analysis, which refers to the systematic assessment of the project impact on men and women and on the economic and social relationships between them; (iii) Gender planning, which refers to the formulation of specific strategies to bring about equal opportunities to men and women; and (iv) Mainstreaming, to consider gender issues in all aspects of ADB operations, accompanied by efforts to encourage women's participation in the decision-making process in development activities.

259. The SPS and safeguards requirements also reiterate the importance of including gender issues in the preparation of safeguards documents at all stages to ensure that gender concerns are incorporated, including gender-specific consultation and information disclosure. This includes special attention to guarantee women's assets, property, and land-use rights and restoration/improvement of their living standards; and to ensure that women will receive project benefits.

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[13] child labor means the employment of children whose age is below the statutory minimum age of employment in the relevant country, or employment of children in contravention of International Labor Organization Convention No. 138 'Minimum Age Convention" (www.ioo.org)

[14] forced labor means all work or services not voluntarily performed, that is, extracted from individuals under threat of force or penalty

4. Project Description

260. The Gulpur Hydropower Project with design capacity of 100 MW will use the flow of the Poonch River for power generation. The Project site is located in Kotli District of Azad Jammu and Kashmir at latitude 33°27' and longitude 73°51', about 9 km South of Kotli Town (**Figure 2-1 Section 1,** 'Project Setting').

261. **Figure 4–1, '**General Layout Plan of the Project' illustrates the layout of the Project. The Project's major components include dam, intake structure, and power house. All the project structures will be located near Barali village on the Poonch River about 11 km downstream of Kotli and about 6 km downstream of the confluence of Ban Nullah with the river. The intake structure and intake portal of the power tunnel will be located on west bank of the Poonch River, 150 m upstream of dam structure on the eastern face of a ridge. The power house and outlet will be located on right bank of Poonch River about 800 m downstream of the dam structure. A low flow section of a length of about 800 m will be created downstream of the dam to the outlet of the powerhouse.

262. The Normal Operating Level (NOL) of the Project shall be at an elevation of 532 meters from the sea level. MPL, in consultation with EPC Contractor and Engineer, has finalized a freeboard of 2 m for the land acquisition and resettlement. **Figure 4–2, '**Area Inundated by Reservoir' shows the inundation area at El. 534 m.

4.1 Land Required for Project

263. The area expected to be occupied by the Project structures, reservoir, colony, camp and approach roads is given in **Table 4–1**. The Table shows that the private land constitutes about 7.3 percent of the total area to be occupied by the Project. About 93 percent (292 hectares) of land required for the proposed project is expected to be utilized for the reservoir. In total, the proposed project will require 314 hectares of land, out of which 92.7 percent is government owned.

Figure 4–1: General Layout Plan of the Project

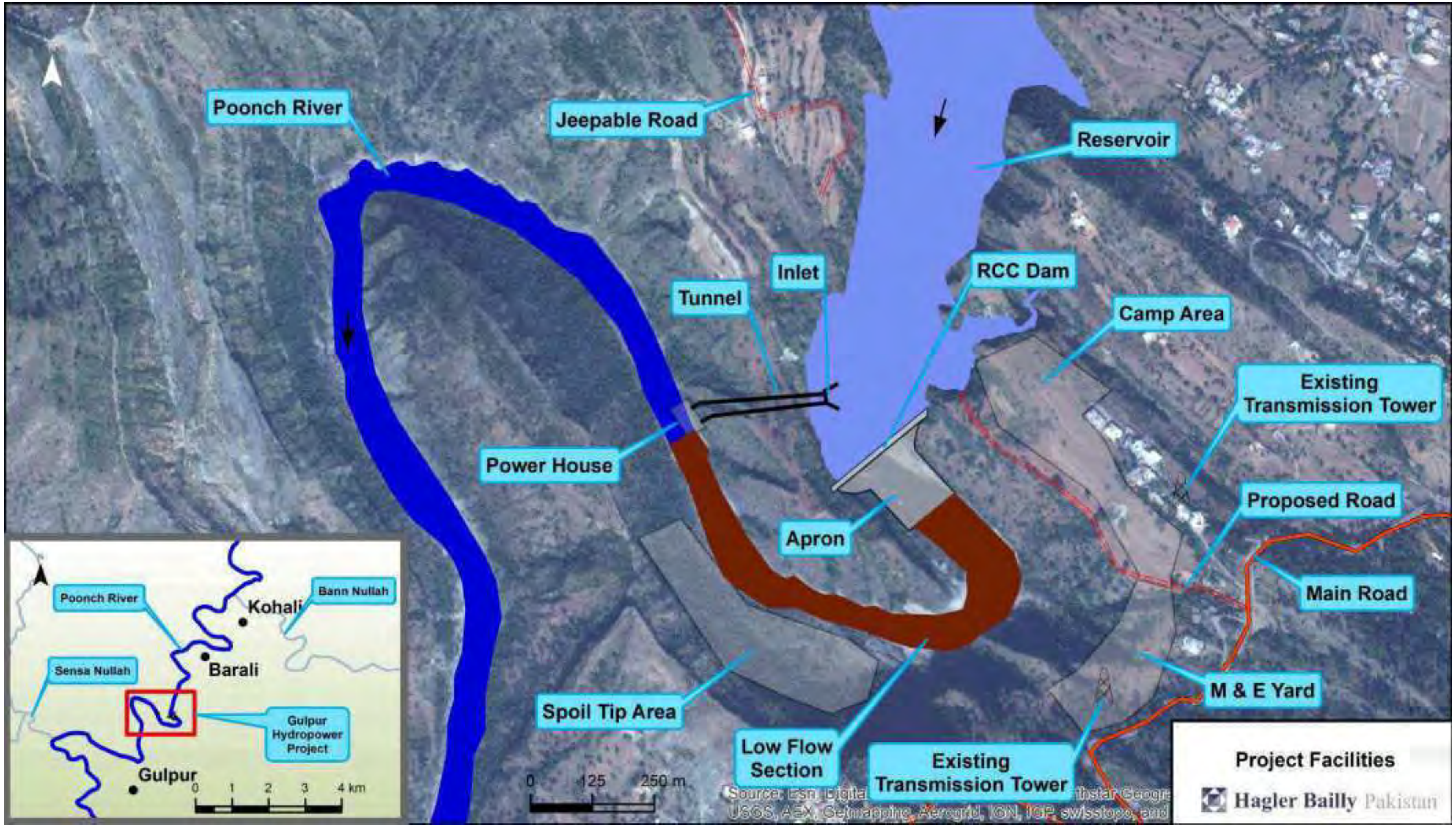


Figure 4–2: Area Inundated by the Reservoir

Table 4–1: Area Requirement for the Proposed Project

No	Structure/ Item	Total Land Area (Hectares)	Govt. Land (Hectares)	Private Land (Hectares)
1.	Reservoir (Submerged Area)	292.34	274.86	17.49
2.	Main Camp	3.73	3.73	0.00
3.	Spoil Tip Area	4.72	4.72	–
4.	Dam Structure Area	5.46	5.46	–
5.	Power House Structure	5.46	–	5.46
6.	M&E Yard	1.99	1.99	–
Total		**313.70**	**290.75**	**22.95**
Percentages		**100%**	**92.7%**	**7.3%**

4.2 Main Components of the Project

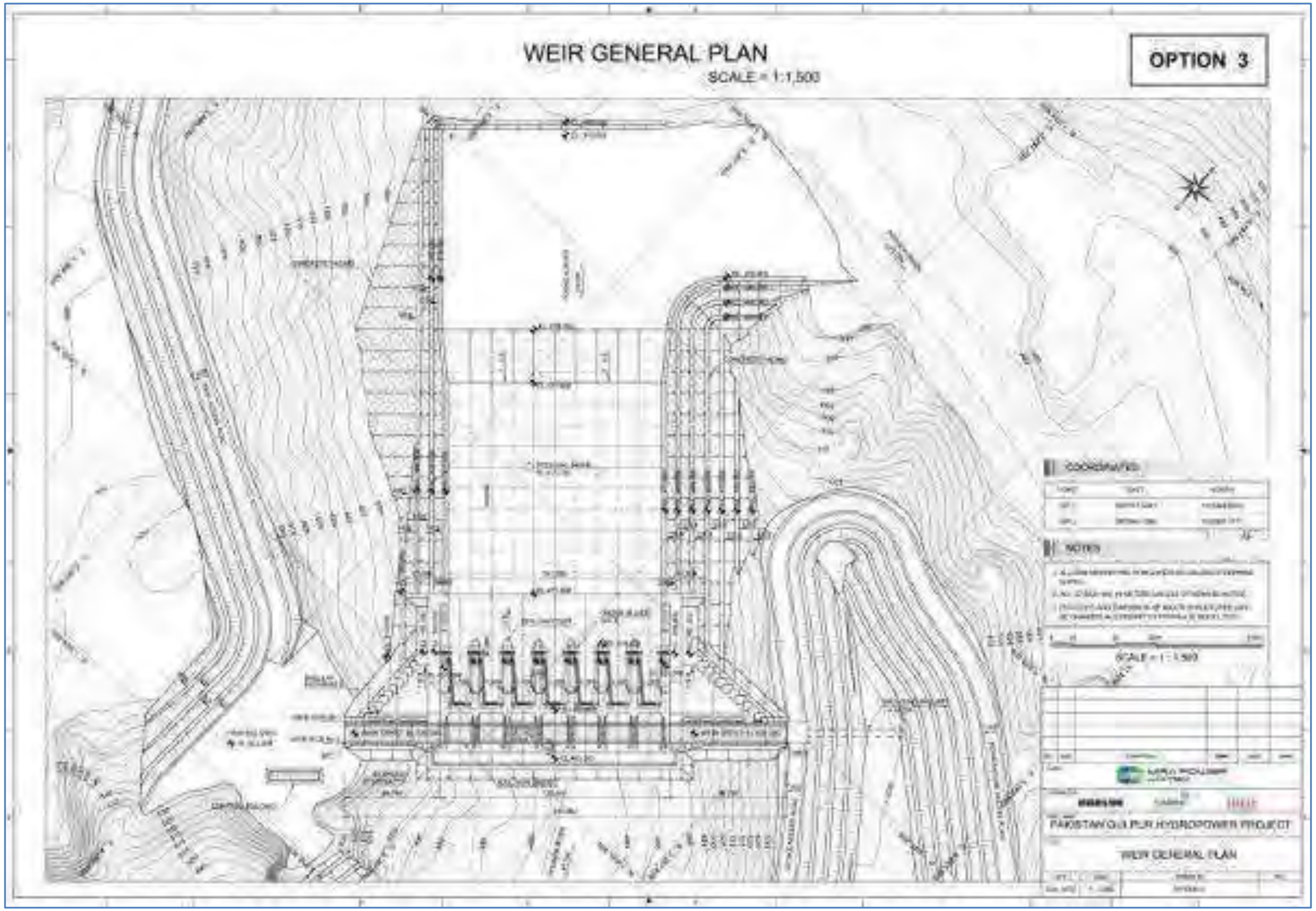
4.2.1 The Dam

264. The dam will be concrete gravity dam (CGD) with dimensions of height: 66 m, length 205 m, and width 80 m to prevent overflow. 100-year frequency flood (13,334 cumec) has been applied to the spillway overflow section, and spillway type has been determined as radial gate type in consideration of economic aspects, constructability, functionality, operations and management. The discharge capacity of the spillway has been designed to maintain the normal operation level (El.532.0m) in case of the 100-year frequency flood. Seven gates (width 11.5 m, height 25.0 m each) will be installed inside the dam body. The dam has been designed to withstand the Probable Maximum Flow (PMF). A 9.5 m wide roadway bridge with its crest at El. 533 m will provide access from one bank to other bank of the river. Bridge shall also be used to operate gate hosting equipment. **Figure 4–3** to **Figure 4–5** illustrate the dam and intake design respectively.

4.2.2 Intake and Penstocks

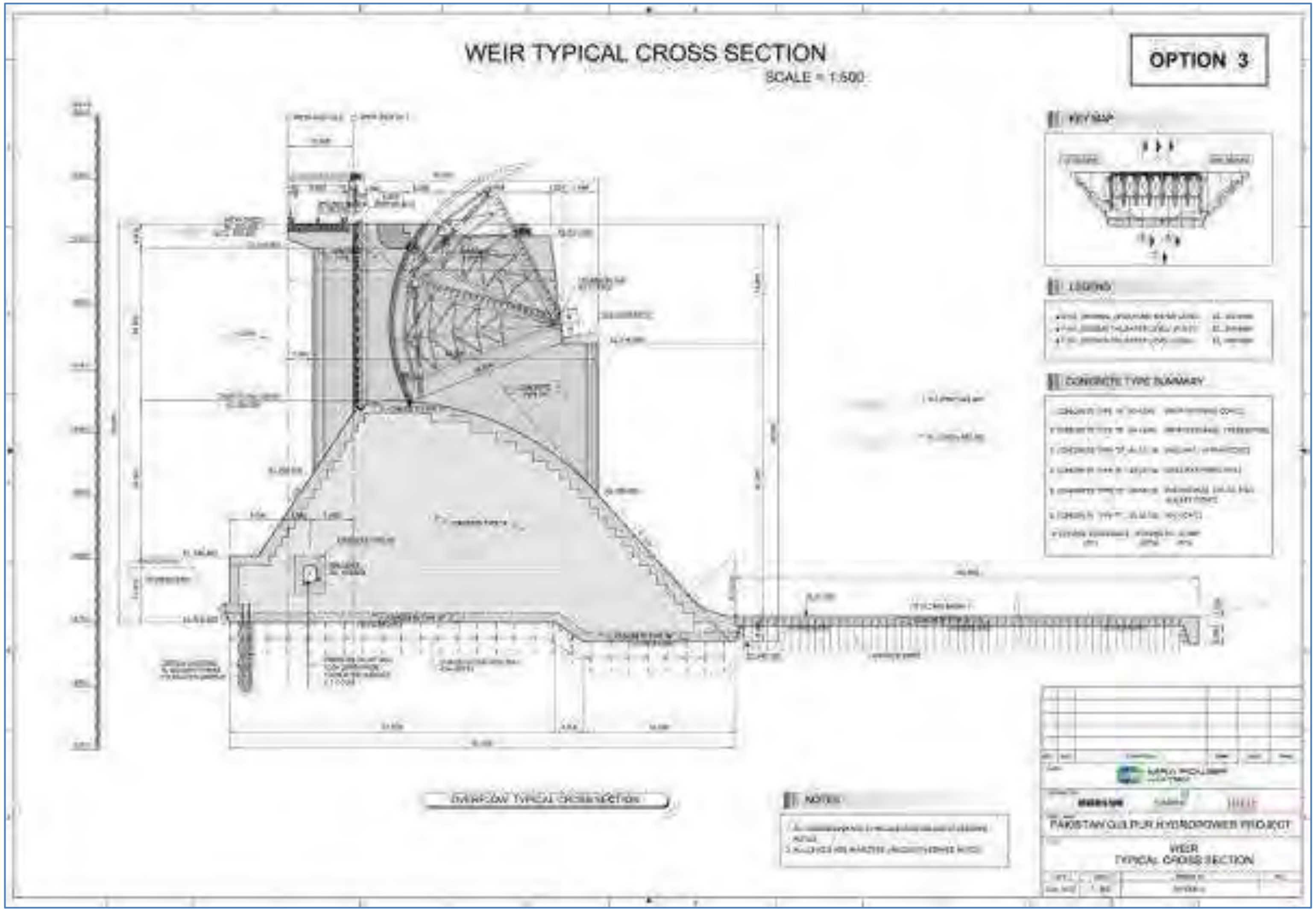
265. The intake structure will have a bell-mouthed entrance with trash-rack and a gate shaft. The intake arrangements are shown on **Figure 4–5**. The intake will connect to a steel penstock with a diameter of 8.0 m, which will be divided into three steel penstocks, each with a diameter of 3.75 m, up to the powerhouse.

Figure 4–3: Layout of Dam Structure



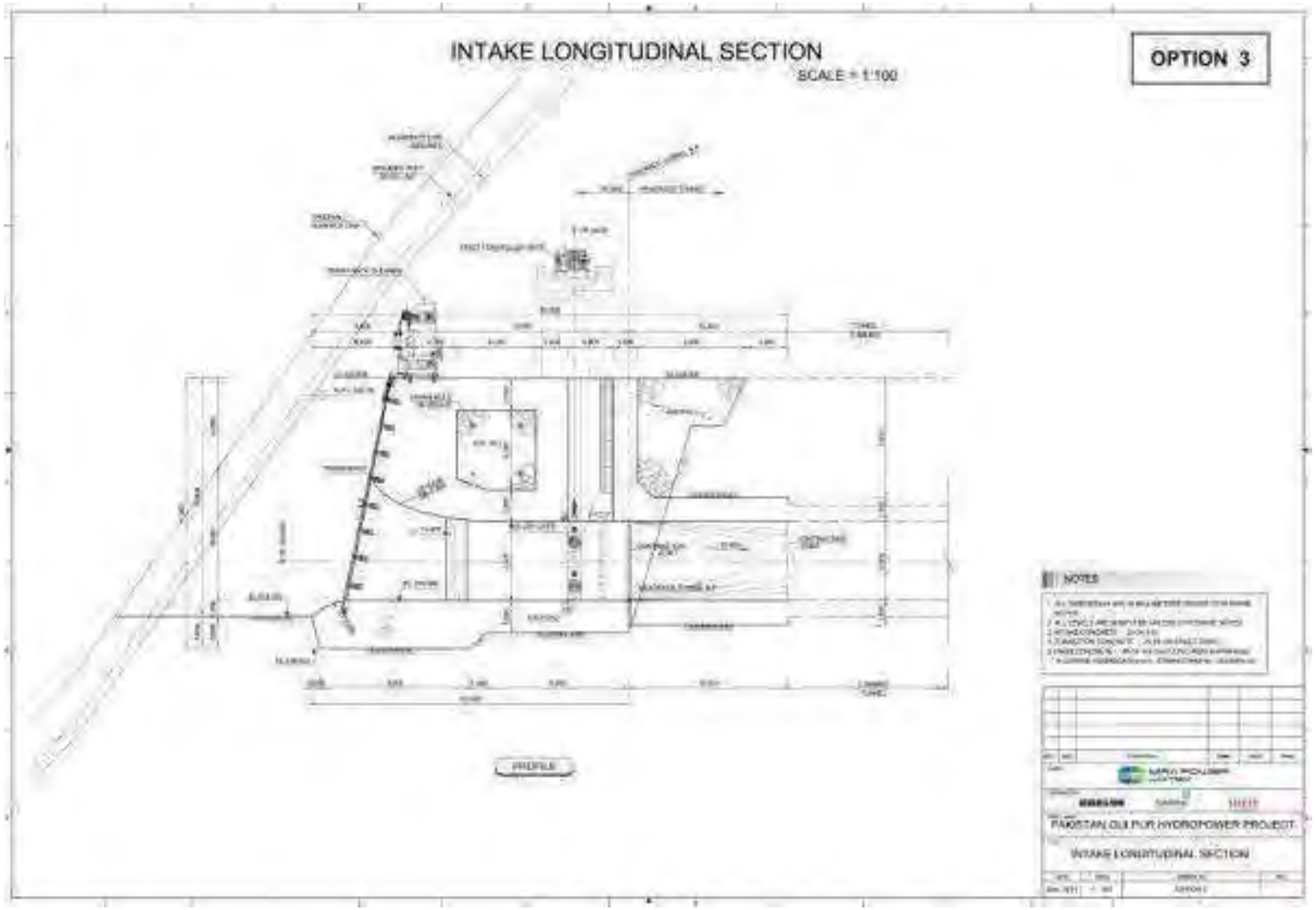
Source: Mira Power Ltd.

Figure 4–4: Details of Dam Structure



Source: Mira Power Ltd.

Figure 4–5: Details of Tunnel Intake



Source: Mira Power Ltd.

4.2.3 Powerhouse

266. The horizontal alignment of the tunnel has been to set to minimize its length. The radius of the curvature has been determined as 300 m to provide sufficient space in addition to the minimum turning radius required for the excavation equipment and steel form (200 m). The tunnel alignment has been designed to cross where the ground condition is sound, and for the tunnel axis to intersect with major fault zones as perpendicularly as possible. Sufficient cover thickness was allowed where the tunnel route crosses below gullies or valleys. Total installed capacity of the powerhouse will be 100 MW and power will be generated with the help of two Kaplan turbines[1], each with flow of 102 m^3/s (cumec) at full capacity and a minimum rated flow of 20 cumec. At times inflows to Gulpur reservoir will drop below 20 cumec. Thus the turbines would have to be switched off until sufficient water is available to turn them back on. Water from draft tubes will be released back into the river with the help of a tailrace channel. A retaining wall has been proposed to protect the powerhouse from high tailwater level during floods.

4.2.4 Environmental Flow Release

267. As discussed in **Section 8.6**, Balance between Environmental Degradation and Economic Benefit, impact of varying levels of environmental flow (EFlow) on project economics and ecosystem integrity were assessed. MPL discussed these impacts with key stakeholders to select an EFlow regime that achieves a balance between the benefits to the ecosystem and the financial loss to the Owner and economy. An EFlow of 4 cumec is proposed to achieve a balance between environment and development. This corresponds to 9.8% of the minimum mean monthly flow of 41 m^3s^{-1}, and 19.9% of the mean minimum five day average flow of 20.1 cumec at the dam site[2]. Principle reasons for setting the EFlow at this level are:

- The relatively small segment (700 m) of the river impacted by low flow due to diversion of river water into the power house tunnel (**Figure 4–1**),
- Adoption of a non-peaking mode of operation for the powerhouse to maintain flow and avoid ecological degradation in the section of the river downstream of the powerhouse to Mangla reservoir (see **Section 9.4,** 'Peaking vs Non-Peaking Operation'), and
- A gain in ecosystem integrity of the river and populations of key fish species through establishment of protection in the river through implementation of the Biodiversity Action Plan (BAP) an outline of which is presented in **Section 12.8,** 'Biodiversity Action Plan'.

4.2.5 Turbine Operating Mode and Rule

268. As discussed in **Section 9.4,** 'Peaking vs Non-Peaking Operation', the powerhouse will not be operated in a peaking mode to avoid stress on the river ecology downstream of the power house. The dam operating rules will be finalized later at the

[1] The turbine configuration is subject to optimization at the detailed engineering stage, where three Francis type turbines with identical or varying flow and power generation capacities may be considered.

[2] Mean annual flow at the dam site is 128 m^3s-1. Mean minimum five day discharge is a flow indicator that is more relevant to the ecological aspects of the river in terms of stress on the aquatic ecosystem, and was used as a flow indicator for environmental flow assessment (See **Appendix H** 'Environmental Flow Assessment' for further details)..

detailed design stage. Dam operation plan will incorporate Climate Change factor as well. The operating rule for the power house assumed for the purpose of this study is summarized below:

Where:

F = river flow in m^3s^{-1}.

C= powerhouse capacity = 198 m^3s^{-1}.

M = minimum turbine capacity = 20 m^3s^{-1}.

E = minimum EF release in m^3s^{-1}.

NOL = normal operating level of the reservoir.

If F > C+E m^3s^{-1}:

- E released from dam;
- C diverted to turbines and released down tailrace;
- remainder spills over dam.

If F between C+E and M+E:

- E released from dam;
- F diverted to turbines and released down tailrace.

If F < M+E:

- NOL maintained;
- turbines switched off;
- F released from dam.

4.2.6 River Diversion

269. Diversion of river flows during construction is required at the dam structure. A diversion tunnel and coffer dam diversion plan has been proposed for the construction of the dam. The water will be diverted downstream through two diversion tunnels by constructing a coffer dam. This cofferdam will provide dry region for the construction of dam and other project components.

4.3 Transmission Interconnection

270. The transmission line of the National Transmission and Dispatch Company Ltd. (NTDCL) to which the project will be connected to for evacuation of power generated passes through the Project site about a kilometer southeast of the power house (**Table 4–1**). The terrain along the probable routes for the connecting transmission line is rocky with sparse vegetation and no built up structures. NTDCL will be responsible for the design and construction of the interconnection which in all likelihood will be located adjacent to the Project site, and will be initiated about two years prior to the expected date of commissioning of the Project.

4.4 Construction Schedule

271. The Project will take about 48 months for completion and commissioning. The construction period for different components of the Project is presented in **Table 4–2**: .

Table 4–2: Summary of Construction Periods

Feature	*Time (Months)*
Weir	30
Intake and Penstock liner	20
Power Tunnel	32
Powerhouse construction and installation	24
Commissioning (Dry & Wet)	3

4.5 Workforce and Camps

272. The Project will employ about 700 skilled, semi-skilled and unskilled workers for its construction. Majority of unskilled and to some extent semi-skilled and skilled workforce will be employed from the local area. However, the contractor will engage specialized workforce including engineers, geologists and construction management staff from the outside area. While most of the local workforce will go back to their dwellings on daily basis, approximately 400 will be accommodated in the camp located near the project structures. Adequate temporary camps, offices and ancillary facilities at convenient locations near the site will be established. Owing to the hilly terrain, there is a limitation in the availability of suitable areas near the project structures for establishing residences, workshops, batching plants and material storage areas separately (see **Figure 4–1**). Moreover, accommodation is also readily available in Kotli City[3] on rental basis which the contractor may hire for establishing main office and hostels for the workforce. Around 120 people will be employed during the operation of the Project, 40 of which will be accommodated in the camp located on Project site. Drinking water meeting NEQS will be provided to the workforce at the camps and in the working areas. The project EHS guidelines will be followed in operation of the camps.

4.6 Access Routes for Construction Sites

273. The Project falls in a terrain with high hills having steep slopes and narrow valleys in between. Though the dam and power house sites lie close to the main road connecting Kotli to Mirpur, construction sites are located down the hills having very steep slopes. The contractor will develop access road to connect the Project facilities to the main road. About 250 meters of this road will be located outside the Project site. The proposed road is shown in **Figure 4–1.**

274. The site is located about 170 km from Islamabad and 285 km from Lahore, it is directly approachable from Islamabad and Lahore by a two-lane, all-weather paved mountainous road. Access to the Project site from Islamabad is via Kahuta to Kotli and to Gulpur. Cement and sand for the Project (quantities and sources indicated in **Table 4–3**) will mainly be transported through this route. The other route is from Lahore via GT Road to Dina and then to Mirpur and to Gulpur (**Figure 4–6**), which will be used for transport of imported machinery and equipment. Both the routes will be used for transport of coarse aggregate, rock material for stone pitching, and reinforcement steel. Limits set by the National Highway Authority (NHA) for the axle loads of the vehicles will be followed to avoid damage to the access roads.[4]

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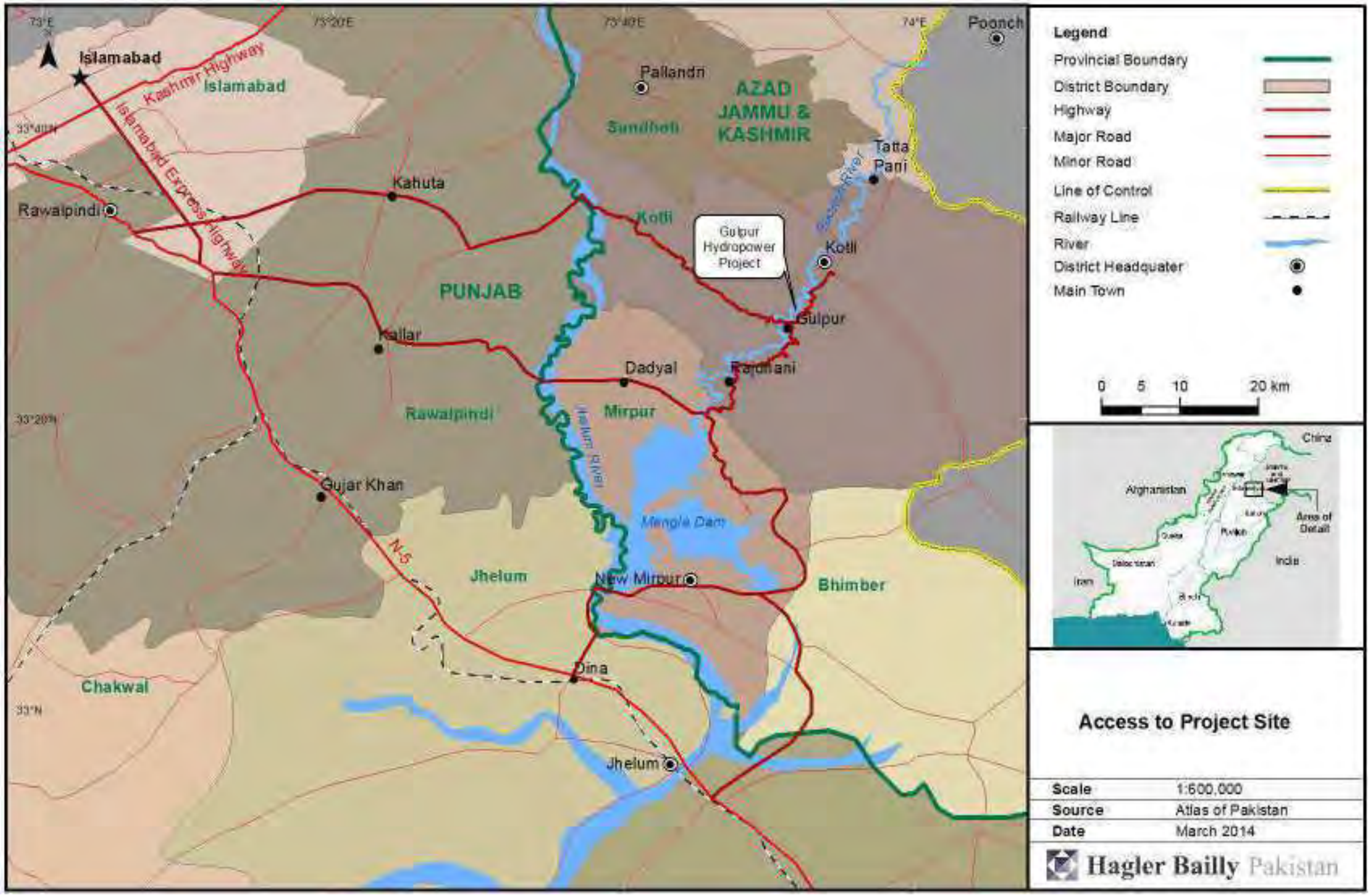
[3] Verbal communication with real estate agents in Kotli.

[4] See http://downloads.nha.gov.pk/index.php?option=com_content&view=article&id=395:axle-load-control-axle-load-limits&Itemid=85 for axle load limits set by NHA.

Figure 4–6: Access Route for Transportation of Machinery and Equipment



4.7 Construction Material

275. The materials used for the construction of the proposed project include coarse aggregates, fine aggregates (sand), rock for stone pitching and riprap, earth, water, cement and steel. Estimated quantities of various materials along with the source are shown in **Table 4–3**.

Table 4–3: Quantities and Sources of Construction Material

No.	Item	Quantity	Source
1	Coarse Aggregate	300,000 cu m	The material will be extracted from the following sources: River bed boulders, gravel, cobbles. Crusher plants are already in operation near Kotli and Gulpur Towns. This will be part of the Sediment Mining Plan and subject to its implementation. The terms of reference for the Sediment Mining Plan are provided in **Appendix F.** Sandstone from excavation of dam, tunnel and power house areas. Quarrying limestone from Sawar (22 km from Kotli on Kotli-Tatta Pani Road), Dandli (16 km from Kotli on Dandli-Ghoi Road), Jhanjora (34 km from Kotli on Tatta Pani-Ghoi Road). Small scale quarrying is already being done on these sites by a local contractor for road and building construction.
2	Fine Aggregate (Sand)	150,000 cu m	While sand can be mined from the river bed, its quality is not suitable for the Project construction. Moreover quantities available from the river are not sufficient for Project purposes. Therefore, sand will be transported from licensed mines in Lawrencepur and Qibla Bandi located in Attock District about 200 km from the Project facilities.
3	Rock Material for Stone Pitching and Riprap	5,000 cu m	Rock material will generally be available from the excavation of the dam site and will be used for the construction of dam, power house and tunnel.
4	Cement	90,000 tonnes	There is no cement factory in AJK. 60,000 tonnes of Portland cement will be required and transported from Islamabad, Nowshera and Attock located at a distance of 200 to 300 km from Kotli City. 30,000 tonnes of slag cement will be required and transported from Karachi (about 1,500 km from Kotli) through rail and road transportation. Road network is available from the factories up to Project site. However, transportation on large truck-trailers will be difficult as about 100 km of the road passes through hilly terrain, encountering very sharp turns and steep gradients. Therefore, a caravan of about 30 trucks, each with a capacity of approximately 10-12 tonnes will be required to meet daily demand of cement of about 300 tonnes.
5	Reinforcement Steel	15,000 tons	Steel of the desired specification will be transported from re-rolling mills located at Lahore and Rawalpindi.

No.	Item	Quantity	Source
6	Water (including concreting, water sprinkling, compaction of earth/rock fill for cofferdams)	100,000 cu m	Availability of ground water in the Project area is limited. Poonch River and Bann Nullah are the only sources for water. Water from the river and nullah would however need some treatment to make it silt and sulfate free for use in concreting.

4.8 Construction Machinery

276. The Project will require various types of machineries for construction purposes. These will include bulldozers, excavators, blasting equipment, shovels, dumpers, batching plant, crushing plant, tankers and trucks.

4.9 Water Requirement During Construction and Operation

277. River water will be used for sprinkling to control dust during construction, compacting, and for maintenance of vegetation during operation. River water is not considered to be acceptable for use in batching of concrete during construction, and will need treatment before it can be used for this purpose. The Project will require about 100 m^3/day of spring water at peak during construction, both for construction purposes and for the camp, which will be obtained from sources approved by the local authorities avoiding impact on existing local use. The Project will install its own water treatment facilities to provide drinking water and water for use in the offices and the camp area during operation, requirement for which is estimated at 10 m^3/day.

4.10 Excavated Material

278. The Project will generate about 1.0 million cubic meters of rock material (mostly sandstone and siltstone) from excavation. Excavation for dam will generate about 0.56 million cubic meters, power tunnel 0.21 million cubic meters and power house 0.20 million cubic meters. Depending upon the quality of the excavated material, some quantity will be used to meet the requirement of aggregate rock fill at cofferdams and stone pitching. The area is mostly constituted of high hills that are generally occupied by forests, limited area of nearly flat benches that are occupied partly by settlements and partly used for cultivation, and narrow river and nullah (stream) gorges. The topography of the land in vicinity of the project structures and in the surroundings is such that limited area is available for disposal for the waste material. The spoil tip area shown in **Figure 4–1** will be used to deposit the excavated material. Details of rock material to be excavated are given in **Table 4–4.**

Table 4–4: Rock Excavation Quantities and Periods

Feature	*Estimated Quantity (m^3)*	*Time (months)*	*Peak Quantity m^3/day*
Dam	663,000	14	1600
Intake	88,045	2	600
Powerhouse	614,263	4	1200

4.11 Project Cost

279. The Project cost is estimated at US$ 315.00 million.

5. Description of Environment

280. The description of environment has been prepared for three different environments, the physical, ecological, and the socioeconomic. Each type of environment has its own specific Study Area defined which was surveyed. The surveys and data collection was carried out to establish baseline information for assessment of impacts due to the Project, and for comparison in future to monitor and evaluate impacts due to the Project in the construction and operation phases.

5.1 Physical Baseline

5.1.1 Area of Influence

281. The potential impacts of the Project on its surrounding physical environments include air and water quality impacts, noise generation, land transformation and changes to soil. These are expected to reduce with the increased distance from the Project facilities, affecting more the areas located closer, up to five kilometers, to the Project facilities. For this, a study area of five kilometers around the site was delineated in view of potential impacts, to assess the baseline conditions in the areas likely to be affected by the Project due to its proximity to the Project site. This is referred to as the Physical Impact Study Area or simply Study Area in this section (**Figure 5-1**).

5.1.2 Geology

282. The Study Area is a part of land formations developed at the foothills of Himalayan Ranges through tectonic events subsequent to those that caused the formation of the Himalayas. The Project area contains middle Siwalik formations developed from the sedimentary deposits (**Figure 5-2**) contributed by a number of drainage channels from the uprising Himalayan Mountain Ranges. The rock formations include extremely folded beds, having almost vertical dips, of various types of sandstones, clay–stones and siltstones. As compared to Himalayan Ranges, the mountains of the Project area have low to medium surface relief. The Poonch River and nullahs generally pass through deep and narrow gorges having almost vertical slopes. Occasionally, relatively wide valleys are also encountered which are being used for settlements and agricultural activities. The typical examples of such settlements in the Project area are Kotli and Gulpur towns. Similarly, some open and relatively flat areas are also present on the raised terraces of the mountains. Invariably these areas are also used for settlement and agricultural activities. The typical examples of the raised benches are the Barali Village, Rehmani Mohalla and Kameli in the vicinity of the Project facilities.

283. Mostly the mountains are covered with primary soils, except along the river and nullahs where the beds are almost devoid of soil material. Within the flood plains where slopes are milder to nearly level, deposits of secondary soils are observed. Such areas include Mandi, Mandi Juzvi, Hill Kalan, areas of Kotli Town and a small bench near Jamalpur Village, part of which are used for agricultural purposes.

284. Major geological formations in the Project area are:

Pliestocene and Recent Deposits Overburden

285. The overburden present in the area is river alluvial material and overburden on the terraces. River alluvial material is present on the river bed, and along the slopes of the river valley. The thickness of alluvial material in the river bed is between 3.0 m to 5.0 m. This material consists of sandy gravels, cobbles and some boulders, which are rounded to sub–rounded, few sub–angular, semi spherical, some platy and oblonged. These generally are of igneous and metamorphic origin, but some sedimentary (sandstone and limestone) origin are also present. The overburden on the terraces and especially along the alignment of power tunnel and around the proposed portal consists of weathered clay and siltstone with pieces of sandstone. The terraces in and around to Barali village area consist of sand, gravel and silt.

Scree, Talus and Vegetation

286. Overburden on the slopes of the river valley is of detritus and detached blocks and boulders of sandstone, at places mixed with weathered and eroded siltstone and claystones. The material is mostly composed of different sizes of broken pieces of rocks due to weathering effect on parent rock. The vegetation consists of self–grown plants and grass, thorny bushes and small trees planted by Water and Power Development Authority (WAPDA) Watershed Management Section and AJK Forest Department.

Classification of Rocks

287. Petrographically, this part of Nagri Stage of Siwaliks also has three main units of rocks which are:

- Sandstones of various strength and cementation
- Claystones
- Siltstones

Figure 5-1: Physical Impact Study Area

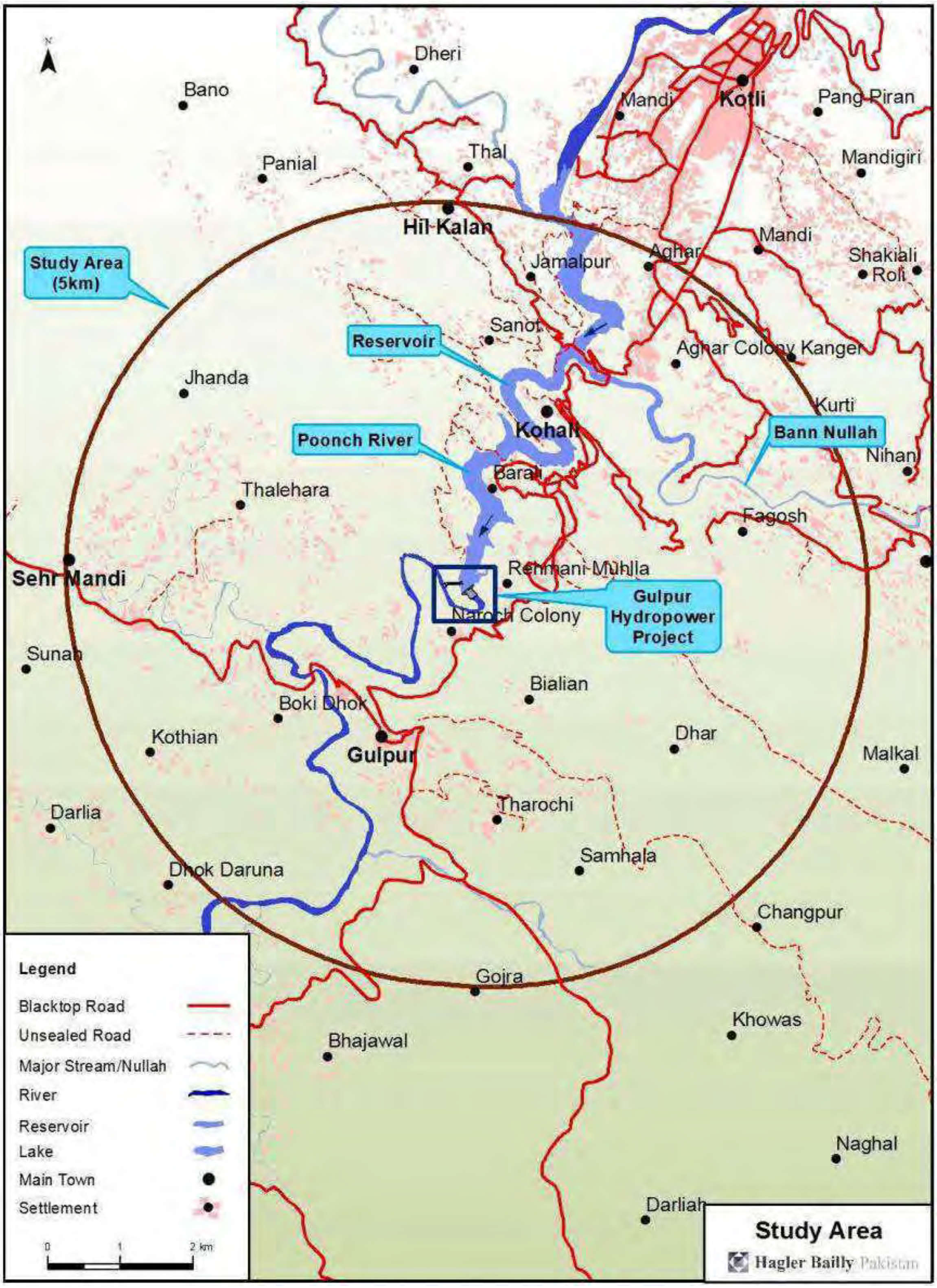
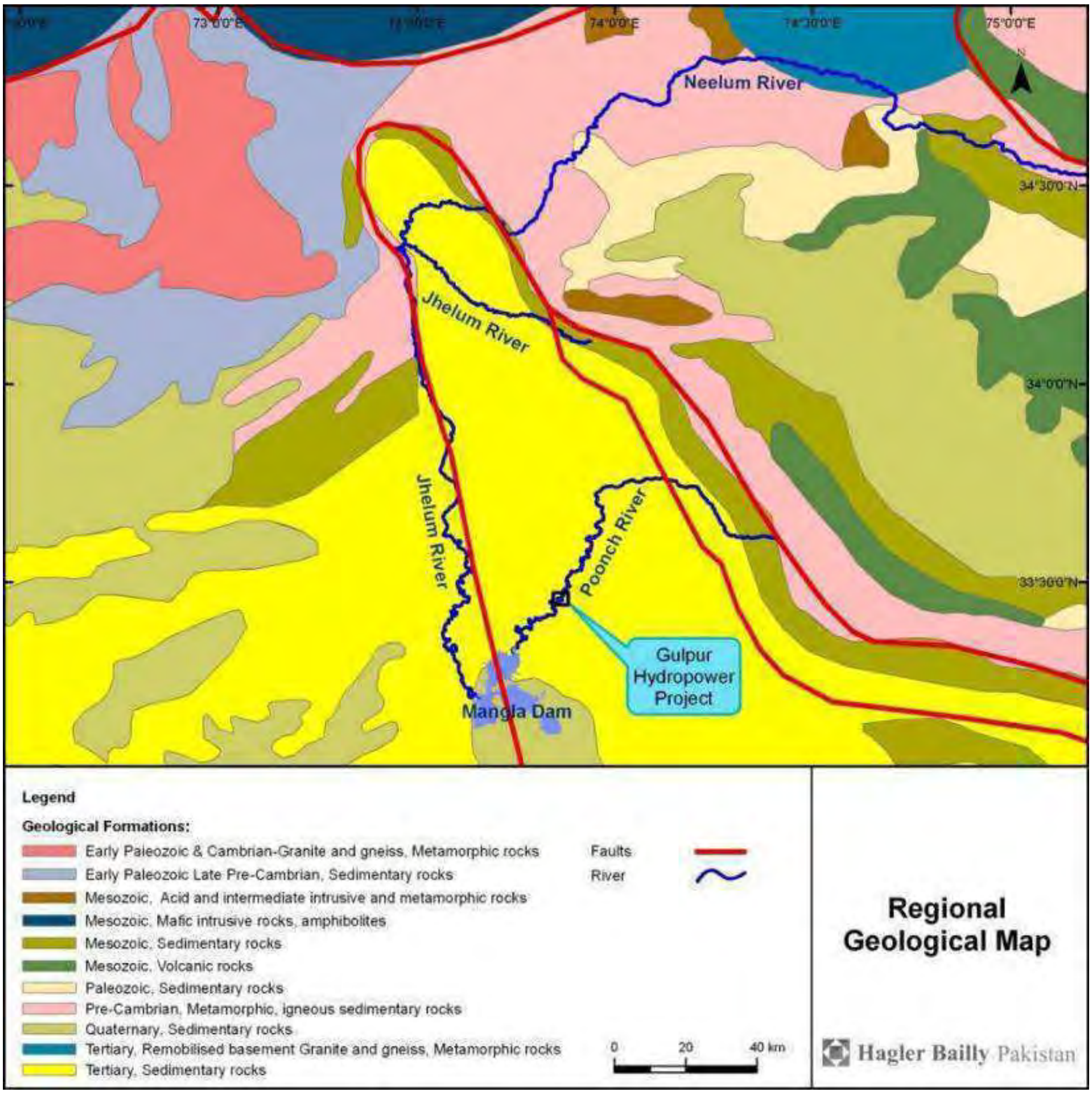


Figure 5-2: Regional Geological Map



Sandstone

288. Sandstones of this part of Nagri (middle Siwaliks) are classified into three categories:

- Sandstone–1: This type of sandstone is always present in the form of ribs and lenses in the main beds of Sandstone–2.
- Sandstone–2: Moderately strong to strong, dirty greenish grey to light brownish grey, medium to coarse grained, moderately to well cemented and cross bedded.
- Sandstone–3: Moderately weak to moderate strong, light brownish grey to grey, fine grained, at places silty, slightly to moderately weathered, highly weathered at places, thinly bedded, closely jointed and fractured generally present in thick beds of clay and siltstone.

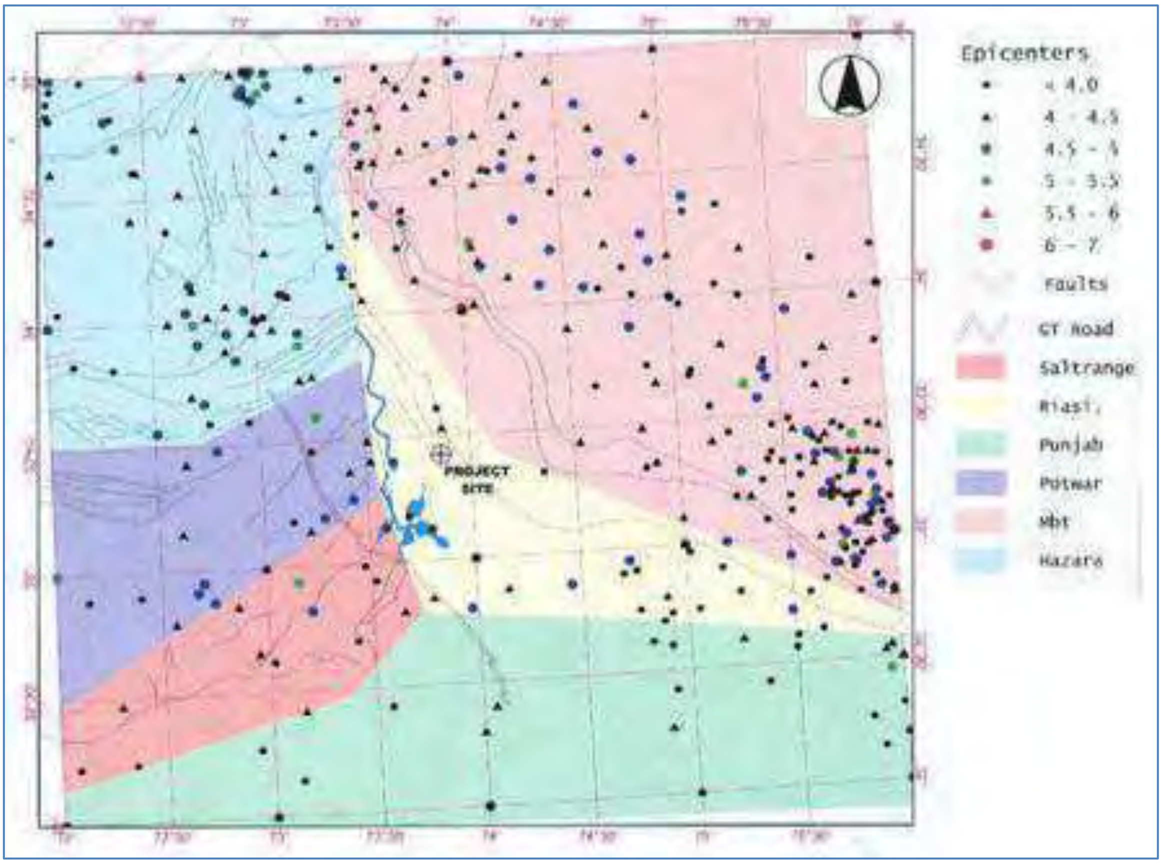
Claystone/Siltstone

289. Alternate beds of Claystone/Siltstone of various shades vary in thickness from place to place. Siltstone is moderately weak to moderate strong, various shades of brown and brownish grey, moderate thick to thinly bedded, partly laminated, moderately weathered at exposed surfaces, moderately to closely joint and moderate fractured.

5.1.3 Seismicity

290. Earthquakes pose a multitude of hazard to dams, either by direct loading of the structures or by initiating a sequence of events that may lead to dam failure. The project area lies very close to the Riasi Thrust which is a branch of the Main Boundary Thrust (MBT). Virtually, the former almost passes through or near to the course of the Poonch River, while the latter bounds the Project area at a distance of about 5 km towards east. Consequently, the proposed Project will be located in active seismic region that has experienced numerous large earthquakes with magnitude greater than 7. These are believed to be associated with MBT in Himalayan range. Detailed Seismic Hazard Study is included in **Appendix A.**

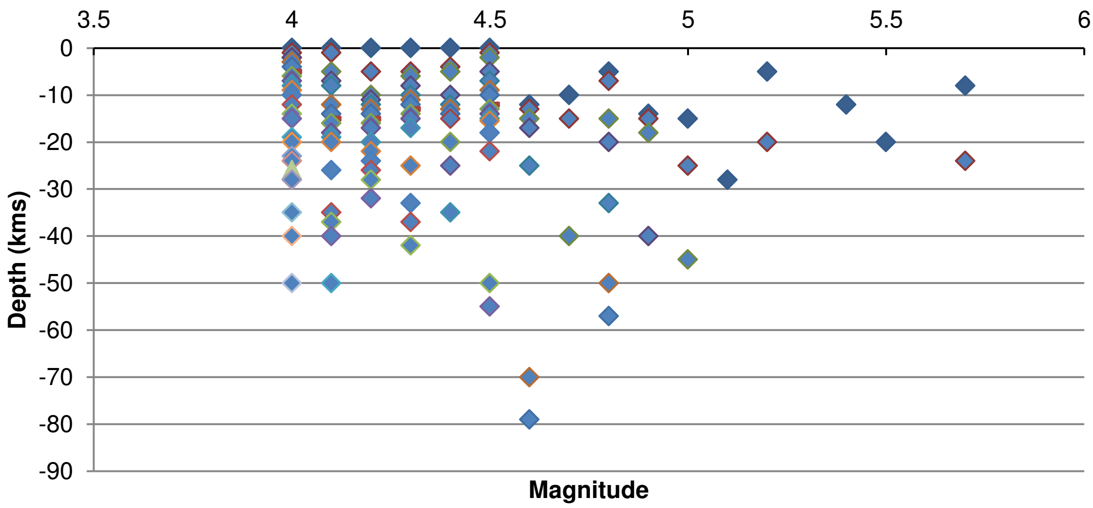
Figure 5-3: Seismotectonic Map of the Area



291. The micro-seismic data of the region indicate that the region is very active on a micro-seismic level with frequent earthquakes of magnitude greater than 4. The largest earthquake recorded by regional network is the Kangra earthquake of magnitude Ms=8.0 occurred on 4th April 1905 about 200 km southeast of the project site. Two earthquakes of magnitude greater than 6 have also been recorded in this area.

292. **Figure 5-4** shows distribution of seismicity with depth in the region as recorded by Mangla microseismic network. Major concentration of earthquakes is within upper 20 km. It is important to note that all the events having magnitude 5 or greater are originated within shallow depth (< 20 km). This aspect of seismicity depicts that seismic forces are active at shallow depth, which increases earthquake hazard within this region. Majority of the events falls within focal depths less than 30 km. Though, events with magnitude greater than 5 do not seem to occur beyond 30 km depth, nevertheless, events with magnitude 4 to 5 do occur at depths up to as much as 60 km. There is only one earthquake that was located at focal depth of 79.3 km.

Figure 5-4: Micro-seismicity of the Project Area



5.1.4 Topography

293. The relief in the catchment area of Poonch River varies from El 200 m to 4,500 m. This elevation range was divided into 9 elevation bands with 500 m intervals. It is clear from **Figure 5-5** that most of the catchment area of proposed Project (approximately 67%) has an elevation in the range of 500–2,500m. The proposed location of Project site has an elevation of 500 m ±50 m.

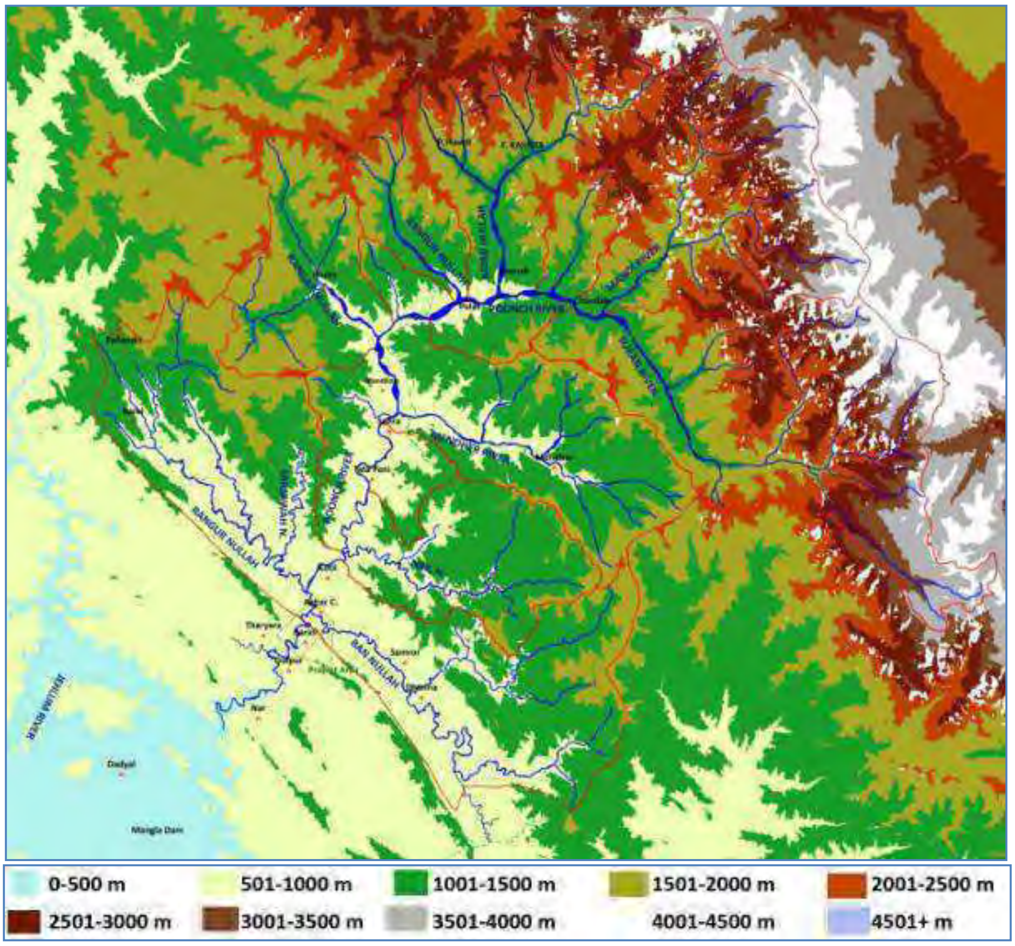
5.1.5 Soils

294. The texture of the primary soils varies from moderately fine to moderately coarse depending upon the rock type from which these have developed. However, the secondary soils are mostly moderately coarse textured. The soils of the raised terraces in floodplains are generally devoid of the stony material. The soils of lower terraces generally contain varied quantities of pebbles, cobbles and boulders.

295. During site visit conducted in August 2013, soil samples were collected from the following 4 locations:

- Barali village
- Gulhar
- Jamal Pur
- Bann Nullah

Figure 5-5: Elevation Band Map of Catchment Area of Poonch River



296. The sample locations were well distributed to represent the Project area; **Figure 5-6** shows the sampling locations. Test results of these samples are presented in **Table 5-1**. TKN (nitrogen) and phosphorous contents of the samples indicate moderate fertility of soil. Metal contents do not vary significantly through the area sampled, indicating absence of contamination from any industrial activity or spills.

Figure 5-6: Soil Sampling Locations

Table 5-1: Soil Analysis Results

No.	Parameters	Method	Unit	LDL	Test Results			
					Barali	Gulhar	Jamal Pur	Bann Nullah
1	Nitrogen (TKN)	APHA–4500 N_{org} B	mg/kg	0.1	1.53	3.02	1.38	1.8
2	Phosphorous	APHA–4500 P C	mg/kg	0.05	2	1.72	2.6	2.36
3	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.5	3.55	<0.50	<0.50	<0.50
4	Chromium (Cr)	USEPA 3050 B	mg/kg	0.5	19.32	15.76	28.65	26.11
5	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.5	75.16	95.19	100.9	76.69
6	Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	27,153	21,934	26,119	25,842
7	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5
8	Sulfate $(SO_4)^{-2}$	Gravimetric	mg/kg	5	299	213	201	102
9	Total Dissolved Solids (TDS)	Gravimetric	mg/kg	5	989	1,1931	688	994

* Source, physical baseline survey, sampling, testing and analysis conducted in August 2013, (LDL: Lowest Detection Limit <: Less Than)

5.1.6 Air Quality

297. No air quality monitoring data is available for the Project area. In general there are no major sources of air pollution, viz., industries, exist in the Project area except road traffic in the valleys of Poonch River and Nullahs. The ambient air quality monitoring within the Project area was carried out through monitoring stations and the sampling points are shown in **Figure 5-6**. Representative samples of the ambient air quality in the Project area were analyzed, which would also help in assessing the conformity to standards of the ambient air quality during the construction and operation of the Project. The existing ambient air quality of the study area serves as an index for assessing the pollution load and the assimilative capacity of any region and forms an important tool for planning further development in the area.

298. Air quality monitoring was carried out in August 2013 for the following four parameters:

- Carbon Monoxide (CO)
- Nitrogen Dioxide (NO_2)
- Sulfur Dioxide (SO_2)
- Particulate Matter (PM_{10})

299. The methodology followed is given in **Appendix A.** The values obtained are reported in **Table 5-2**. It can be seen that the measured levels of CO, NO_2, and SO_2 are well below the limit set by the standard. In case of CO, the 24 hour average measured level was about 0.9 mg/m^3 compared to NEQS limit of 5 mg/m^3 for an 8 hour average. Given this difference and the absence of industrial or transport related emission sources in the area, it is highly unlikely that the 8 hour limit for CO will be exceeded. The air quality in the project area can therefore considered to be in compliance with National Environmental Quality Standards (NEQS) for Ambient Air.

Figure 5-7: Air Quality Sampling Points

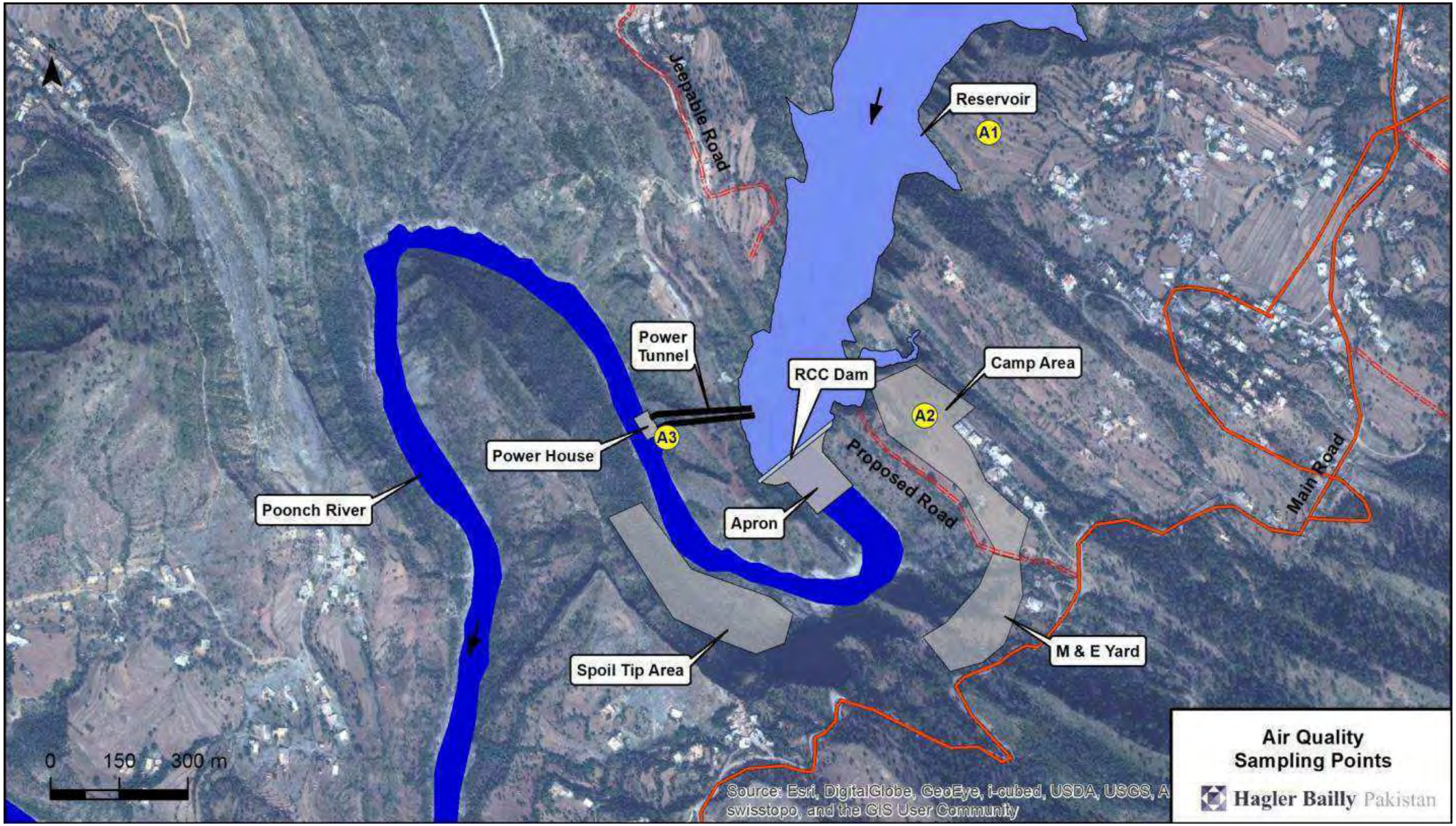


Table 5-2: Average Obtained Concentrations of Priority Air Pollutants

Parameter		Carbon Monoxide (CO)	Nitrogen Dioxide(NO_2)	Sulfur Dioxide (SO_2)	Particulate Matter (PM_{10})
Unit		***mg/m^3***	***ug/m^3***	***ug/m^3***	***ug/m^3***
Duration		24 Hours	24 Hours	24 Hours	24 Hours
Lowest Detection Limit		0.01	5	5	2
National Environmental Quality Standards		5[1]	80	120	150
IFC Standards				125	150
Average Obtained Concentration	Proposed Power House Site	0.85	<5.0	<5.0	97
	Proposed Camp Area	0.82	<5.0	<5.0	88
	Bann Nullah	0.72	<5.0	<5.0	75
	Proposed Batching Plant	0.93	<5.0	<5.0	67

Source, physical baseline survey, sampling, testing and analysis conducted in August 2013

1. The NEQS specifies an 8 hour average limit.

300. The ambient particulate matter PM_{10} was 97ug/m^3 at proposed power house site and 88 ug/m^3 at the proposed camp area.

5.1.7 Noise

301. Noise level monitoring was conducted at two different residential locations (**Figure 5-8**). These locations were chosen as their will be closest to the proposed Project facilities area. The standard procedures for measurement of noise levels as specified in the NEQS require sound measurement over a 24 hour period, which is then divided into daytime and night time segments. Sound level measurements were divided between two locations over 24 hour period. The duration of each measurement was two hours each. This methodology was adopted to record fair representation of noise levels over two locations spread over 24 hour period. A sound meter[1] using fast response time and Leq[2] method was used. The measurements were taken on March 19th -20th 2014. The sound meter was placed on the roof of the house nearest to the proposed Project site at two different settlements. This was done to avoid barrier effect of the walls of the house and to record the highest possible sound measurement. No significant variation in the daytime and nighttime noise levels was observed. **Figure 5-8** shows the values obtained during noise level monitoring at proposed Project site.

302. Noise level was observed to be in range of 45 to 56 dBA at two receptor settlements where monitoring was conducted. NEQS and IFC standard for daytime noise is 55 dBA and nighttime noise level is 45 dBA. It was observed during field data collection that morning noise levels were higher due to the contributions by pet animals

[1] Extech model number 407780

[2] Leq is the preferred method to describe sound levels that vary over time, resulting in a single decibel value which takes into account the total sound energy over the period of time of interest.

such as hens, goats and dogs in the area. Daytime noise levels in Naroch Colony exceeded the IFC standards for residential area and were higher than noise levels in Rehmani Mohallah due to the contribution of noise from the river rapids. Naroch Colony is located at higher altitude and faces narrow valley which amplify the noise from the river rapids.

303. The nighttime noise levels at both the settlements exceeded IFC standards due to the noise contribution from the river. The measurements recorded during the survey are summarized in the **Table 5-3.**

5.1.8 Climate and Meteorology

304. There are number of meteorological stations within and in the vicinity of the catchment area where data is available for meteorological parameters. These include Sehr Kakota, Plandari, Mangla, Bagh, Rawalakot and Khandar. Kotli is the representative station for which meteorological parameters like temperature, precipitation, humidity and evaporation are available.

305. Generally, the Project area falls in sub–humid and sub–tropical zone. It has moderate summer and cold winter. The climate is influenced by monsoon the months of July and August. Consequently, the weather is pleasant in the months of March to May and August to October.

306. **Winter Season:** Though the duration of winter season depends on altitude, it generally lasts from November to February in proposed Project area. It is characterized by heavy frost in the lower areas and some snowfall at higher elevation. Rain and snow during winter season come from north–western air currents, and snowfall starts at higher elevations towards the end of November or early in December

307. **Spring Season:** Though there is no characterized spring season in the area, but the weather is pleasant in the months of March to April. This is the period of intense phonological activity at the higher elevations and can be termed as spring.

308. **Summer Season:** This is characterized by dry spells in April to June followed by frequent showers in the moist or wet zone. At this time of the year the lower valleys are hot. Hot winds from Punjab and sunny weather in arid and semi–arid parts cause intense summers.

309. **Rainy Season:** It starts with the advent of monsoons either towards the end of June or early in July and lasts till middle or sometimes up to the end of September. The bulk of rainfall is received during this period in the wet zone. After the rainy season, the sky becomes clear and there is very little rain, if any, during October to November.

Rainfall and Humidity

310. The average annual precipitation in the area is 1,237 mm. However, there is a great seasonal variation. The maximum rainfall occurs during the months of July and August when the average precipitation is 266 mm and 271 mm, respectively. Minimum rainfall is experienced in November with the average of 24 mm (**Table 5-4**). **Figure 5-9** presents the yearly precipitation and evaporation trend in Project area. Evaporation data plotted in Figure 5-6 is for the period 1997-2002, same as that reported in **Table 5-4**.

311. Mangla Reservoir is the nearest station where the evaporation data was available. Climatic conditions of this reservoir are similar to that of Kotli and as such this data has been utilized for Kotli. Mean monthly maximum and minimum evaporation at Mangla Reservoir is 229 mm and 46 mm, respectively.

Figure 5-8: Noise Sampling Locations

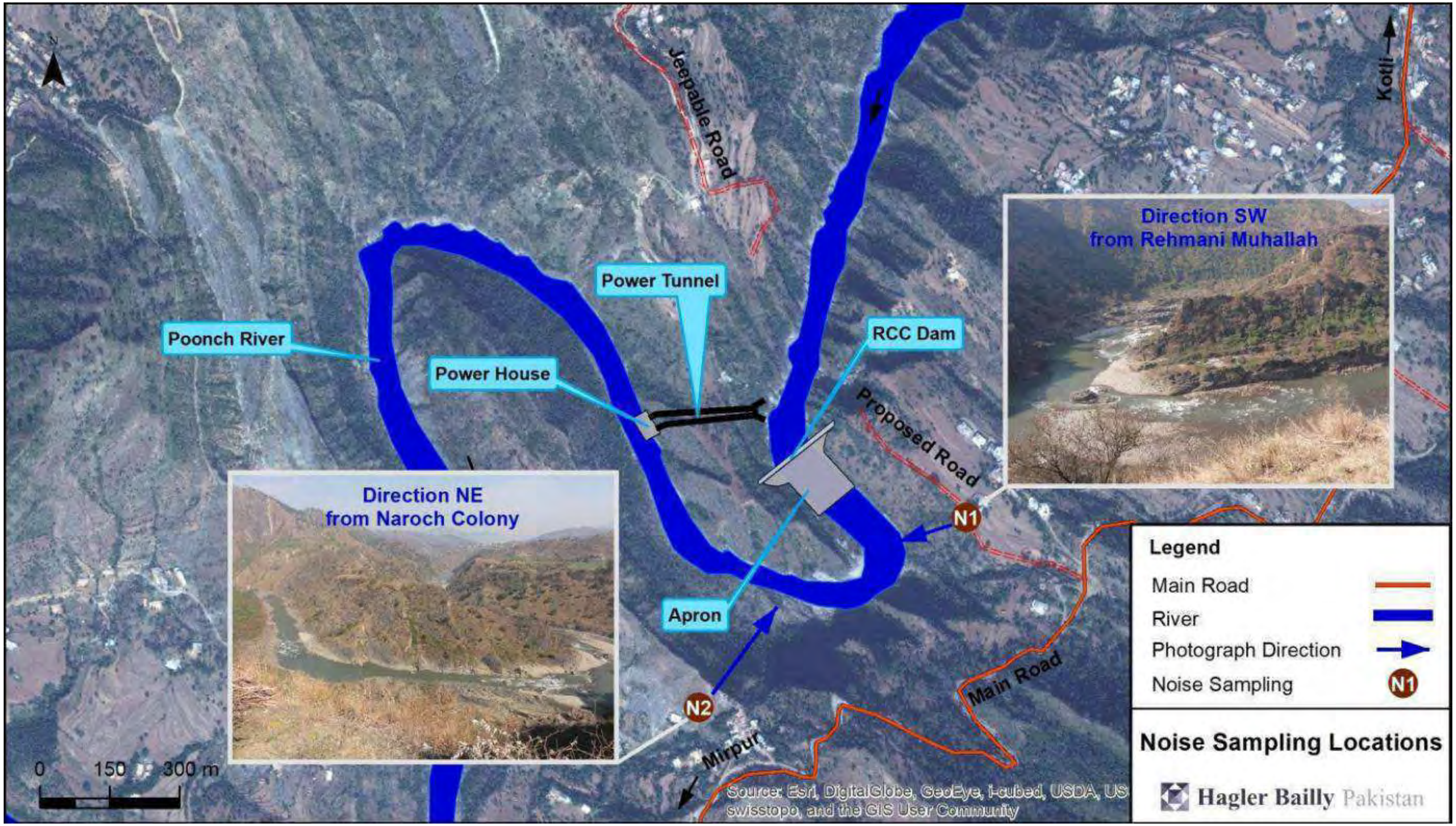


Table 5-3: Noise Data Collected at two Settlements near Project Facilities

Receptors	Average (dBA)	Date	Start Time	Time	NEQS/IFC standards (dBA)[3]	Criteria met/ exceeded
Rehmani Mohallah	50	03/19/2014	09.00	Daytime	55	Met
Rehmani Mohallah	47	03/19/2014	13.30	Daytime	55	Met
Rehmani Mohallah	45	03/19/2014	18.15	Daytime	55	Met
Rehmani Mohallah	46	03/19/2014	21.00	Nighttime	45	Exceeded
Rehmani Mohallah	44	03/20/2014	01.30	Nighttime	45	Met
Naroch Colony	56	03/19/2014	11.15	Daytime	55	Exceeded
Naroch Colony	55	03/19/2014	16.00	Daytime	55	Met
Naroch Colony	51	03/19/2014	20.30	Daytime	55	Met
Naroch Colony	52	03/19/2014	23.15	Nighttime	45	Exceeded
Naroch Colony	55	03/20/2014	04.00	Nightime	45	Exceeded

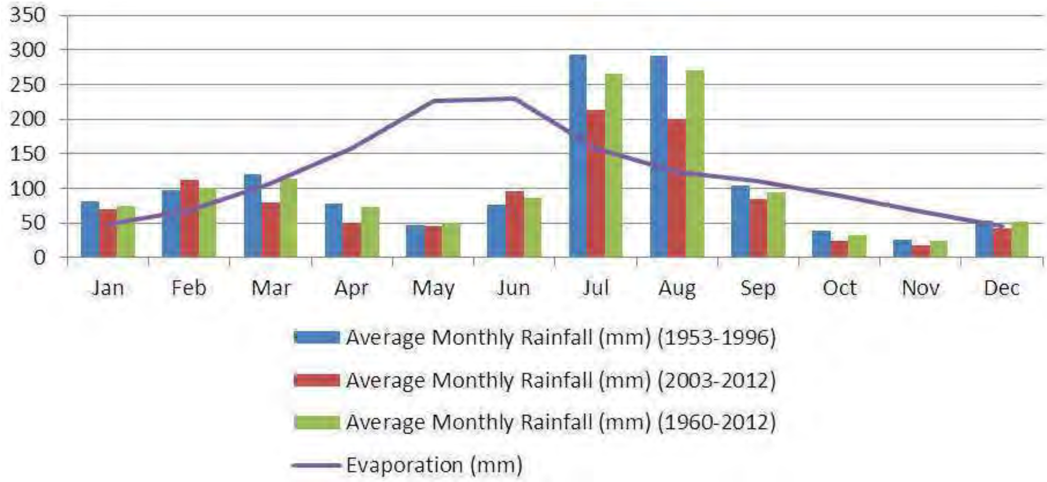
Table 5-4: Summary Table for Average Monthly Rainfall at Rehman Bridge Station

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Monthly Rainfall (mm) (1953–1996)	81.4	96.9	119.9	77.9	46.8	76.6	293.9	292.0	104.3	38.6	25.0	53.0	1,289
Average Monthly Rainfall (mm) (2003–2012)	69.0	111.6	79.9	50.7	44.5	95.0	214.0	200.5	83.8	24.2	17.2	42.0	1032.3
Average Monthly Rainfall (mm) (1960–2012)	75.2	101.2	113.9	73.3	49.5	85.6	266.0	270.8	93.5	32.2	24.1	51.7	1236.9
Evaporation (mm)	48	68	108	158	226	229	157	123	111	89	66	46	1,427

* Source Pakistan Water and Power Development Authority (data not available from 1997 to 2002)

[3] International Finance Corporation (IFC), Environmental Health and Safety Guidelines, Noise Management, April 2007, http://www.ifc.org/wps/wcm/connect/06e3b50048865838b4c6f66a6515bb18/1-7%2BNoise.pdf?MOD=AJPERES

Figure 5-9: Average Monthly Rainfall and Evaporation



Temperature

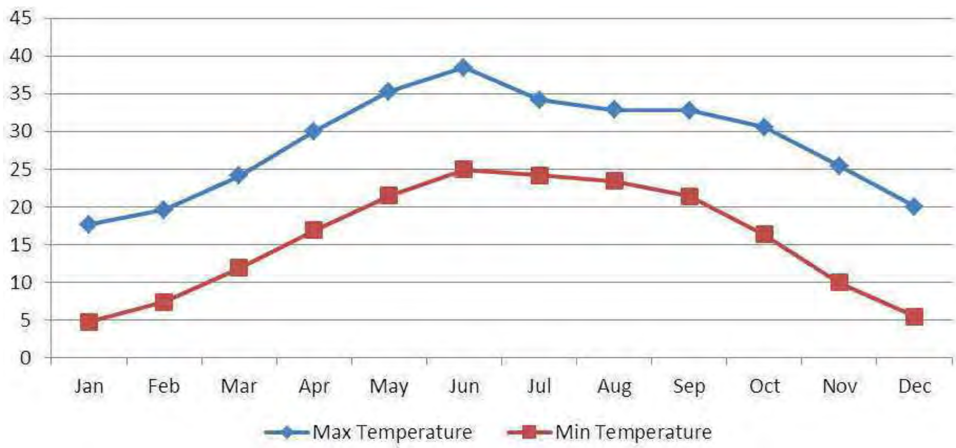
312. Temperature in different parts of the tract varies according to the elevation. Temperature begins to rise rapidly from the end of March, till June, which is the hottest month. The temperature remains high during July to September in the arid zone, because it lies beyond the reach of the monsoons. With the onset of southwest monsoon by the end of June, the temperature begins to decrease gradually; however, the drop is rapid only after October. January is the coolest month of the year in the region. The data shows that the average monthly mean maximum temperature varies from 17.6°C in January to 38.4°C in June, whereas monthly mean minimum temperature ranges between 4.8°C in January and 24.9°C in June. (**Table 5-7** and **Figure 5-10**)

Table 5-5: Summary Table for Max/Min Average Monthly at Kotli

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Max Temperature (°C)	17.6	19.6	24.1	30	35.3	38.4	34.2	32.9	32.8	30.6	25.4	20.0	28.4
Min Temperature (°C)	4.8	7.37	11.9	16.9	21.4	24.9	24.2	23.44	21.4	16.35	9.9	5.5	15.6

* Source Pakistan Water and Power Development Authority

Figure 5-10: Average Monthly Temperatures in ºC



Wind

313. Winds disperse air pollutants and are an important aspect in any environmental impact assessment study. Movement of air pollutants is dependent on the wind speed, wind direction, temperature and humidity. There is no complete data set available for wind speed and direction in the proposed Project area. To provide a general picture of these factors, stations were established and observations were carried out during the physical survey of the proposed Project area.

314. Because of the physiographic features of the Project area, wind direction is East/Westerly at the proposed Project site. The detailed wind speed, direction, humidity and temperature data is provided in **Table 5-6**.

Table 5-6: Wind Data at the Proposed Project Site

Time	Proposed Power House Site			Proposed Camp Area		
	Direction	Wind Speed	Humidity	Direction	Wind Speed	Humidity
		m/s	*%*		*m/s*	*%*
15:00	W	5.4	63	W	2.7	52
16:00	W	4.3	60	W	2.8	55
17:00	W	4.7	58	W	4.5	54
18:00	WE	5.9	68	WE	4.9	57
19:00	WE	5	70	E	5.2	58
20:00	WE	3.8	72	E	5	58
21:00	W	3	78	W	4.6	59
22:00	W	4.7	79	E	3.8	63
23:00	W	5.8	80	E	2	64
24:00	W	5.3	84	E	1.8	66
1:00	W	4.8	80	WE	1.8	67
2:00	W	4.6	78	E	1.3	69
3:00	W	4.2	65	E	1	75
4:00	WE	4	63	E	0.8	74
5:00	WE	4.8	62	WE	2.4	78
6:00	WE	5.3	60	W	2.8	78
7:00	WE	4.9	58	W	3.7	82
8:00	W	4.5	57	W	2.2	80
9:00	W	3	55	WE	4	64
10:00	W	3.8	53	WE	4.3	62
11:00	WE	3.1	52	WE	5.3	60
12:00	WE	3	50	W	5	55
13:00	W	2.9	48	W	5.1	52
14:00	W	3.8	45	W	4.7	50

* Source, physical baseline survey, sampling, testing and analysis conducted in August 2013

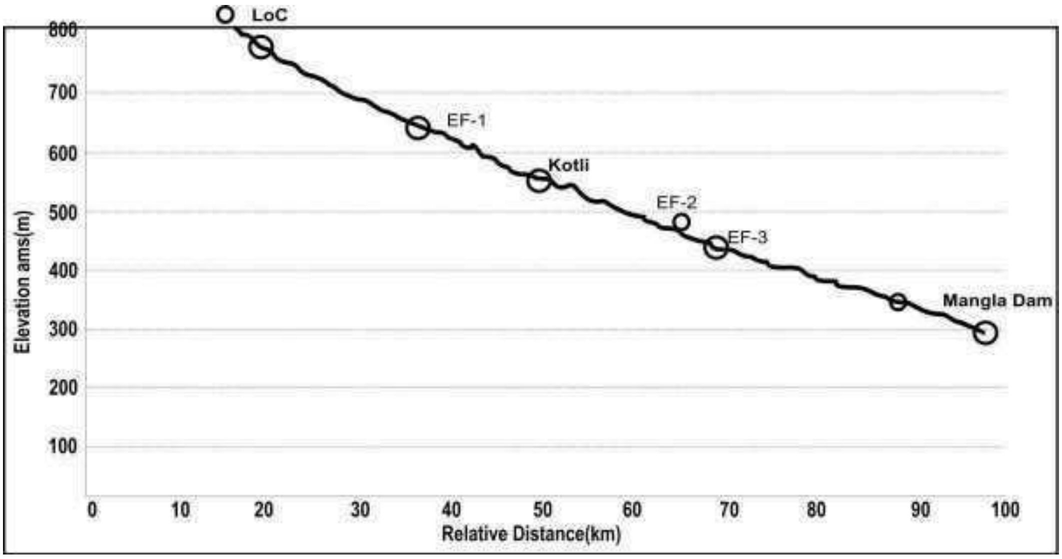
5.1.9 River Habitats

315. Consistent with the approach adopted in **Section 2.3** Introduction, to describe the variations in the river landscape, four segments of river of approximately 20–30 km each were selected for analysis of broad variations in river habitats along the 100 km length of the river in AJK. As illustrated in **Figure 2-3** in **Section 2**, Segment A extends from LoC to Tata Pani, Segment B extends from Tata Pani to Kotli, Segment C extends from Kotli to Rajdhani, and Segment D extends from Rajdhani to Mangla Reservoir.

Slope of the River Bed

316. The slope of the river bed in a section of the river indicates the type of habitats that are likely to occur in that section. **Figure 5-11** shows the elevation model of the river from LoC to Mangla Reservoir. The slope is generally even, about 0.8%, and eases out near Mangla reservoir where the river widens and the flow in gentler.

Figure 5-11: Longitudinal Profile of Poonch River from LoC to Mangla Reservoir



Habitat Types

317. The classification of river habitats in this section has been derived from the reference *Methods for Stream Habitat Surveys, Aquatic Inventories Project, Natural Production Program* Habitat characteristics and associated data are summarized in **Table 5-7**.

318. Google Earth™ images of the Poonch River were used to determine the habitat type categorized as pools/glides, riffles, and rapids, as defined below. High flow months of May and June and flood conditions, when the habitat types would vary considerably, were avoided, and instead the focus was on the condition of the river in the remaining part of the year when variations through time in habitat types are relatively low. Therefore, Google Earth™ images captured during March 2011 were used for this aerial observation. Photographs illustrating habitat types are included in **Figure 5-12**.

Table 5-7: Summary of Stream Characteristics at Four Segments along the Poonch River

Segment	*Length (km)*	*Slope (%)*	*Habitat Type (%)*				*Land Use Type and Vegetation (%)*					
		Avg	*Pools/Glides*	*Rapids*	*Riffles*	***Total***	*Agricultural*	*Scrub Forest*	*Pine Forest*	*Residential*	*River and Nullah*	***Total***
Area (m^2)			236,787	580,814	1,844,849	**2,662,450**	30,127,168	4,768,389	70,074,653	2,198,096	3,114,123	**110,282,429**
Segment A	**25**	**0.76**	**9%**	**22%**	**69%**	**100%**	**27%**	**4%**	**64%**	**2%**	**3%**	**100%**
			263,327	580,038	756,082	**1,599,447**	50,168,945	28,793,039	39,708,137	4,062,668	1,840,705	**124,573,494**
Segment B	**17**	**0.66**	**16%**	**36%**	**47%**	**100%**	**40%**	**23%**	**32%**	**3%**	**1%**	**100%**
			306,863	385,894	776,364	**1,469,122**	29,970,391	4,757,985	20,315,380	2,936,865	1,989,523	**59,970,144**
Segment C	**35**	**0.37**	**21%**	**26%**	**53%**	**100%**	**50%**	**8%**	**34%**	**5%**	**3%**	**100%**
			798,170	335,694	869,026	**2,002,890**	44,767,371	45,558,364	62,735,467	2,354,237	2,277,146	**157,692,585**
Segment D	**18**	**0.31**	**40%**	**17%**	**43%**	**100%**	**28%**	**29%**	**40%**	**1%**	**1%**	**100%**

Pools and Glides

319. Water surface slope is usually close to zero in this case. The types of pools found in the Poonch River are mainly:

- straight scour pools, formed by mid–channel scour, generally with a broad scour hole and symmetrical cross section, and
- lateral scour pools, formed by flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock), generally asymmetrical cross section, and includes corner pools.

320. Glides are generally uniform depth and flow with no surface turbulence. Gradient is low, with a 0 to 1% slope. Glides may have some small scour areas, but are distinguished from pools by their overall homogeneity and lack of structure, and are generally deeper than riffles with few major flow obstructions and low habitat complexity.

321. Based on a visual review of Google Earth^{TM} images, it was not possible to differentiate between pools and glides. These two classes of habitats are, therefore, reported in combination in **Figure 5-12**.

Riffles

322. Flow in riffles is fast, turbulent, and shallow over submerged or partially submerged gravel and cobble substrata. Cross sections are generally broad and relatively uniform. Gradient is low, with usually a 0.5% to 2.0% slope.

Rapids

323. Flow in rapds is swift and turbulent including chutes and some hydraulic jumps swirling around boulders. Exposed substrata composed of individual boulders, boulder clusters, and partial bars. Gradient is moderate, with usually a 2.0% to 4.0% slope.

324. The results of the visual classification of river habitat units in **Figure 5-12** indicate that outside of floods and very high flows including:

- Pools and glides constitute 15–40% of the river, with the exception of an area between LoC and Madarpur (Segment A), where pools are not very frequent.
- Rapids constitute less than 17% of the river between LoC and Madarpur (Segment A). However, between in Segment B, and in Segment C, rapids are significant, decreasing again in Segment D.
- Riffles are the dominant habitat in all segments, accounting for 43% to 69% of the length of the river.

Figure 5-12: Photographs Illustrating Habitat Types and Variations in Poonch River

a. Riffles and rapids downstream of Barali Bridge (Segment A)

b. Lateral scour pools and riffles (Segment A)

c. Pool near Gulpur (Segment C)

5.1.10 Land Use Type and Vegetation

325. An study area of 3 km from the river bank on both sides of the river was selected to show broad variations in vegetation along the course of the river. **Figure 5-13** and **Figure 5-14** show sample maps used to calculate habitat areas and percentages for each Segment. (Description of segments is given in **Section 1.3** in **Section 1**.)

326. Results of land use and vegetation type shown in **Table 5-7** indicate that:

- Agriculture accounts for about 27% and 40% of the land use in Segment A and Segment B, respectively. In Segment C, where the valley widens, about 50% of the land in the valley is used for cultivation whereas only 28% of land is used for agriculture in Segment D.
- Forests are the second main land use. About 64% of land in Segment A is under pine forests. In Segments B, C and D, only 30–40% of land is under pine forests. Segment B and Segment D have a high proportion of scrub forests, 23% and 295 respectively whereas Segments A and C have below 10% of scrub forests.
- Residential area account for less than 5% of the land use; houses are generally compact and located within agricultural areas.
- Poonch River and nullahs account for below 3% of the total land cover.

5.1.11 Land Ownership

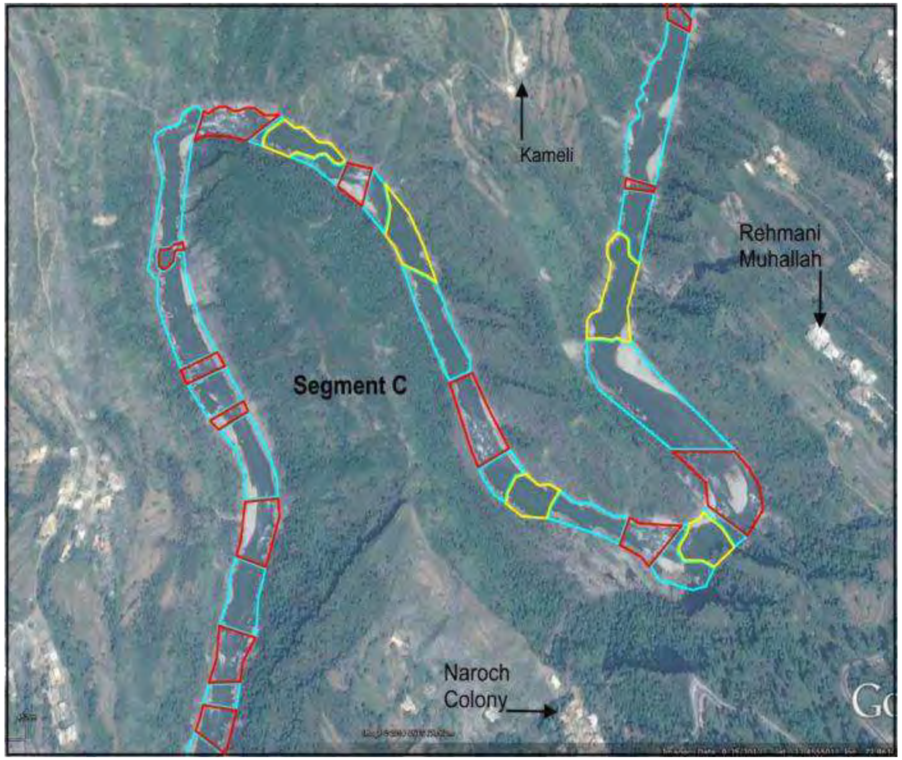
327. The land on the hills generally belongs to the Forest Department. The land on the high benches within hilly areas, however proprietary, is used for cultivation and settlements. The river and nullah (stream) beds along with the adjacent slopes are owned by the government. As such, the proposed Project components, viz., Dam, intake structure including intake portal of the power tunnel and powerhouse including penstocks, will be located on the government land. Though some proprietary land exists in campsite, it lies on a quite high bench and will not be affected by the construction activities.. Similarly, the land required for construction camps and colony has been proposed to be acquired from the land available on the raised benches near the structures.

328. The reservoir is expected to consume both government and proprietary lands. Of this, however, the major chunk is the government land. The proprietary land likely to be submerged by the reservoir will be a small fraction of the total reservoir area.

5.1.12 Valley Topography

329. For the analysis of change in valley topography from LoC to Mangla Reservoir, data for four cross sections along Poonch River and seven sections on the tributaries was obtained from Google Earth. The locations of the cross sections studied are given in **Figure 5-15**. Valley cross section plots are illustrated in **Figure 5-16** for Poonch River and in **Figure 5-17** for the tributaries**.** Profiles of cross sections show that except for the last section on the Poonch River closer to Mangla Reservoir, the river valley is well defined with steep slopes and occasional topographic relief on one side of the valley where agriculture and settlements are common. Except for the Hajeera Nullah upstream near LoC, the valleys through which tributaries flow have comparatively steeper profiles most likely generated by erosion from higher occasional flows associated with rainfall events.

Figure 5-13: Sample Google Earth™ Images Marking Habitat Types (Red- Rapids, Blue- Riffles, Yellow-Pools



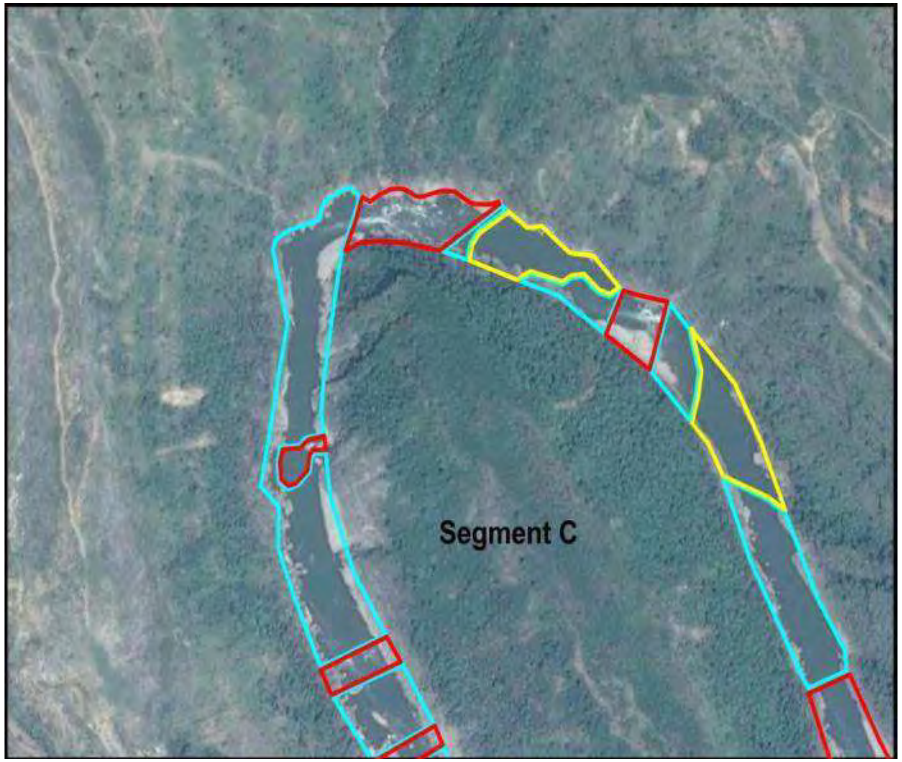


Figure 5-14: Sample Distribution Map Used to Calculate Area Percentage for Each Use Type of Each Segment

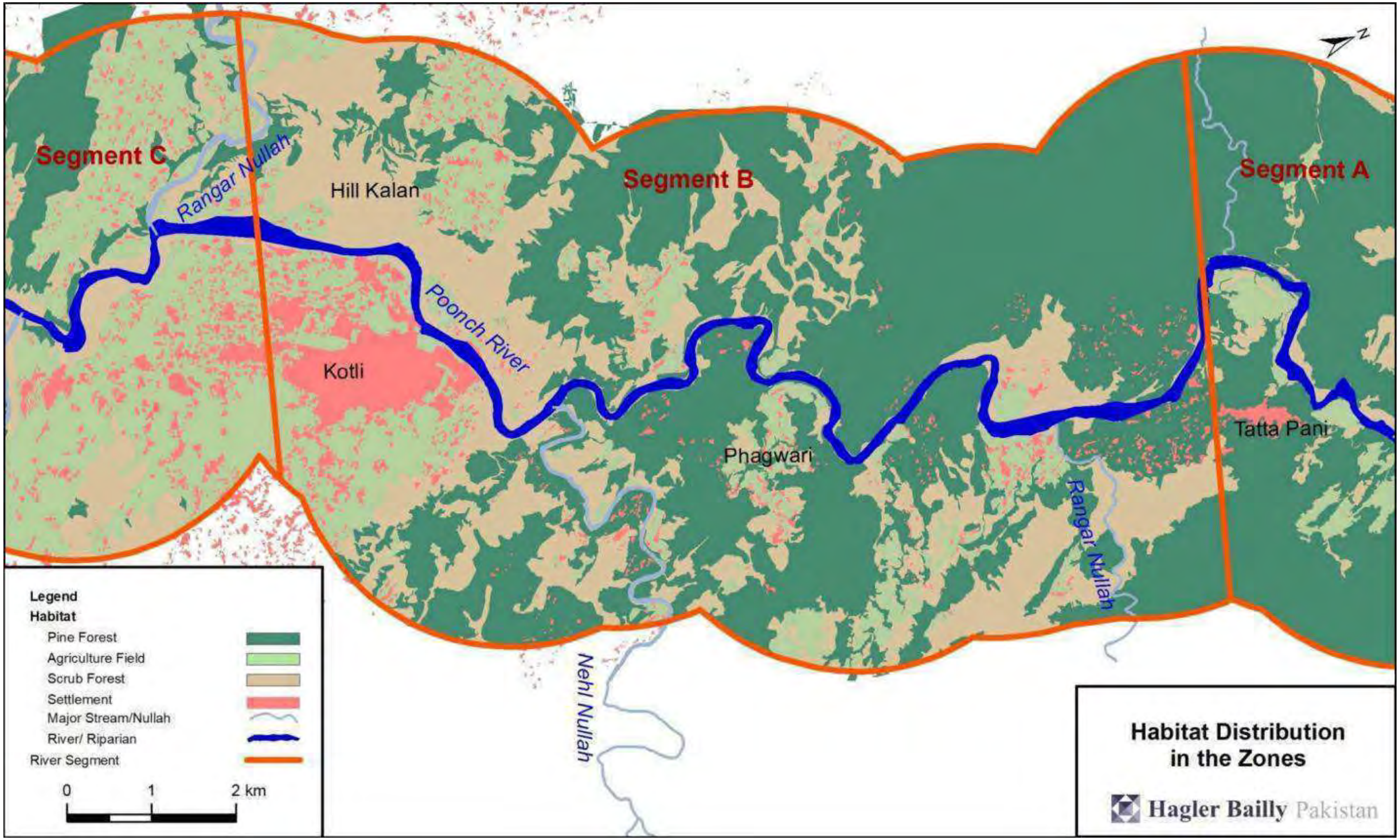
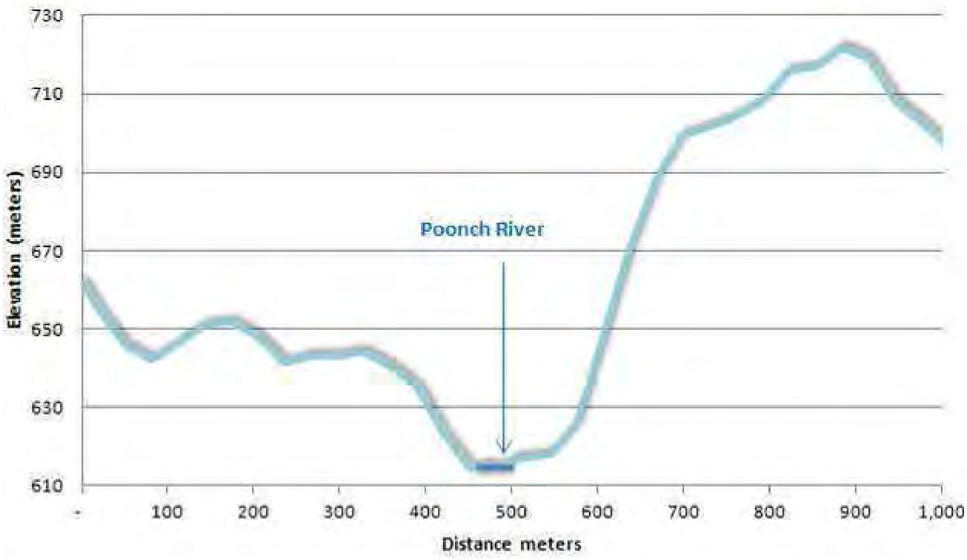
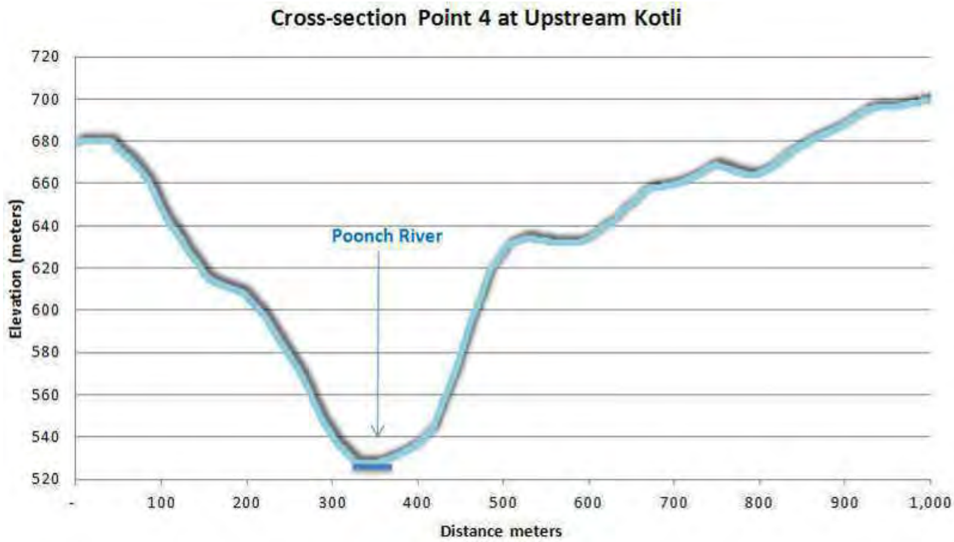


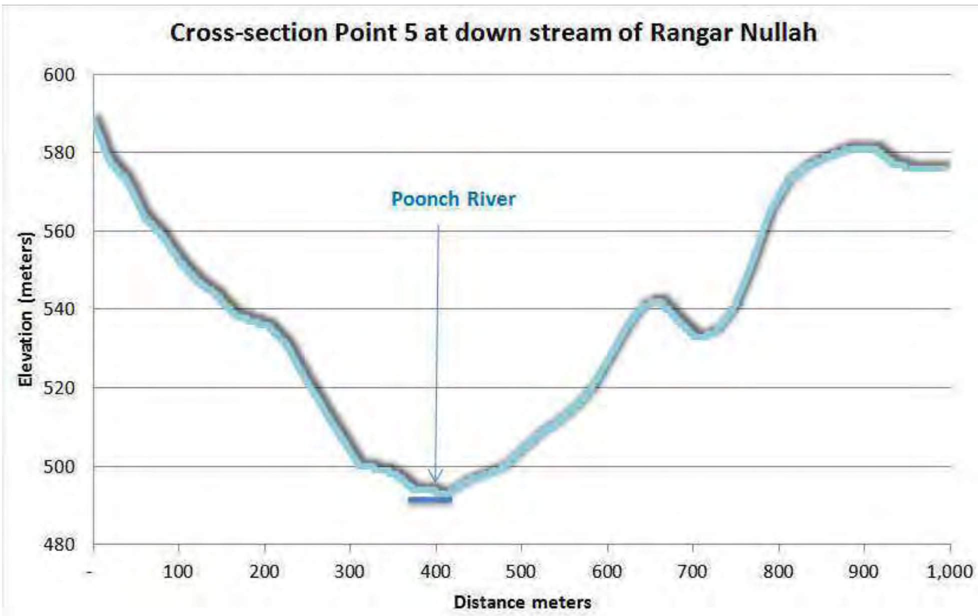
Figure 5-15: Locations of Perpendicular Cross Sections along Poonch River

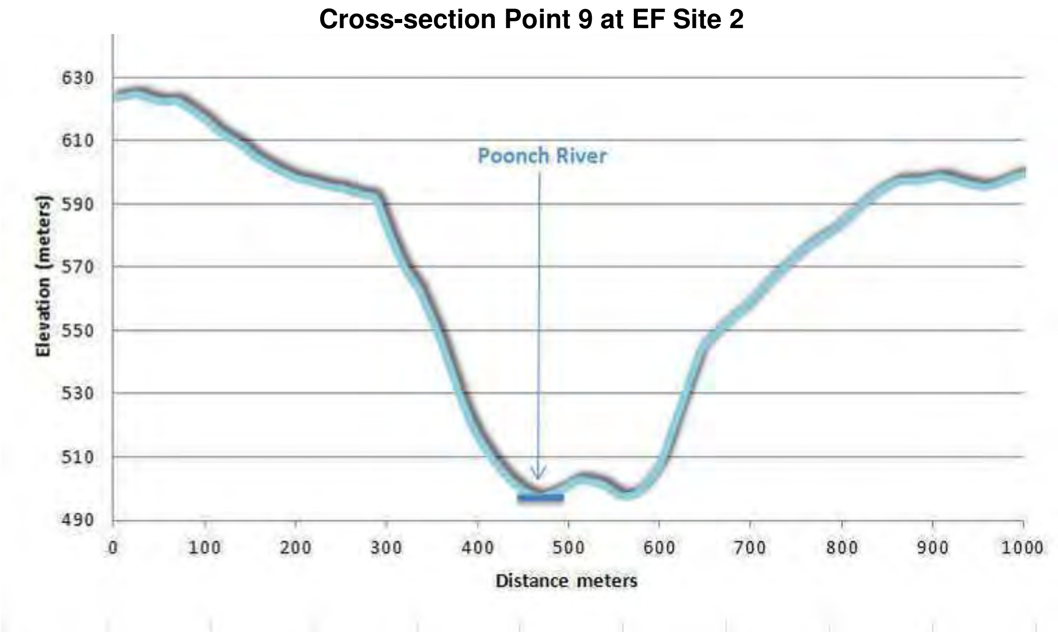
Figure 5-16: Topographic Profiles of Poonch River Cross Sections

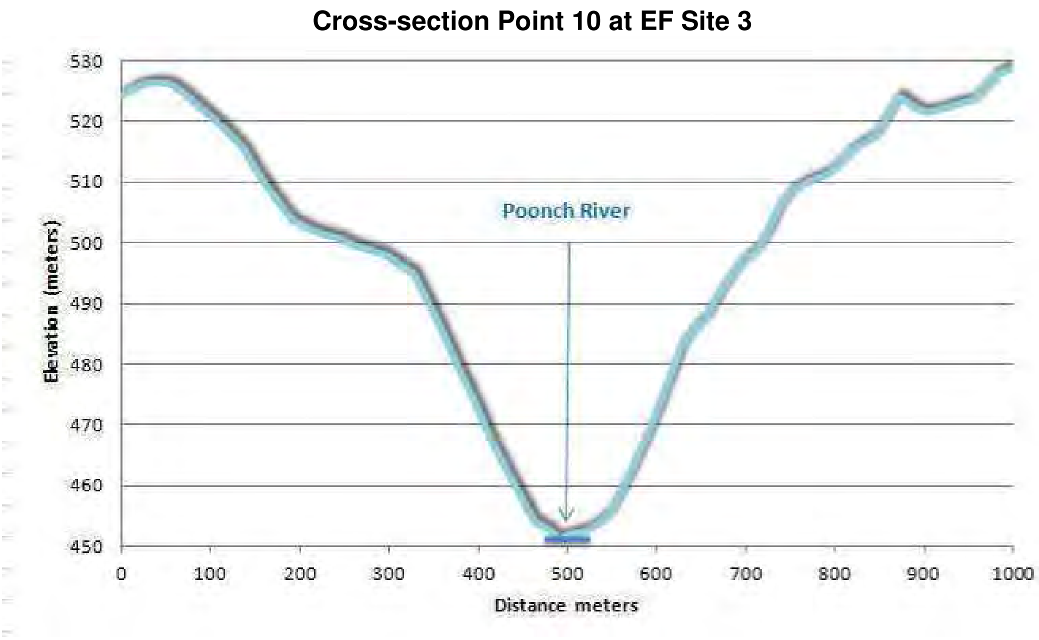
Cross-section Point 3 at EF site 1






Cross-section Point 5 at down stream of Rangar Nullah
Poonch River
Elevation (meters)
600
580
560
540
520
500
480
-
100
200
300
400
500
600
700
800
900
1,000
Distance meters


Cross-section Point 9 at EF Site 2
Poonch River
Elevation (meters)
630
610
590
570
550
530
510
490
0
100
200
300
400
500
600
700
800
900
1000
Distance meters


Cross-section Point 10 at EF Site 3
Poonch River
Elevation (meters)
530
520
510
500
490
480
470
460
450
0
100
200
300
400
500
600
700
800
900
1000
Distance meters

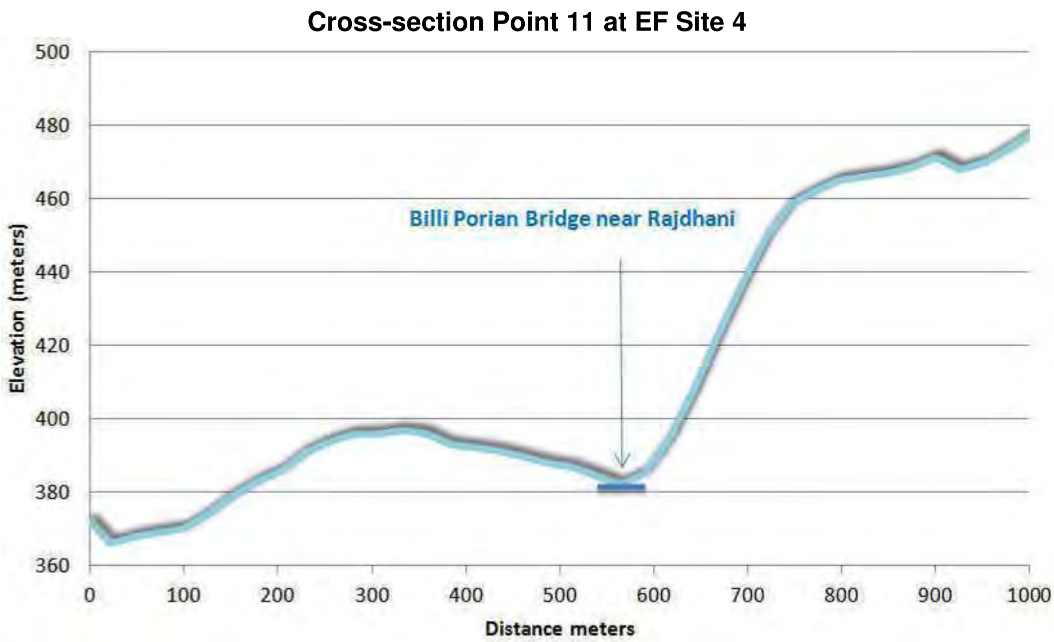
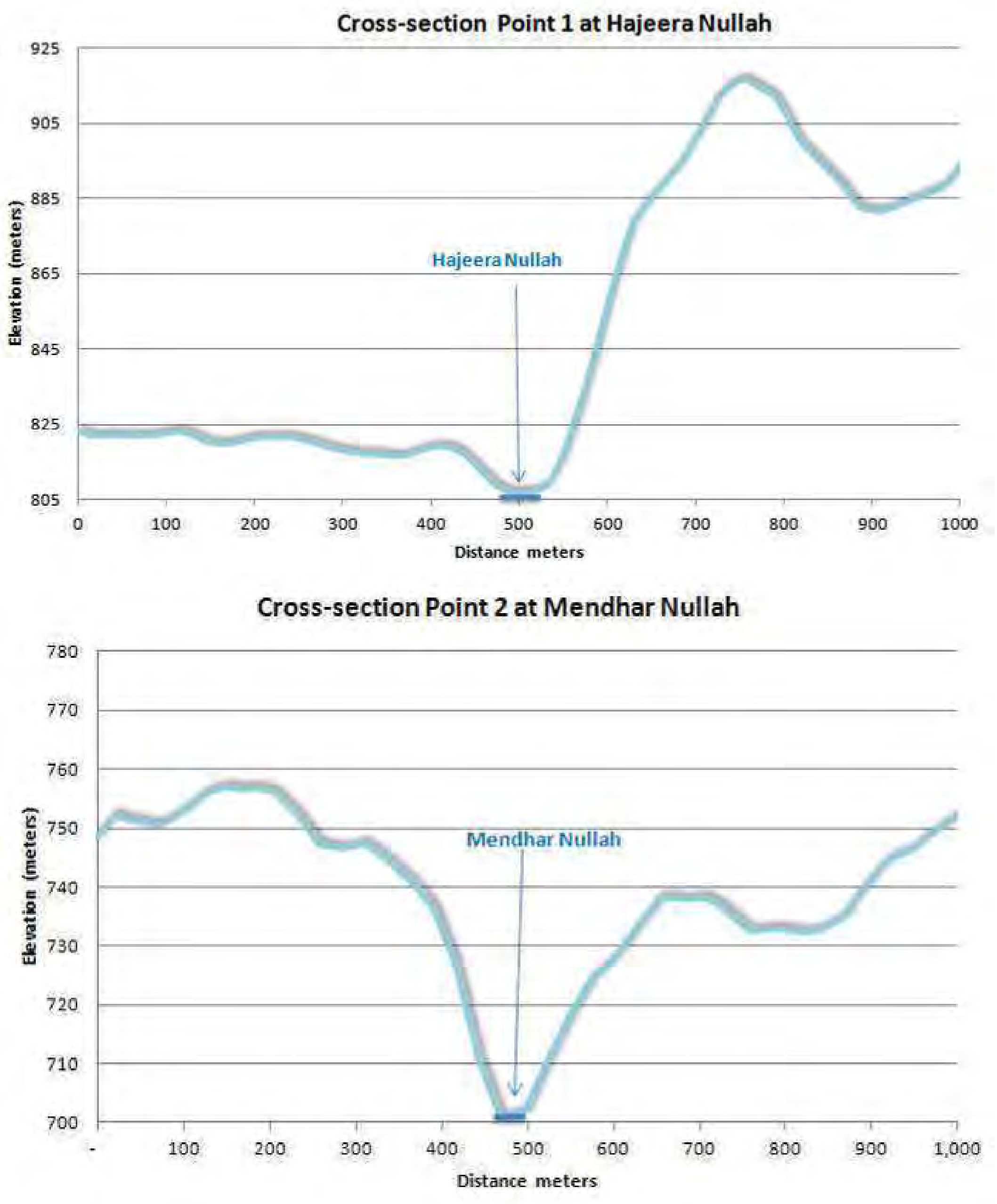
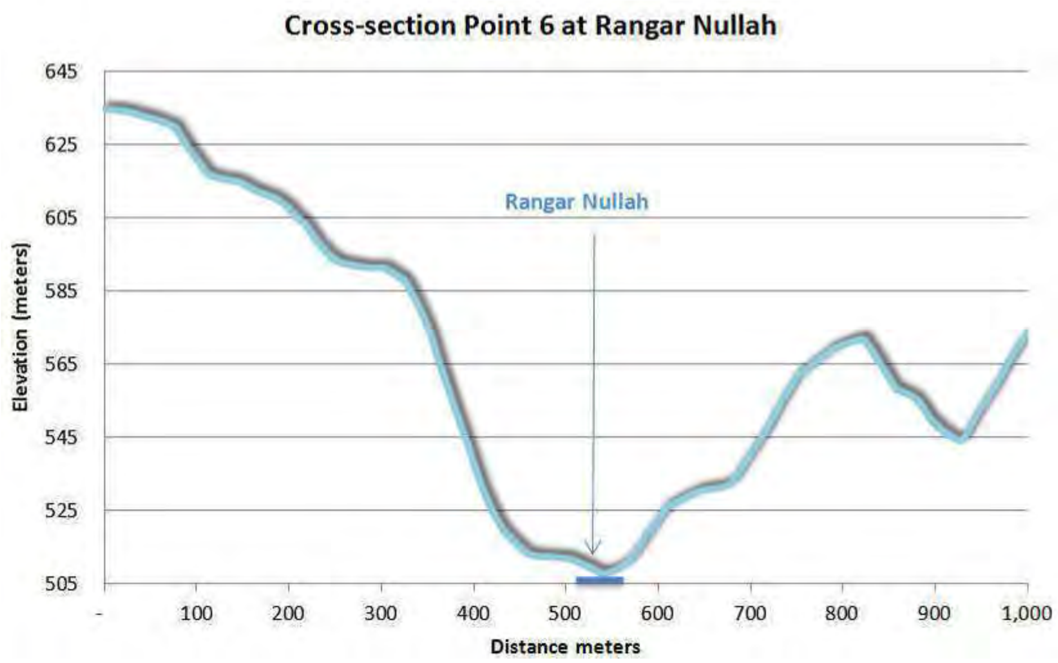
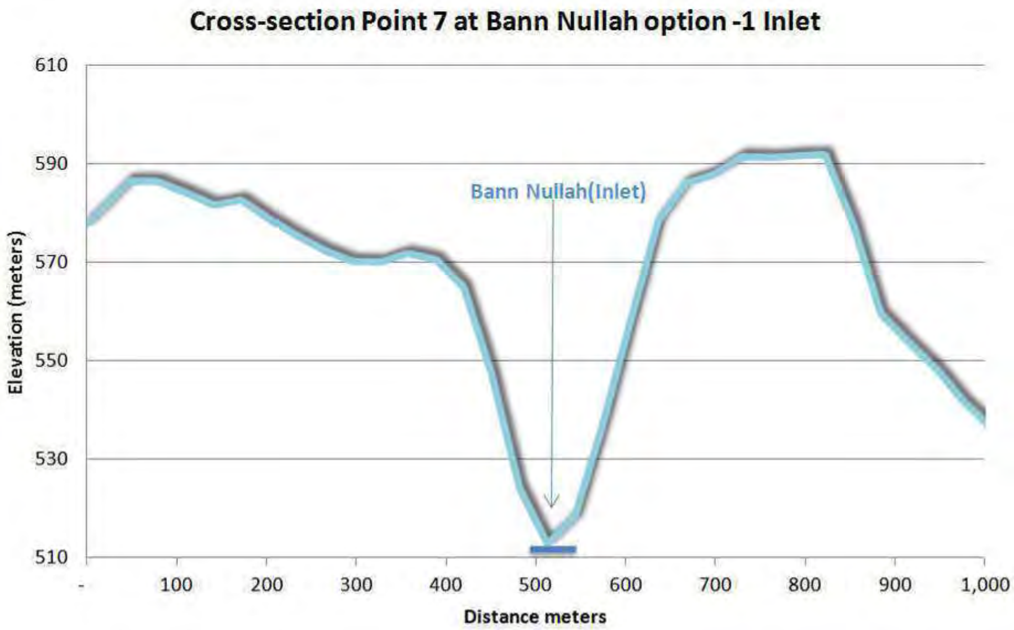

Cross-section Point 11 at EF Site 4
Billi Porian Bridge near Rajdhani
Elevation (meters)
500
480
460
440
420
400
380
360
0
100
200
300
400
500
600
700
800
900
1000
Distance meters

Figure 5-17: Topographic Profiles of Tributary Cross Sections

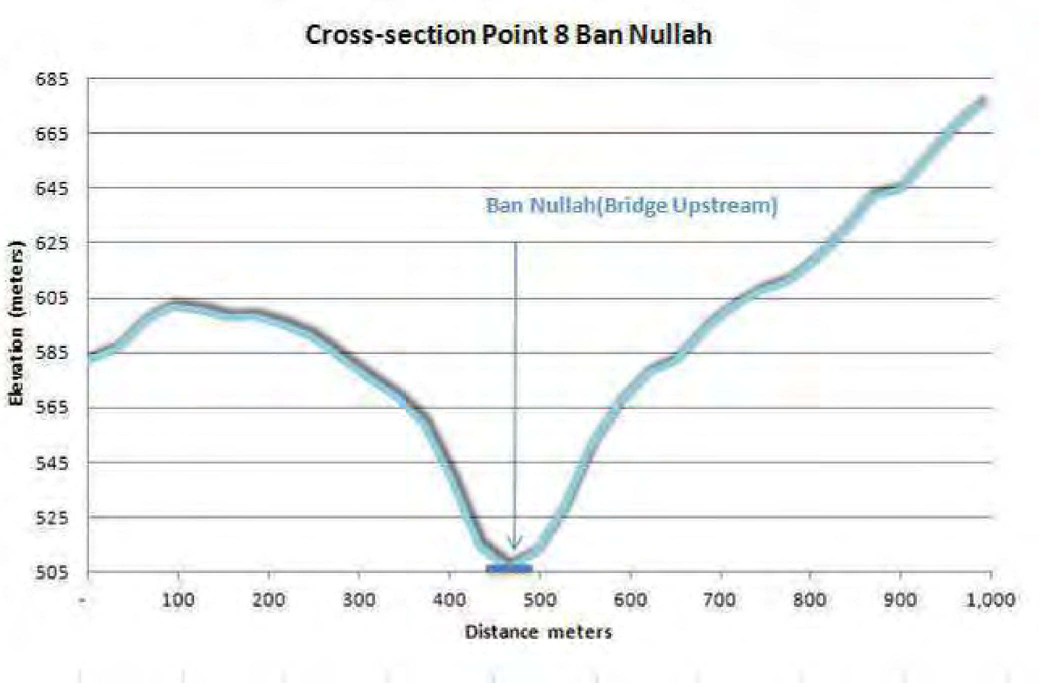




Cross-section Point 6 at Rangar Nullah
645
625
605
585
565
545
525
505
Elevation (meters)
Rangar Nullah
-
100
200
300
400
500
600
700
800
900
1,000
Distance meters



Cross-section Point 7 at Bann Nullah option -1 Inlet
610
590
570
550
530
510
Elevation (meters)
Bann Nullah(Inlet)
-
100
200
300
400
500
600
700
800
900
1,000
Distance meters



5.1.13 Water Quality

330. The water quality of the river is appropriate for irrigation and other non–consumptive purposes., The river water is not suitable for drinking and cooking as it is contaminated by the wastewater effluent from towns, villages and settlements established along the river as well as located in the river drainage area. This particularly implies for the Kotli town.

331. Sampling and analysis of the water quality parameters of water in the Poonch River was undertaken to evaluate its suitability for aquatic environment. Grab samples were taken at one location upstream of Kotli town and at one location downstream of Kotli town. **Table 5-8** includes locations at which samples were taken and the results of laboratory analysis. Samples were therefore taken in late December 2013 in the low flow dry season when there was no rain in the catchment to capture conditions when the pollutant concentrations would be maximum.

332. The analysis shows that all the toxic metals are below the limits set in the National Standards for Drinking Water (NSDW). Levels of all other parameters do not indicate any concern for aquatic environment. The water quality is characteristic of a river fed by snow melt, rainfall, and springs in a mountain environment with little or no industrial activity and low population density in the catchment. An increase in level of nitrates downstream of Kotli is indicative of nutrients added by flow of sewage from Kotli town into the river. The dissolved oxygen in the river is reported to be above 7.5 mg/l in summer, and above 8.5 mg/l in winter, which indicates well oxygenated waters for supporting aquatic life[4].

[4] Kramer, D.L. 1987. Dissolved oxygen and fish behavior. Environmental Biology of Fishes. 18(2):81-92.

Table 5-8: River Water Quality

Parameters	*Unit*	*LOR*[5]	*NSDW*[6]	*WHO*	*Upstream of Kotli Town*[7]	*Downstream of Kotli Town*[8]
Silver	µg/l	1	–	–	ND	ND
Aluminum	µg/l	1	<200	200	103	84
Arsenic	µg/l	1	≤50	10	ND	ND
Boron	µg/l	1	300	300	6	10
Barium	µg/l	1	700	700	46	41
Cadmium	µg/l	1	10	3	ND	ND
Chromium	µg/l	1	≤50	50	ND	ND
Copper	µg/l	1	2,000	2,000	7	5
Iron	mg/l	0.001	≤1.5	1.5	0.394	0.425
Mercury	µg/l	1	≤1	1	ND	ND
Manganese	µg/l	1	≤500	500	57	62
Nickel	µg/l	1	≤20	20	17	18
Lead	µg/l	1	≤50	1	ND	ND
Antimony	µg/l	1	<20	20	ND	ND
Selenium	µg/l	1	≤10	10	ND	ND
Zinc	µg/l	1	5,000	3,000	1	8
BOD	mg/l	5.00	–	–	ND	ND
COD	mg/l	4.00	–	–	ND	4.99
Nitrate	mg/l	0.001	–	–	1.710	4.050
Phosphate	mg/l	0.001	–	–	ND	ND
TDS	mg/l	10.000	<1,000	<1,000	104.00	108.00
TSS	mg/l	4.000	–	150	4.00	4.00
pH		0.100	6.5–8.5	6.5–8.5	7.82	8.12
Temp.	°C	1.000			9.70	10.30

Ground Water

333. The Project area in Kotli District is devoid of any large aquifer. This is because of the stony formation of the area and steep slopes of the mountains. However, limited quantity of groundwater is available in Kotli Valley that is exploited for supply of potable water to the town. The consumptive requirement of the communities at other places is generally met from the spring water. It has been observed that the settlements are

5 Level of Reporting

6 S,R.O. 1062 (I)/2010, National Environmental Quality Standards for drinking water

7 33 34 41.22 N, 73 56 10.49 E, Near Kallar Bridge at EF Site 1 shown on **Figure 5-23**

8 33 27 16.51 N, 73 52 10.46 E, Near Project facilities, EF Site 2 shown on **Figure 5-23**

located where spring water is available in addition to the availability of level ground for housing and cultivation. The ground water test results are discussed in **Section 5.3.6.**

5.1.14 Hydrology

334. A stream gauging station on Poonch River is being maintained at Rehman Bridge near Kotli by WAPDA since 1960. Measurements include stream flows and suspended sediment concentrations. Rehman Bridge Gauging Station is located just downstream of Bann Nullah about 5 km southeast of Kotli Town. Between Rehman Bridge gauge site and proposed Dam site, there are no major tributary/nullahs joining the main river, thus discharge and sediment data available at Rehman Bridge gauge is directly applicable for the proposed Project. Stream flow record of Poonch River at Rehman Bridge for the period 1960 to 2011 available in the form of mean daily flows was used to present inflow time series. **Figure 5-18** shows mean monthly flows and runoff in Poonch River whereas **Figure 5-19** gives the mean annual flows of Poonch River.

Figure 5-18: Monthly Flows and Runoff of Poonch River

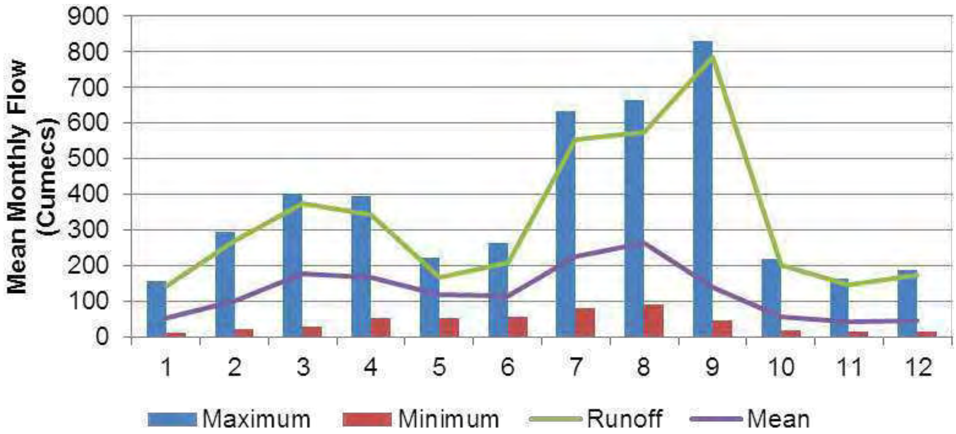
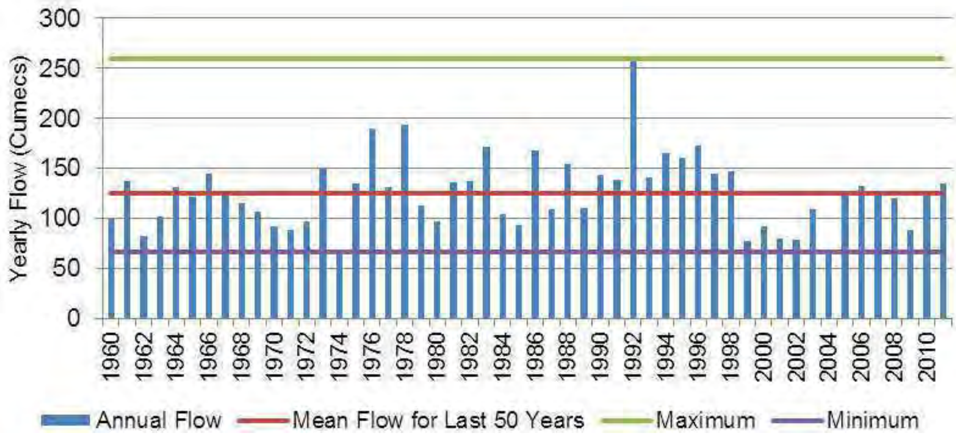


Figure 5-19: Mean Annual Flows of Poonch River



335. Like other rivers of Pakistan and AJK, Poonch River exhibits seasonal variations in the discharges. Daily mean river flow data recorded at gauge station located about 6

km upstream of the proposed Dam location has been collected for a period of 43 years (from 1960 through 2002) for hydrological study. The analysis of data shows that monthly mean discharges varied from 41 cumecs[9] in November to 279 cumecs in August, while the annual mean had been 128 cumecs during this period. Overall, the river discharges varied from a minimum of 12 cumecs in January 1966 to a maximum of 830 cumecs in September 1992. However, the annual mean minimum and maximum flows had been 69 cumecs and 260 cumecs, respectively. The annual mean had been 128 cumecs that corresponds to a runoff of 4,044 MCM.

336. The configuration of the drainage area combined with the cloudbursts during monsoon results in instantaneous flood peaks in the Poonch River in a short period after the rains. The historical instantaneous flood peaks experienced at the Dam site during the reference period from 1960 to 2002 had been in the range of 878 cumecs (on 2nd August, 1979) to 12,150 cumecs (on 10th September, 1992) with an average of 4,671 cumecs. The detailed Hydrology Specialist report is given in **Appendix D** of this report.

Poonch RIver

337. The main surface water resource of the Project area is the Poonch River, which flows along Kotli– Mirpur Road and enters into Mangla Reservoir. Poonch River is a main tributary of Jhelum River. The Project is going to utilize the flows of the Poonch River that initiates from the Indian side of Kashmir draining south side of Pir Panjal Range. The total catchment area (**Figure 5-20**) of the river at the Project Dam site is about 3,800 km^2. Besides the discharge of main trunk, the river receives discharge of many natural streams (Nullahs). Bann Nullah is one of these, which have its confluence with the river about 200 m upstream the Project Dam and where the intake of the power tunnel is going to be located. Other tributary of the river that falls in the Project area is Rangar Nullah that has its confluence with river at about 2 km upstream of Dam site.

338. Like other rivers of Pakistan and AJK, Poonch River exhibits seasonal variations in the discharges. The daily mean river flow data recorded at gauge station located about 50 m upstream of the proposed Dam location has been collected for a period of 43 years (from 1960 through 2011). The analysis of data shows that monthly mean discharges varied from 41 cubic meters per second (cumecs) in November to 279 cumecs in August, while the annual mean had been 128 cumecs during this period. On the whole, the river discharges varied from a minimum of 12 cumecs in January 1966 to a maximum of 830 cumecs in September 1992. However, the annual mean minimum and maximum flows had been 69 cumecs and 260 cumecs, respectively. The annual mean had been 128 cumecs that corresponds to a runoff of 4,044 (MCM)[10] or 3.28 (MAF)[11].

339. The Poonch River and most of its tributaries originate from mountains ranging in elevation from 3,000 m to 4,500 m above mean sea level. Consequently, the mountains remain covered with snow cap for part of the year that contributes to the river discharges. However, the major contribution in the annual flows comes from the monsoon rains that are spread from July to September. The configuration of the drainage area combined with the cloud bursts during monsoon results in instantaneous flood peaks in the Poonch River in a short period after the rains. The historical instantaneous flood peaks experienced at the Dam site during the reference period from

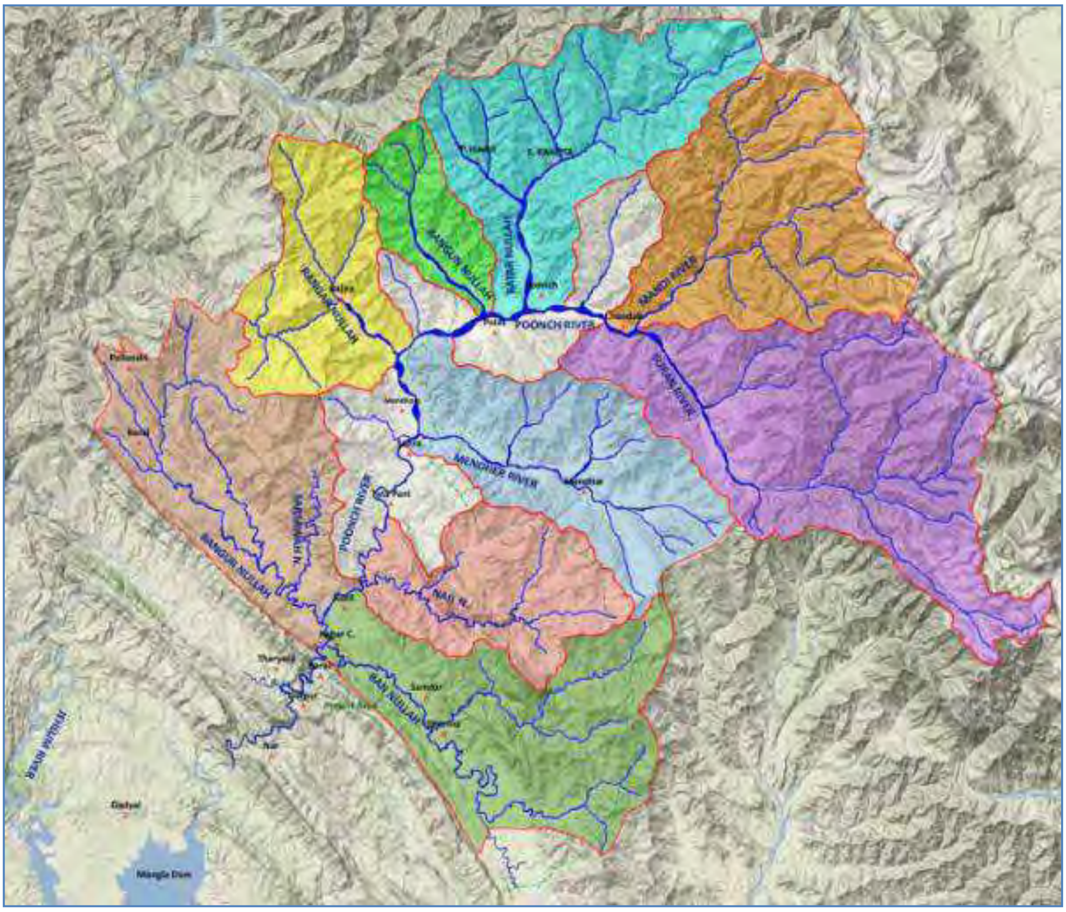
9 cubic meters per second

10 million cubic meters

11 million acre feet

1960 to 2011 had been in the range of 878 cumecs (on 2nd August, 1979) to 12,150 cumecs (on 10th September, 1992) with an average of 4,671 cumecs. The Project has been designed for probable maximum flood. The study has shown that the Figure for 100 year flood comes to about 13,340 cumecs, while the PMF has been estimated to be 21,640 cumecs. The combined capacity of the main and undersluice Dams are enough to efficiently pass more than the design discharge (about 15,000 cumecs).

Figure 5-20: Poonch River Catchment Area with Highlighted Catchments of Tributaries



5.1.15 Geomorphology of Catchment

340. The geology of the upper catchment is a mix of volcanic rocks, whose layers can be several thousand meters thick, as well as sedimentary rocks and occasional limestones. Lacustrine clays and shales occur near Pir Panjal. This is a region of geologically rapid uplift, and the steep, deeply incised rivers are characterized by very high sediment transport potentials. Landslides on the slopes of the very steep valleys are common and represent a significant source of sediment introduction to the channels.

341. The valleys of the upper catchment are dominated by forests and characterized by a very steep, fast channel within a narrow, confined valley. From the Line of Control (LOC) to the town of Kotli the river gradient remains very steep (6.9-8.3 m/km), but the gradient begins to decrease below Kotli and the river eventually flows in to the Mangla Lake (Reservoir) in the Mirpur district of Azad Jammu and Kashmir. At the proposed

dam site, the Poonch River drains a catchment area of about 3625 km^2. The upper reaches of this catchment are in the lower Himalayas and are covered by dense forests. These regions are relatively inaccessible, whereas the more accessible middle and lower reaches are under increasing development pressure.

342. Geomorphology provides an appropriate basis of classification for describing the physical habitat of riparian and aquatic ecosystems, since the geomorphological processes that shape river channel determine the material from which the channel is formed, the shape of the channel, and the stability of its bed and banks. The channel geomorphology in turn determines the substrate conditions for the riverine fauna and flora and the hydraulic conditions at any given flow discharge. Structural changes to the river channel (damage to the riparian zone, sediment inputs from catchment erosion or reservoir induced changes in the flow regime) can cause long-term irreversible effects for biota[12].

5.1.16 River Geomorphology at Project Site

Longitudinal Profile

343. When examining the longitudinal profile of a river, channel gradient is well correlated with many channel properties including channel planform or type, bed material and reach type[13] and changes in gradient usually mark morphological changes and thus provide the basis for the delineation of longitudinal zones. These breaks can be associated with changes in lithology, or result from tectonic activity or the upstream migration of knick points[14].

344. The longitudinal profile of the Poonch River within the study area (from the LOC to Mangla reservoir) is characterized by a relatively uniformly steep (**Figure 5-21**), narrow valley. The uniformity is likely to relate to the regional response of incision due to uplift. Four EF sites were located along the study reach to examine the impacts of the proposed dam, and these sites similarly display a relatively high degree of similarity in terms of planform and morphological characteristics.

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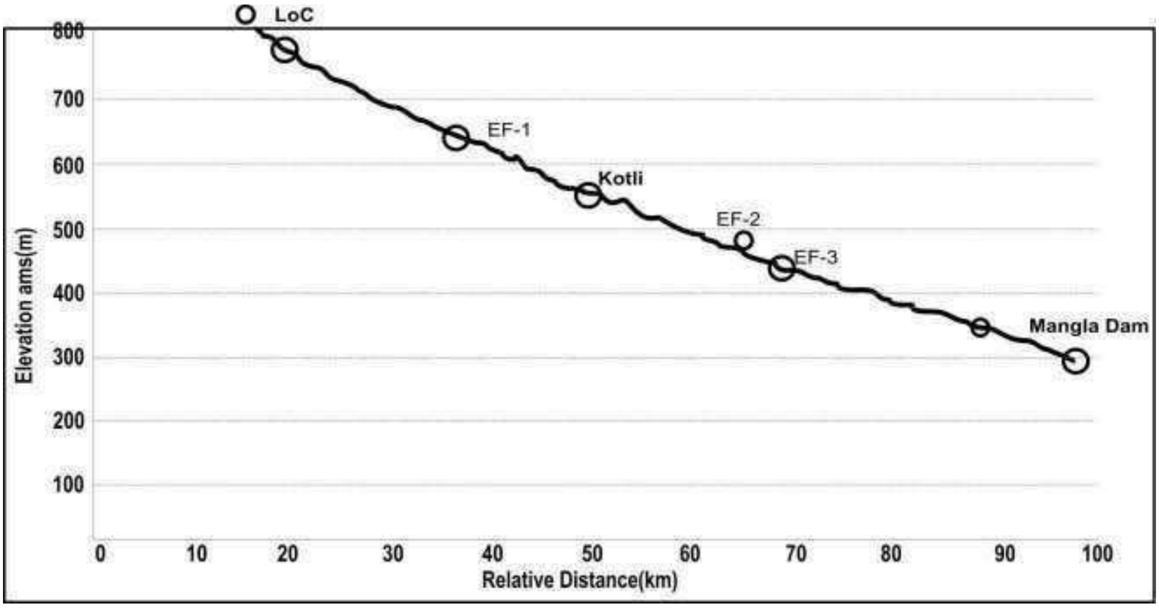
12 Kochel, R.C. 1988. Geomorphic Impact of Large Floods: review and new perspectives on magnitude and frequency. In Baker, V.R., Kochel, R.C. and Patton, P.C. (eds) Flood Geomorphology. Wiley-Interscience, New York, 169-87.

13 Ibid.

14 Dollar, E. S. J. 1998. Palaeofluvial geomorphology in southern Africa: a review. Progress in Physical Geography, 22, 325 - 349.

Figure 5-21: Longitudinal profile of the Poonch River indicating the relatively uniform gradient and position of the EF sites, Kotli town and Mangla Dam.



Sediment Load

The form (morphology) of a river channel is dependent on the interaction between the supply of sediment from its catchment, and the ability, or capacity, of that section of the river to transport the sediment it is supplied with. The proposed Gulpur HPP will affect both the sediment supply (through trapping in the reservoir) and transport potential (through the proposed reduced flows). An understanding of the present day sediment yield conditions was necessary to enable the prediction of changes that could be expected under different releases scenarios.

345. There are three components of sediment load:

- The dissolved load: the salts and nutrients which are dissolved in the water and moved downstream in solution.
- The suspended load: the sediment (usually very fine material) carried in suspension in the water column.
- The bedload: that component of the sediment load (the larger sediment fractions) transported along the bed of the river.

346. The dissolved load has no impact on the geomorphology and is thus not considered further in this report.

Suspended Load

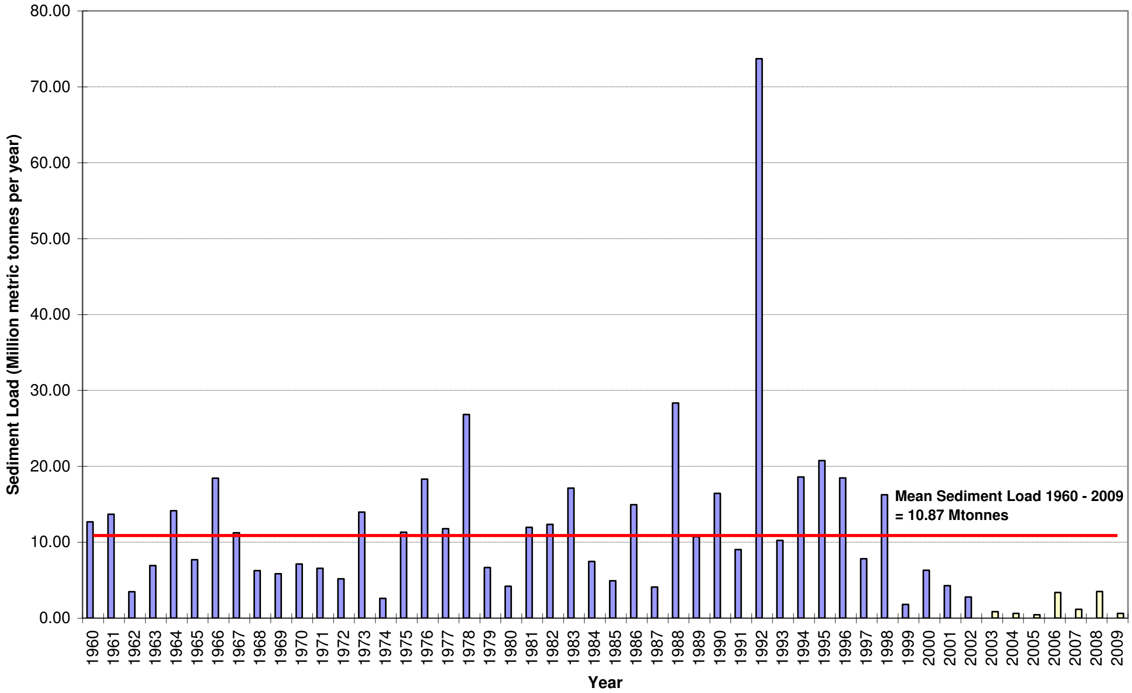
347. The 1960 to 2011 observed suspended sediment loads at the Rehman Bridge gauge station on the Poonch River near Kotli were provided by the Surface Water Hydrology Project (SWHP) of the Water and Power Development Authority (WAPDA) for use in this study. The mean suspended sediment load of the Poonch River is c. 10.87 MTa^{-1} [15][16]; **Figure 5-22**). Although cobble and boulder beds are extensive morphological

[15] million tonnes per annum

features on the river bed and banks, the sand fraction represents a large portion of the river bed and banks. Data from the neighboring Jhelum River, indicate that sands are also the dominant bed load[17], which suggests that the same may be true for the Poonch River.

348. The Poonch River flows into the large Mangla reservoir and a large volume of sediment has been deposited around this inflow (**Figure 5-23**). Observed measurements of sediment deposition indicated that 0.308 BCM[18] of sediment was deposited in the Mangla Reservoir between 1967 and 2002[19].

Figure 5-22: Annual Suspended Sediment loads in the Poonch River (1960 to 2009)[20].



[16] Mott MacDonald (2011). Gulpur Hydroelectric Power Project: Review of Requirement for Desanding Bay (Final Report), Sambu Construction Co. Ltd, November 2011.

[17] Qureshi, M.M., A.S. Shakir and E. Lesleighter (2013). Channel Forming Discharge in Rivers: A Case Study of Jhelum River in Pakistan. *Pakistan Journal of Engineering and Applied*

[18] Billion Cubic Meters

[19] Izhar-ul-Haq, Dr. and S. Tanveer Abbas, (2007) Sedimentation of Tarbela and Mangla Reservoirs. Pakistan Engineering Congress, 70th Annual Session Proceedings, Paper No. 659, pg 23-46.

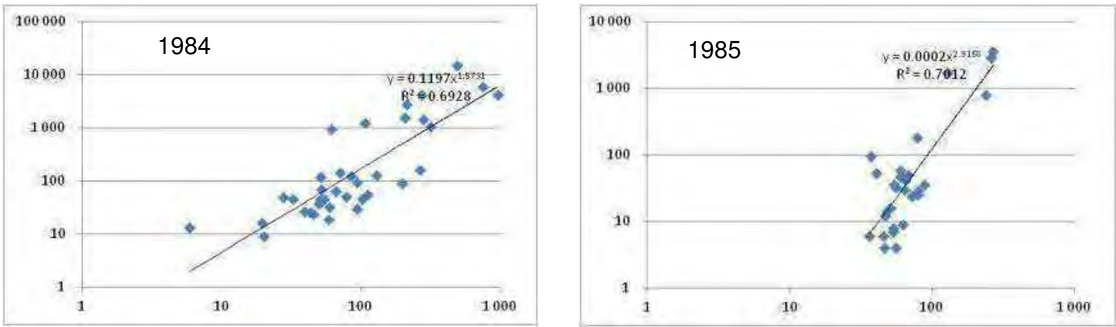
[20] Mott MacDonald (2011). Gulpur Hydroelectric Power Project: Review of Requirement for Desanding Bay (Final Report), Sambu Construction Co. Ltd, November 2011.

Figure 5-23: Large Volumes of Sandy Sediment Deposited where the Poonch River enters Mangla Reservoir

349. The 1960 to 2011 record of observed suspended sediment at the Rehman Bridge gauge station on the Poonch River near Kotli was made available by the Surface Water Hydrology Project (SWHP) of the Water and Power Development Authority (WAPDA) to Hagler Bailly Pakistan for use in this study. Since applying sediment rating curves to discharge records often yields inconsistent correlations (Leopold et al.)[21], annualized suspended sediment-discharge rating curves were generated to account for variable rainfall, changing catchment vegetation cover and the consequent inter-annual variability of sediment-discharge relationships (**Figure 5-24**)

Figure 5-24: Annual Suspended Sediment-Discharge Relationships in 1984 and 1985

Suspended sediment loads (vertical axis) are indicated in ppm, with discharge (m^3s^{-1}) on the horizontal axis



Description and Morphology of EF Sites

350. The locations of the Environmental Flow (EF) sites surveyed are shown on the map below (**Figure 5-25**):

[21] Leopold, L. B., Wolman, M.G., and Miller, J.P. 1964. Fluvial Processes in Geomorphology, San Francisco, W.H. Freeman and Co., 522p.

Figure 5-25: EF Sites

Gulpur EF Site 1 (Kallar Bridge)

351. EF[22] Site 1 is characterized by a large vegetated island and secondary (seasonally activated) channel upstream of the bridge (**Figure 5-26**).

352. The active channel is fast flowing and dominated by large cobbles and boulders. Backwaters and areas of slower velocity flow are created by back-flooding up the tributaries, as well as in the lee of occasional large bars/islands with secondary channels.

Figure 5-26: Photographs of EF Site 1 at Kallar Bridge

A secondary channel, created by a vegetated island upstream of the bridge at the site, as well as the vegetated lower zones of the channel (inundated during the wet season) create important habitat for fish which breed in these lower velocity areas.

[22] Environmental Flow

Gulpur EF Site 2 (Borali Bridge)

353. EF Site 2 is characterized by bedrock controlled banks and bends. The wider reach has well sorted cobble lateral bars (**Figure 5-27**), but at the site there has been extensive removal of silt and sand at this site enabled by the road access. The lateral bars of cobble, boulders and gravels at the site are thus are largely free of fine material; this being found only in very small lee deposits; but the upper banks of the river are composed of finer material (sand and silts) with underlying extensive cobble deposits. Trees and shrubs are present in this upper seasonally inundated zone of the riparian area.

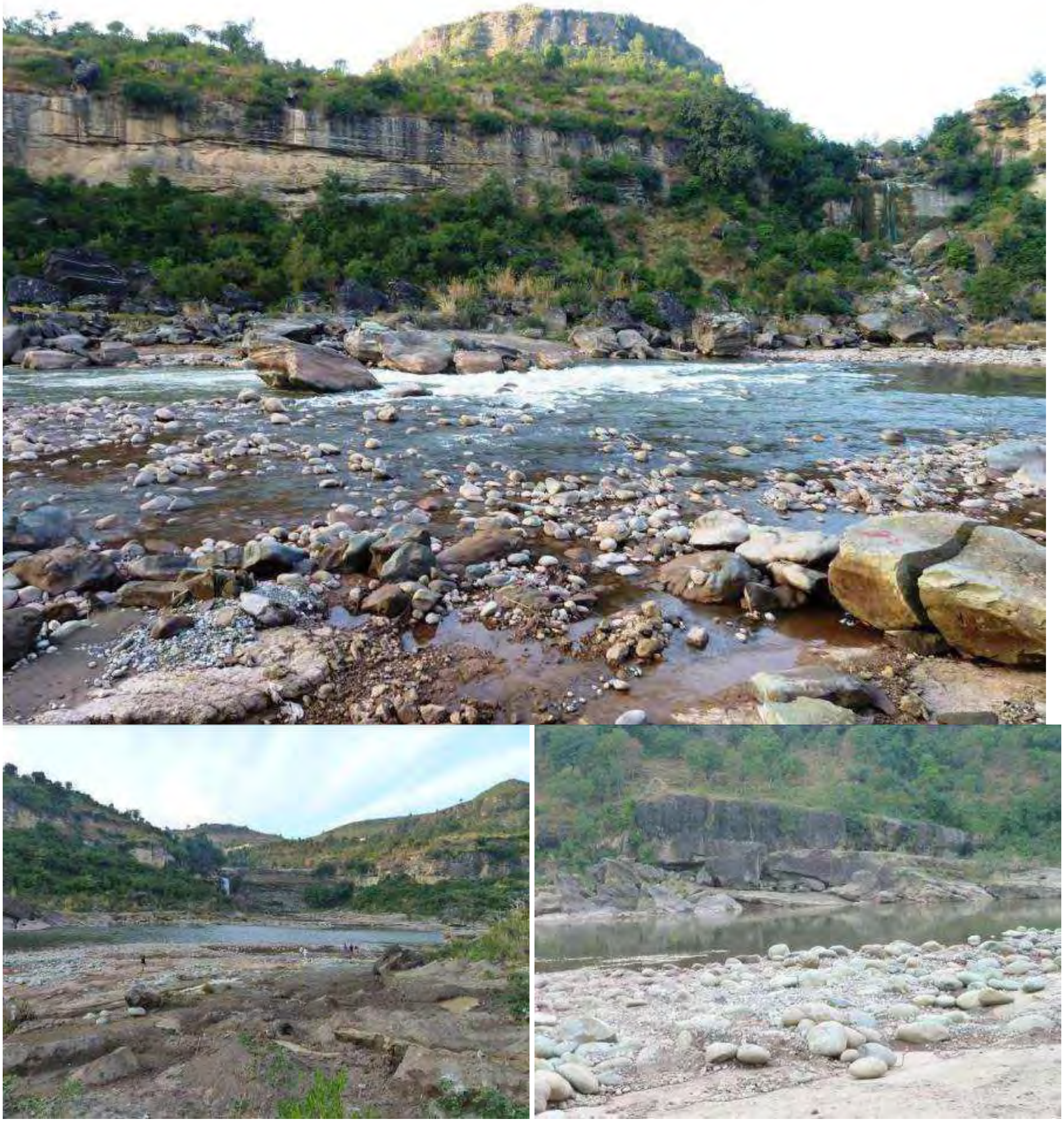
Figure 5-27: Photographs of EF Site 2 at Borali Bridge Indicating Extensive, Sorted Cobble Deposits, Absence of Fine Material and Bedrock Exposures on the Banks

Gulpur EF Site 3 (Gulpur Bridge)

354. EF Site 3 is characterized by large cobble and boulder riffle features and pools in the low flow active channel with cobble and boulder lateral bars, all within a steep, often bedrock cliff, valley sides (**Figure 5-28**).

355. Downstream of the site there is a large bedrock control outcrop - a bedrock pavement with a narrowly incised channel cut through it. During large floods this is likely to cause backup in to the site, possibly creating enhanced sediment deposition conditions.

Figure 5-28: Photographs of EF Site 3 at Gulpur Bridge Showing the Cobble and Boulder Bed, Bedrock Controlled Banks and Cliff Valley Sides, and Finer Sands on the Uppermost Banks.



356. There was evidence of large-scale sand and cobble mining at and immediately upstream of EF Site 3 (**Figure 5-29**). This site may be a preferential site for sand extraction due to the potential backup created by the large bedrock control downstream, since such conditions would promote enhanced deposition of fines during large flood events.

Figure 5-29: Widespread Extraction of Fine Sands and Cobbles at EF Site 2

Ecoclassification of River Reach Represented by the EF Sites

357. An assessment of the 2013 geomorphological status of the river at the EF sites was done using observations and data collected during the site visit (November 2013), available maps, high resolution historical and current satellite imagery, literature sources, data from previous studies and discussions with regional experts[23]. The Geomorphological Assessment Index (GAI) prescribed by the South African Department of Water Affairs and Forestry (Rowntree and du Preez in press)[24] was used for this assessment.

358. The GAI generates a percentage score that enumerates the deviation of the condition of the site from the expected natural (or Reference) condition. The output percentage scores are grouped into 6 Categories (**Table 5-27 Section 5.2.10)**, ranging from A (essentially in the Reference or historic natural Condition) to F (representing the most extremely degraded condition possible). For the purposes of this study, the Reference Condition was set as that condition of the river approximately 30 years ago, prior to the recent expansion of residential areas, sediment mining and roads within the catchment.

359. The EF sites are located in a single long steep reach of the river. Hydrological and land-use impacts are ubiquitous in this region, and the geomorphological condition of all sites is thus considered to be comparable. The Present Ecological State for the geomorphological component of the ecosystem is in an A/B category (close to natural). The slight reduction in condition, relative to the condition that could have been expected

[23] Field and office discussions with Mr Vaqar Zakaria from Hagler Bailly Pakistan and Dr. Muhammad Rafique from the Pakistan Museum of Natural History, Islamabad.

[24] Rowntree, K. and L. du Preez (in press). MODULE B: Geomorphology Driver Assessment Index (GAI), in River Ecoclassification: Manual For Ecostatus Determination (Version 2). Water Research Commission Report, Pretoria, South Africa.

to occur 30 years ago, is due to non-flow related anthropogenic activities in the catchment and within the riparian zone:

- The most important anthropogenic activities with regard to changes in habitat and sediment availability are due to sand and cobble/boulder mining from the river bed and banks (**Figure 5-30**).
- Of much lesser importance is the increase in suspended load/sediment yield (relative to the expected condition 30 years ago) from the catchment due to land use changes.

Figure 5-30: Mining Operation in the Bed of a Tributary where Extraction of River Sediment for Construction and Road Building is Degrading the Instream and Riparian Habitat of these Reaches

5.1.17 Ecohydraulics

Topographic data

360. Topographic river surveys were done by World Wildlife Fund (WWF) and STECO, under the auspices of HBP. At EF Site 1, 11 linked cross-sections were surveyed over a reach distance of 764 m; at EF Site 2, six linked cross-sections were surveyed over a reach distance of 998 m; and at EF Site 3, seven linked cross-sections were surveyed over a reach distance of 705 m. The geographic site positions and survey dates are provided in **Table 5-9** for these three sites. The detailed Hydraulics Specialist report can be found in **Appendix G.**

Table 5-9: Geographic Site Positions and Dates of River Topographic Surveys

EF site		Location (dec. deg., WGS 84)		Topographic survey dates
Number	Name	Latitude (E)	Longitude (N)	
1	Kallar Bridge	73.934733	33.578836	21 - 22.10.2013
2	Borali Bridge	73.869342	33.472497	22 - 23.10.2013
3	Gulpur Bridge	73.837169	33.449514	23.10.2013

361. Aerial photographs showing the locations of cross-sections surveyed at the EF sites, and ground photographs (that show selected cross-sections) are provided in **Figure 5-31** to **Figure 5-36** Survey data were provided (by STECO) in the form of Easting and Northing[25], with elevations relative to the Survey of Pakistan Datum (SPD).

Figure 5-31: The positioning of surveyed cross-sections at EF Site 1 (Kallar Bridge) using a 15 March 2010 aerial view.

25 As far as could be established, the projection used was Kalianpur 1962/India zone I.

Figure 5-32: Composite photographs of the Poonch River at EF Site 1, taken from the position indicated in Figure 5-31 (10 November 2013), showing cross-sections (10 and 11) used for hydraulic characterization in the DRIFT DSS

Figure 5-33: The positioning of surveyed cross-sections at EF Site 2 (Borali Bridge) using a 1 November 2005 aerial view

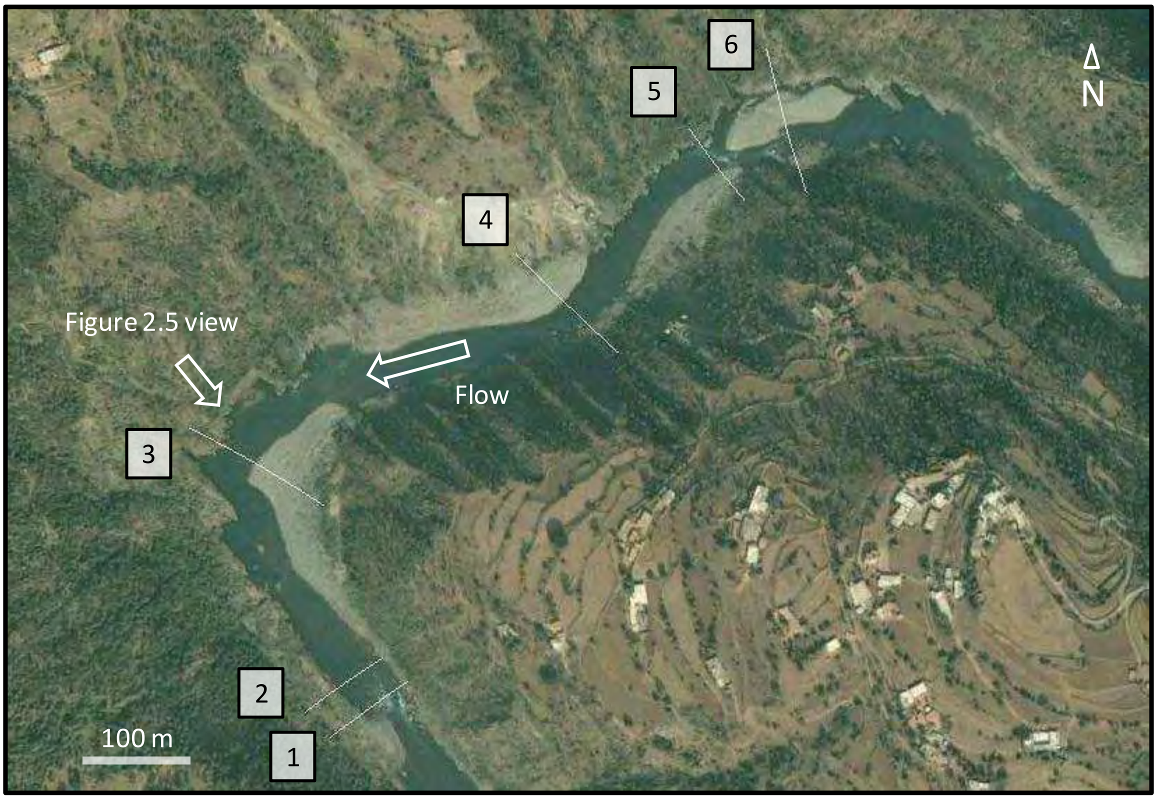


Figure 5-34: Composite photographs of the Poonch River at EF Site 2, taken from the position indicated in Figure 5-33 (10 November 2013), showing cross-sections (1 and 3) used for hydraulic characterization in the DRIFT DSS

Figure 5-35: The positioning of surveyed cross-sections at EF Site 3 (Gulpur Bridge) using a 1 November 2005 aerial view

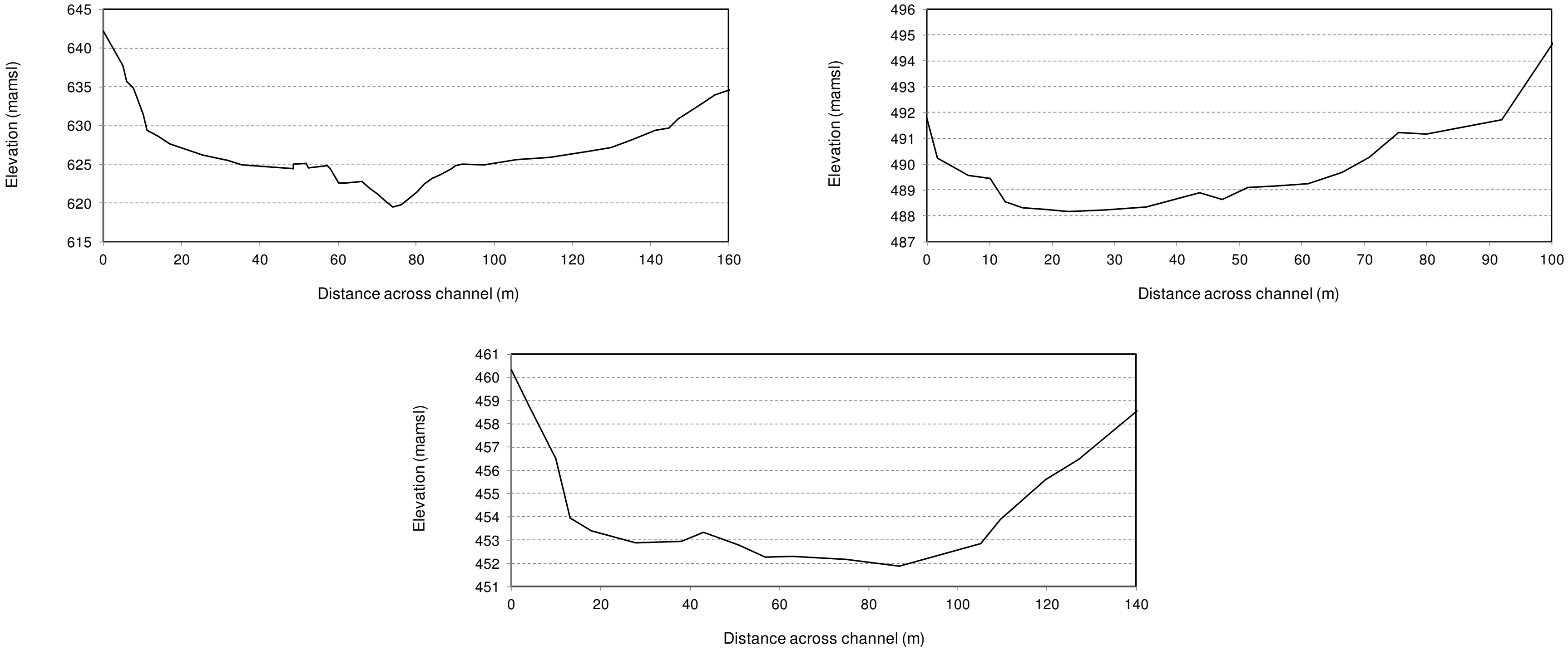
Figure 5-36: Composite photographs of the Poonch River at EF Site 3, taken from the positions indicated in Figure 5-35 (10 November 2013), showing cross-sections (1 and 3) used for hydraulic characterization in the DRIFT DSS

362. The above water channel topography (at the time of data collection) was surveyed by standard land surveying methods. For non-wadeable conditions, the channel bed was surveyed using sonar. Depth sounding took place by mounting the sonar equipment on a float and attaching to a tag line. The cross-sections used to derive hydraulic information for use in the DRIFT[26] DSS[27] are plotted in **Figure 5-37**.

[26] Downstream Response to Imposed Flow Transformation

[27] Decision Support System

Figure 5-37: Plots of Selected Cross-Section Profiles: Top-Left: EF Site 1 (Cross-Section 10) Top-Right: EF Site 2 (Cross-Section 1), Bottom: EF Site 3 (Cross-Section 1)



Hydraulic data

Stage measurements

363. Stage measurements were made on the right and left banks of the surveyed cross-sections at the time of topographic surveys (**Table 5-10**), and these data are included in **Table 5-11** and **Table 5-12**. Also included are the approximate (surveyed) stages corresponding to historic high flows and floods, including: high flows during the previous wet season, and the 2010 (EF Site 1,) and 1992 (all EF sites,) floods. These stage measurements are valuable for calibrating the hydraulic models for high flows, particularly for this study where only a single set of directly measured low flow rating (stage-discharge) data are available.

Discharge measurements

364. Discharge measurements were provided by manual gauging and also by making use of measurements from the Rehman Bridge Gauge on the Poonch River at Kotli.

Manual gauging

365. Manual gauging was performed using an acoustic Doppler profiler, held in position along the transect using a tag line. The velocity-area method (BS 3680) was used for discharge computation.

366. The discharges measured at the three EF sites were 17.2, 37.9 and 40.0 $m^3 s^{-1}$, respectively.

Table 5-10: Stage and Discharge Data for EF Site 1

EF Site 1				
Date	**21.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge (m3 s-1)	**17.2**	**476**	**995**	**3060**
Cross-section	**Stage (m amsl)**			
1	618.71	622.20		623.36
2	618.90	620.56	621.78	622.70
3	619.02	620.53	621.85	623.32
4	619.54	627.48		630.22
5	620.26	625.73		
6	620.75	623.26	625.93	
7	620.99	624.94		628.70
8	621.13	624.93		
9	621.38	624.42		626.01
10	624.38	626.53	627.32	629.07
11[28]	624.45	627.68		629.33

[28] Note: cross-section 11 was used directly in the DRIFT DSS (Section 6)

Table 5-11: Stage and Discharge Data for EF Site 2

EF Site 2				
Date	**23.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge (m3 s-1)	**37.9**	**700**		**4500**
Cross-section	**Stage (m amsl)**			
1	489.56	491.17		
2	489.65			
3	490.07	493.92		495.78
4	490.75	495.68		498.31
5	491.65	495.70		498.81
6	492.52	496.21		499.56

Table 5-12: Stage and discharge data for EF Site 3

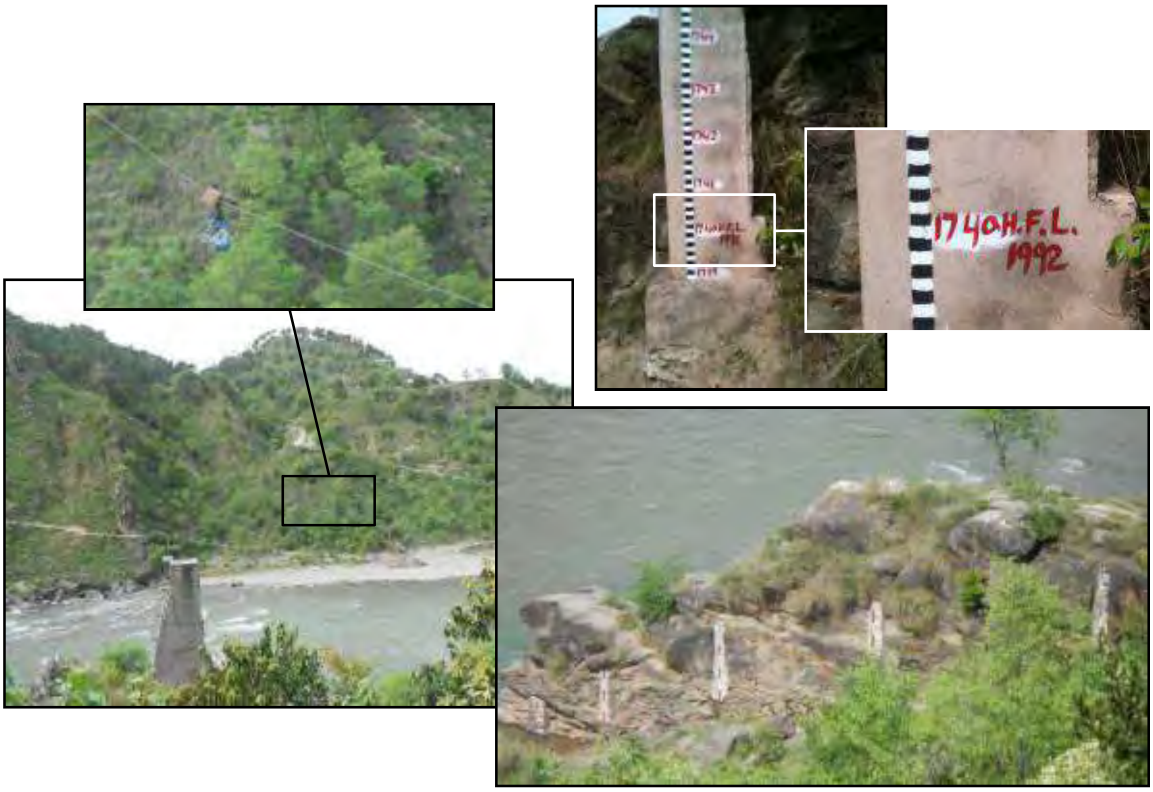
EF Site 3				
Date	**24.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge (m3 s-1)	**40.0**	**700**		**4500**
Cross-section	**Stage (m amsl)**			
1	452.82	455.59		458.72
2	453.61	455.26		460.29
3	453.60	456.65		458.81
4	453.48	456.03		458.34
5	453.69	455.02		458.97
6	455.46	459.17		464.59
7	455.97			

Rehman Bridge Gauge

367. Records from the Rehman Bridge Gauge on the Poonch River at Kotli, located *c.* 130 m downstream of its confluence with the Ban Nullah, were used to provide the maximum discharge for the wet season prior to the survey in October 2013, and historic floods[29] in 2010 and 1992 (refer to **Figure 5-38**).

[29] Historic maximum flood discharges and their corresponding surveyed stage levels

Figure 5-38: Photographs of the Rehman Bridge Gauging Station, located *c*. 130 m below the confluence of the Poonch River and Ban Nullah



Note the 1992 High Flood Level (HFL) of 1740 ft amsl[30] (Source: Mr Yasir Abbas, NESPAK)

5.1.18 Traffic Survey

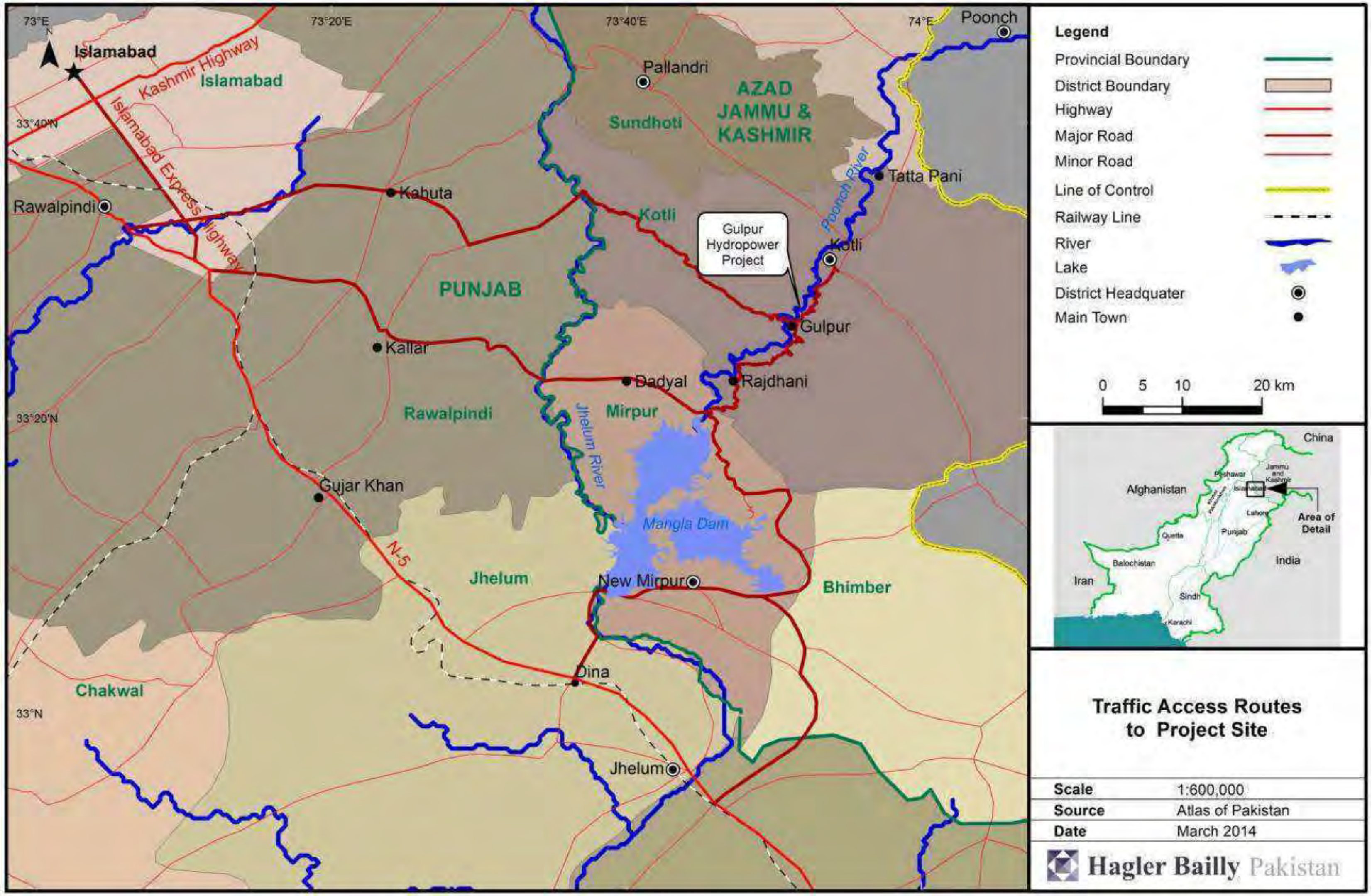
368. Traffic count surveys were conducted at two different locations in and around Kotli which are listed as follows:

- Location 1: Gulpur Junction
- Location 2: Palak Junction

369. **Figure 5-39** shows the location of the survey points. Locations 1 and 2 correspond to the nodes where the impacts of Project related traffic are likely to be high. Location 1 also represents the level of traffic that will be experienced at the point near Project site where the access road for the project connects to the main road. Separate counts were made for cars, jeeps, large vans (flying coach in local terminology), Suzuki vans (small vans), trucks and buses, and motorbikes.

[30] above mean sea level

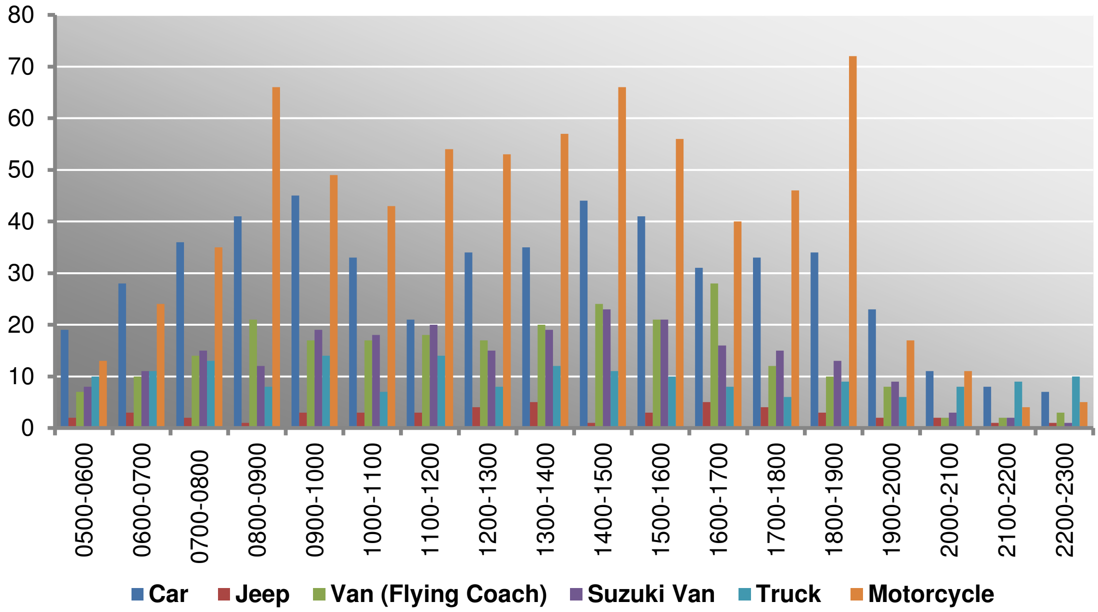
Figure 5-39: Traffic Survey Points



Location 1: Gulpur Junction

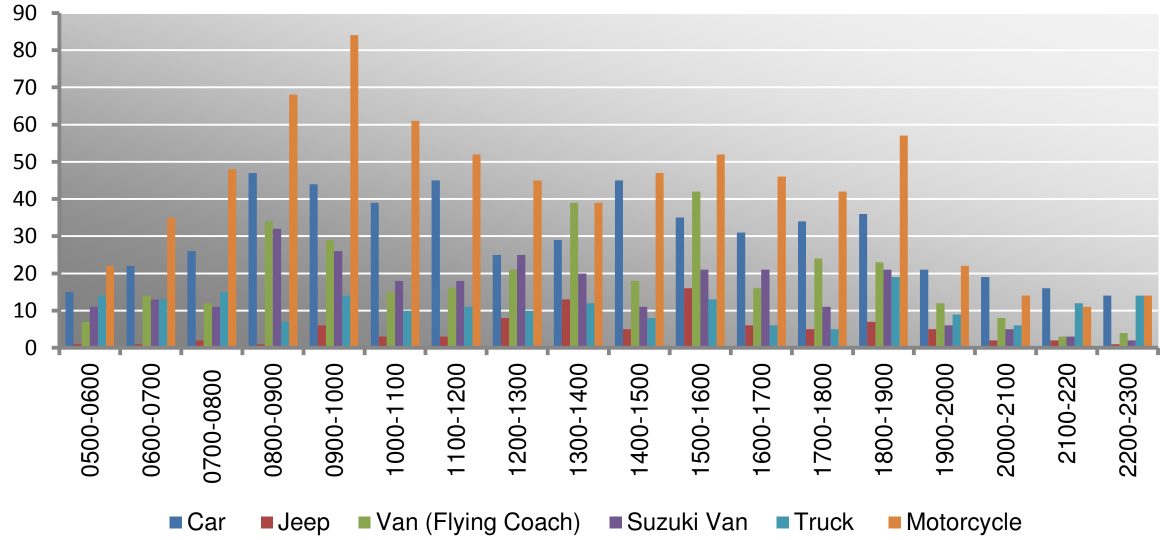
370. **Figure 5-40** shows that the traffic activity varies at different times of the day starting from lower number of vehicles in early and gradually increasing towards the mid–day. There is a dip in the afternoon and then another rise in traffic count in the evening and finally a drop towards later evening and still lower at late night. There are three main peaks in traffic, first is around the 0900 hours which is normally the time when people have to reach to the offices and business. Next surge is in the afternoon around 1400 hours as that is lunch time in the offices and off time for educational institutions and hence the greater activity. The last peak in the traffic activity is observed in the evening around 1700 hours because this is the time when people leave their work places and return home.

Figure 5-40: Traffic at Gulpur Junction towards Mirpur and Rawalpindi



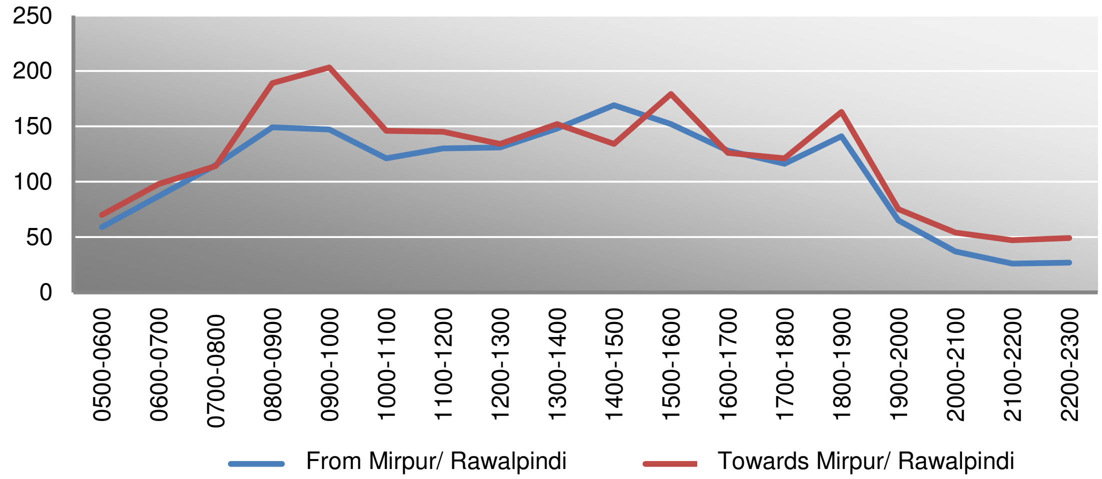
371. The traffic pattern in the opposite direction at the Gulpur Junction follows a slightly different pattern in terms of the number of traffic peaks in which away traffic were three and here there are two clear surges, one at the same time in the morning around the 1000 hours while the next one is observed at around the 1600 hours (**Figure 5-41**)

Figure 5-41: Traffic at Gulpur Junction from Rawalpindi and Mirpur towards Kotli



372. Comparing the two traffic patterns simultaneously it can be seen that the volume of traffic towards Gulpur and then traffic away from the Gulpur is more or less the same but the slight change is observed only in the timings of peak traffic hours. This is due to the reason that people from the adjoining areas come for business to Gulpur in the morning and then return to homes later in the day **Figure 5-42**.

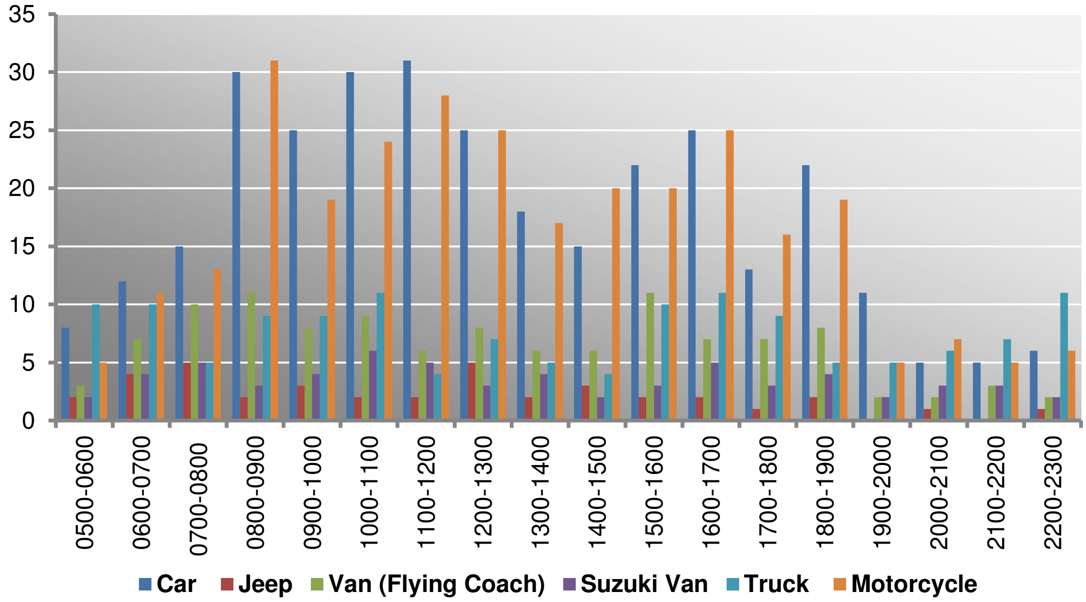
Figure 5-42: Traffic at Gulpur Junction from Kotli towards Rawalpindi and Mirpur



Location 2: Palak Junction

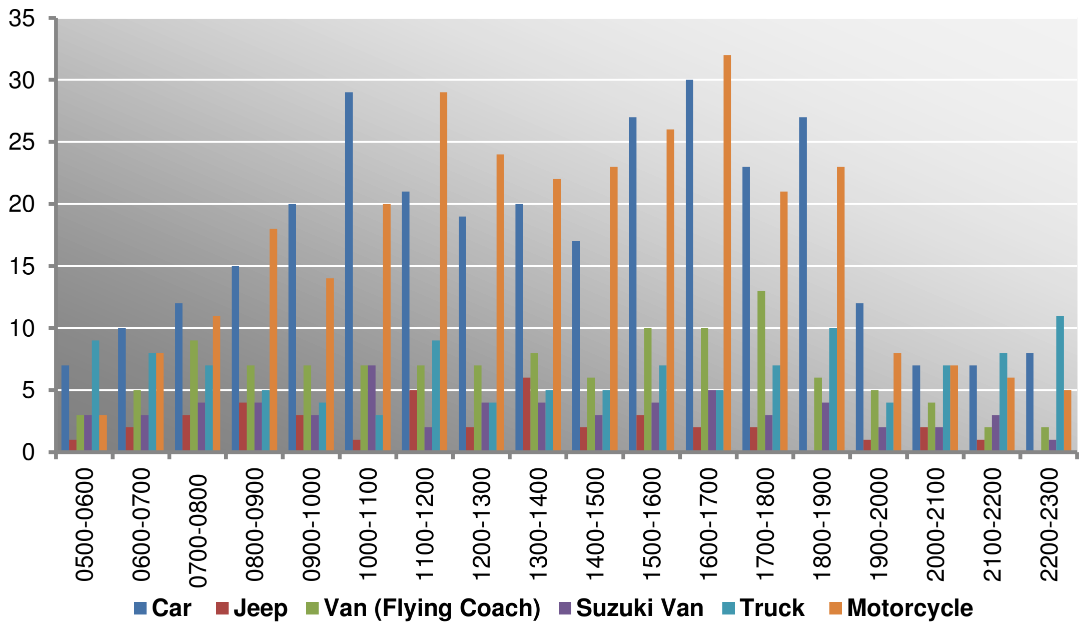
373. **Figure 5-43** shows traffic counts surveyed at Palak junction from Kotli to Dhudial and Mirpur. Major portion of the road users observed were motorcyclists followed by car drivers and truck drivers. The first peak of the day was observed between 0800 and 0900 at this junction. The number of motorcyclists slightly decreased between 0900 and 1000 and then gradually increased till noon. A dip in number of overall road users was observed at 1400 and gradually increased till 1700 on the evening. After 1900 the number of road users decreased significantly.

Figure 5-43: Traffic at Palak Junction from Kotli to Dudhial and Mirpur



374. **Figure 5-44** shows graphical representation of data collected at Palak Junction for the traffic travelling from Dudhial and Mirpur towards Kotli. Major portion of the road users surveyed were motorcyclists followed by car, truck and vans. The number of vehicles increased gradually with a slight decrease 1100 in the morning. The number of traffic users increased until 1700 in the evening and then significantly decreased after 1900 hours.

Figure 5-44: Traffic at Palak Junction from Dudhial and Mirpur to Kotli

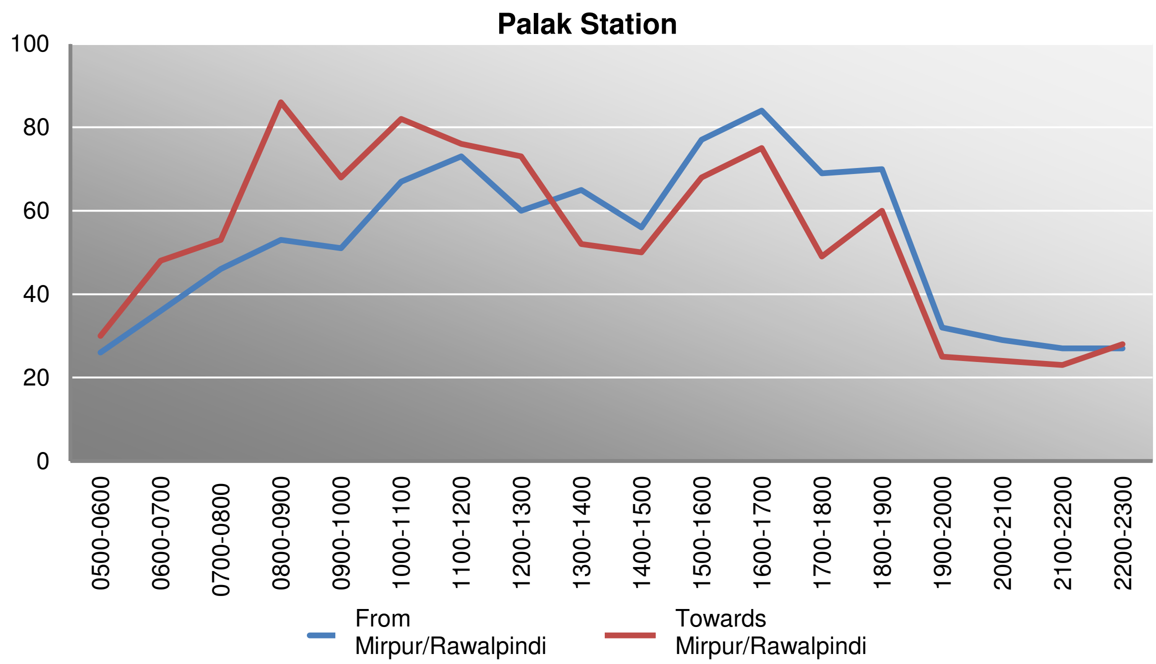


375. **Figure 5-45** shows a comparison of the total number of road users crossing Palak junction from and towards Mirpur. The trends observed indicate that during the

first half of the day, vehicles travelling towards Mirpur were higher than vehicles travelling from Mirpur towards Kotli. The number of users travelling from Kotli towards Mirpur were the largest, between 0800 and 0900 hours.

376. During the second half of the day, the collected data indicated that the number of vehicles travelling from Mirpur was higher than the number of vehicles travelling towards Mirpur.The number of vehicles significantly decreased after 2000 hours at night in both the directions, from and towards Mirpur.

Figure 5-45: Traffic at Palak Junction



5.2 Ecology Baseline

377. This section provides a summary of the terrestrial and aquatic ecological resources in the Ecological Study Area focusing on fish fauna, macro–invertebrates, floral diversity and habitats, mammals, reptiles, and birds. Information presented in this section was collected during two ecological surveys of the Ecological Study Area. The October 2013 survey was conducted from 26th September 2013 to 3rd October 2013 while the December 2013 survey was conducted from 24th December 2013 to 28th December 2013 to study the abundance and diversity of the ecological resources in the fall and winter seasons respectively. The May 2014 survey for fish was conducted from 30th April to 4th May. Information from a previous ecological survey of the Project site and vicinity conducted in May 2013 has also been incorporated.

378. Detailed data, analysis, and discussion of results of the October 2013 survey and December 2013 survey are included in Final Biodiversity Baseline Report for Gulpur Hydropower Project.

5.2.1 Ecological Study Area

379. The Aquatic Study Area for sampling the aquatic resources consists of the stretch of Poonch River from Kallar Bridge to just downstream Rajhdani, as well as the main tributaries of the Poonch River including Ban Nullah, Rangar Nullah and Nehl Nullah. The river banks and areas within 500 m on either side of the river have been included in the Aquatic Study Area and sampling for vegetation, mammals, herpeto-fauna and birds has been conducted in these riparian habitats.

380. The Study Area for sampling the terrestrial ecological resources consists of the Project facilities such as power house, Dam, camping sites etc. as well as a 3 km potential impact zone around each facility. The Terrestrial Study Area has been demarcated by combining all these potential impact zones to account for an area in which the ecological resources may be impacted by Project related activities such as habitat loss, sound, vibrations etc.

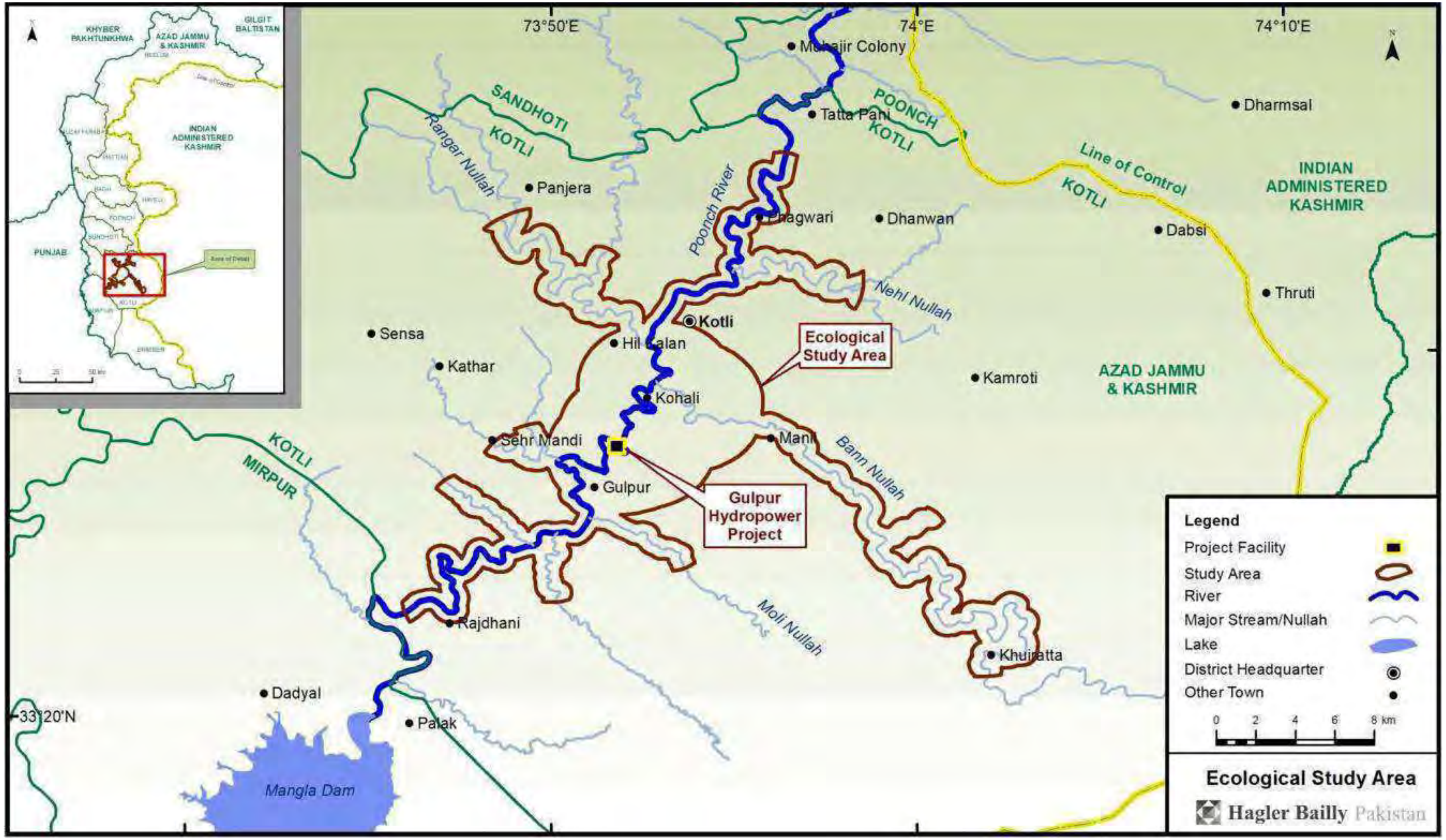
381. The term 'Ecological Study Area' is used to jointly refer to both the Aquatic and Terrestrial Study Areas and is shown on a map in **Figure 5-46**.

5.2.2 Scope

382. The specific tasks covered under this ecological baseline study included:

- A review of the available literature on the biodiversity of the Ecological Study Area.
- Field surveys including:
  - Qualitative and quantitative assessment of flora, mammals, reptiles, birds and invertebrates.
  - Identification of key species, their population and their conservation status in the country and worldwide.
  - Reports of wildlife sightings in the Ecological Study Area by the resident communities.
- Analysis of ecological interaction of selected species with the environment.
- Analysis was also carried out to further develop the basis for evaluating the potential impacts of Project related activities on the biodiversity, specifically seeking any potential critical habitat and ecosystem services in the Ecological Study Area.

Figure 5-46: Ecological Study Area



5.2.3 Methodology

383. The methodology for the field survey was compiled to obtain objective data, and to determine the baseline conditions for assessment of the resulting impacts of the Project for the data collected. During the October 2013 survey, sampling was conducted at 26 points. During the December 2013 survey, sampling for Otter sightings and signs was conducted at six locations, sampling for fish was conducted at 4 locations[31] while sampling for vegetation, mammals and birds was conducted at three (3) sampling locations (the terrestrial habitat that will be occupied by Project infrastructure). Since the herpeto–fauna hibernate in the winter months, reptile and amphibian sampling was not conducted during the December 2013 survey. During the May 2014 survey, sampling of fish was carried out at 9 sampling locations including sites of potential future hydropower projects. Sampling for vegetation in the May 2014 survey was repeated at the same sampling locations as the December 2014 survey i.e. the terrestrial habitats that will be occupied by the Project infrastructure.

384. The December aquatic survey focused on pool habitats in the main river as fish avoid shallow riffle habitats in the main river and the tributaries. With the selection of Option 3 as Project design (**Section 8**, Analysis of Alternatives), the stretch of River that will experience low flows was reduced. In addition, the inundation of the two tributaries, Rangar Nullah and Ban Nullah, also reduced significantly. Similarly, due to this change in the Project design and reduced Project footprint, the anticipated Project impact on the terrestrial ecological resources was reduced. Therefore, the number of sampling locations in the December 2013 and May 2014 survey was reduced compared to the October survey.

385. The timing, location, and scope of the surveys are summarized in **Table 5-14**. Details of sampling methodology used, coordinates of sampling locations and field data collected for both the surveys is presented in **Appendix B**, Final Biodiversity Baseline Report for Gulpur Hydropower Project. A brief summary of the methodology is presented below. The sampling locations are shown on a map in **Figure 5-47** and **Figure 5-48** and **Figure 5-49**.

386. The Biodiversity Baseline and results of the field survey were shared with relevant stakeholders including the AJK Fisheries and Wildlife Department and Himalayan Wildlife Foundation. These consultations were carried our prior to and during the development of the Biodiversity Action Plan and are described in **Appendix L, Biodiversity Action Plan**.

387. The methodology used for sampling the aquatic and terrestrial ecological resources is outlined below. The team members involved in development of the biodiversity baseline are listed in **Table 5-13.**

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31 The fourth sampling location in the main river, Sampling Point A-5 in Figure 5-45, was selected in case an additional EFlow assessment site were to be added for assessment of impacts of a peaking operation. As peaking operation was discarded for environmental reasons, the EFlow assessment sites were limited to three. Data for Sampling Point A-5 could be used in future in case intermittent releases from the dam are ever considered.

Table 5-13: Biodiversity Baseline Team Members

Name	*Organisation*	*Position on team*
Mr Vaqar Zakaria	Hagler Bailly Pakistan	Supervisor
Ms Fareeha Irfan Ovais	Hagler–Bailly Pakistan	Ecologist
Dr Mohammed Rafique	Sub Hagler–Bailly Pakistan[32]	Fish specialist
Mr Mishkatullah	Sub Hagler–Bailly Pakistan	Macroinvertebrates specialist
Mr Ghulam Murtaza	Hagler Bailly Pakistan	Mamamls and birds specialist
Mr Rafaqat Masroor	Sub Hagler–Bailly Pakistan	Herpeto-fauna specilaist
Mr Wajid Saghir	Hagler Bailly Pakistan	Vegetation Specialist

Aquatic Ecological Resource Sampling

388. **Fish:** Fish fauna were collected using cast with mesh sizes 2 x 2 cm, having a circumference of 4m. Nets were cast on line of 200 meters along the bank of River. Collected fish specimens were identified noted and then releases at the spot. Voucher species were preserved in 10% formaldehyde for record. Different micro-habitats of river like pools, riffles and back water were sampled to understand habitats preferences of different fish species. In addition to cast nets, gill nets of different mesh sizes were used for fish sampling in the winter months.

389. **Macro-invertebrates:** Macro-invertebrates were sampled by adopting the standardized rapid biological assessment sampling techniques (using multi-habitat approach) developed by Barbour et al 1999[33]. A Surber Sampler or D frame kick net were used for sampling. Twenty efforts were taken at each sampling station based on percent availability of each biotope. For example if a sampling station comprised of 80% riffle and 20% pool habitat, then 16 efforts of the Surber Sampler were conducted in the riffles and 4 efforts in pool (ratio of 80% to 20%). Samples collected were preserved in 10% formalin. In the laboratory, each sample were put into a sieve of 500 μm mesh size and rinsed with running water (to remove traces of formalin). Macro-invertebrates were then sorted from the samples and identified using a Kyowa Stereozoom Microscope and the identification keys given in Edmondson, 1959[34]; Ali 1967[35]; Ali 1970[36]; Bouchard 2004[37].

390. **Otters:** Sampling of otters was carried out during the winter season when water volumes are low and the signs of the animal can be observed. Sightings and observation

32 Subconsultant to Hagler–Bailly Pakistan

33 Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

34 Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

35 Ali, S.R. 1967. The Mayflies (Order: Ephemeroptera) of Rawalpindi District. Pak. J. Sci. 19 (3): 73-86

36 Ali, S.R. 1970. Certain Mayflies of West Pakistan. Pak. J. Sci. 22 (3 & 4): 118-124.

37 Bouchard, R.W. Jr. 2004. Guide to Aquatic Macroinvertebrates of Upper Midwest. Water Resources Center, University of Minnesota, St. Paul, Minnesota. 208pp.

of signs (faeces, foot marks, dens) were conducted at sampling points in conducive habitats along the river banks.

391. **Riparian vegetation:** Riparian vegetation on the flood plains and bank side vegetation was sampled via a rapid assessment stratified approach, using three quadrats at each sampling site of 10 × 10 m to measure presence, cover and abundance of vegetation species.

Terrestrial Ecological Resource Sampling

392. **Terrestrial habitat characterization:** For terrestrial habitat characterization, satellite imagery, vegetation cover/land use maps, as well as results from the scoping study were compiled to draw terrestrial habitat maps of the Study Area. The focus was to map out all the vegetation zones particularly the vegetation zones that are river dependent, such as floodplain and marginal vegetation zones. The forest types, grazing areas, agricultural fields and other zones and other relevant defining landscape feature were included.

393. **Terrestrial vegetation:** Vegetation was sampled via a rapid assessment stratified approach, using three quadrats at each sampling site of 5 × 5 m to measure presence, cover and abundance and the vegetation species. Sampling was done in all representative habitats, topographic and physiographic conditions of the study area.

394. **Large Mammals:** Line transects (500 m by 20 m) were placed at each sampling location to record all animals or their signs and footprints. All the animals sighted, or their signs (foot marks, droppings, dens) will be recorded. GPS coordinates of the location and habitat type were documented. All the incidental sightings of mammals were recorded. Moreover, relevant literature and local peoples were consulted to get anecdotal information about mammalian species of the area.

395. **Small Mammals:** Live trapping of small mammals was carried out at various sampling sites using Sherman traps. A mixture of different food grains mixed with fragrant seeds was attempted as bait to attract the small mammals. Thirty to forty traps were set at a specific area in two lines approximately 10 m apart and left overnight. Trapped animals were identified and released alive after taking measurements

396. **Reptiles:** Active searching was done along the line transect of 500 m long and 20 m wide placed systematically at each sampling to record presence of signs such as an impression of body, tail or footprints, fecal pellets, tracks, dens or egg laying excavations. The specimens were identified with the help of the most recent key available in the literature.[38] Density and diversity were calculated for each sampling point.

397. **Birds:** The line transects (500 m by 50 m) were placed at each sampling location to record all birds observed. Transects were started early in the morning and in late afternoon and evenings to cover all possible habitats. The birds were identified using the most recent local and international bird identification tools available (Grimmett 2008)[39].

[38] Muhammad Sharif Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Malabar, Florida, pp. 311.

[39] Grimmett, R., Roberts, T., and Inskipp, T. 2008. Birds of Pakistan, Yale University Press.

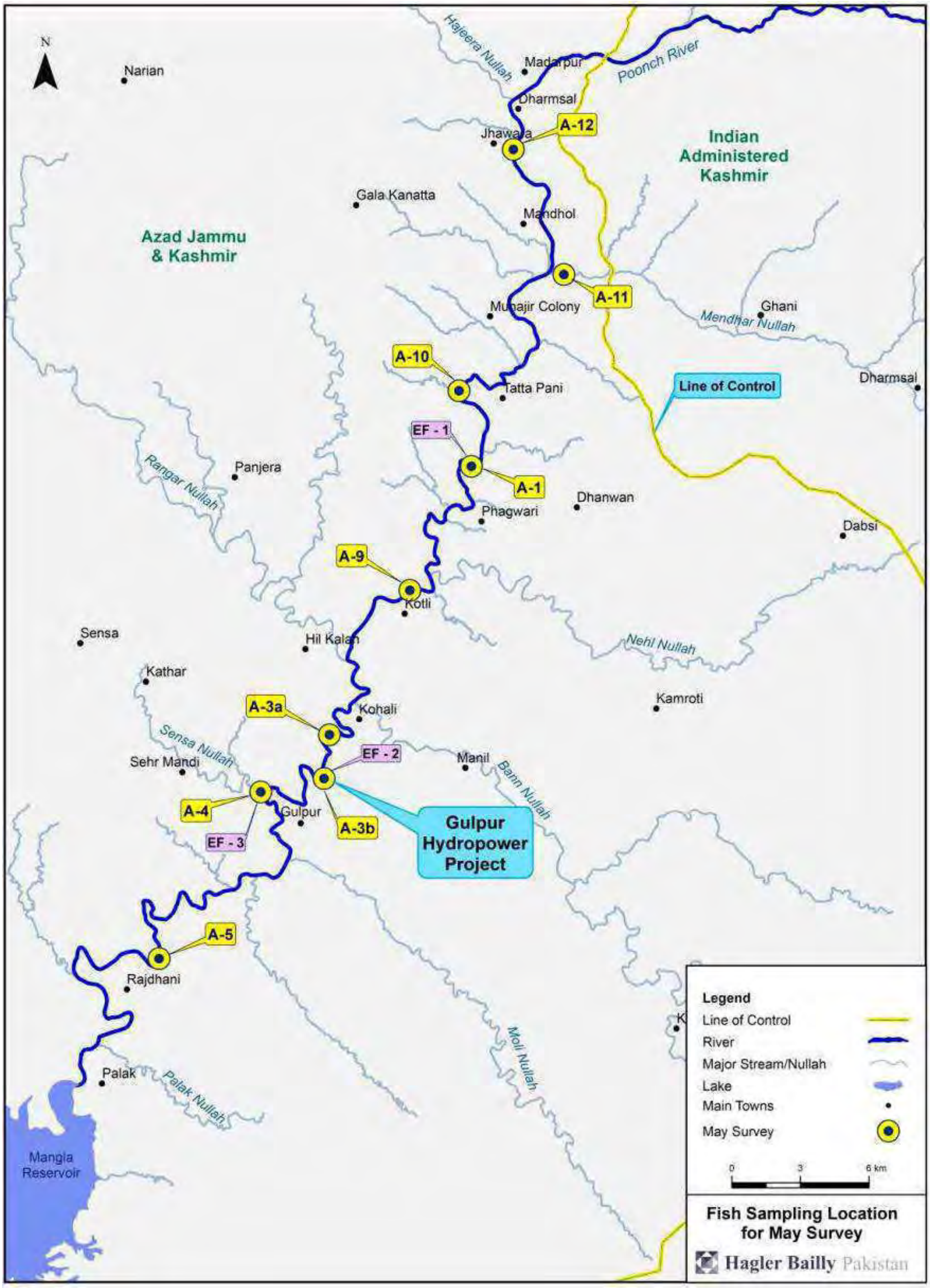
Table 5-14: Timing, Location, and Scope of Surveys in the Ecological Study Area

Survey Period	Area Studied	Scope	Comments
October 2013	River, tributaries, and terrestrial habitats in the Aquatic and Terrestrial Ecological Study Area	Aquatic/River dependent: fish, macroinvertebrates, macrophytes, marginal vegetation, mammals, birds,and herpeto–fauna.	A total of eight sampling locations were selected for aquatic sampling in the river and its tributaries. The river biotopes at each sampling location were identified and sampling for fish and macro–invertebartes was conducted ensuring sampling in each biotope. Sampling of vegetation, mammals, reptiles and birds was conducted on the riparian habitats within 500 m on either side of the river.
		Terrestrial: vegetation, mammals, birds and herpeto–fauna	A total of eighteen sampling locations were selected for terrestrial sampling of vegetation, mammals, herpeto–fauna and birds. A grid of 2x2 km was drawn on a map of the Terrestrial Study Area and the sampling points were marked. The points were then adjusted to ensure habitat representation, accessibility, with a focus on the areas to be impacted. Seven trapping sites for small mammals were selected.
December 2013	River, and terrestrial habitats at the proposed Project location.	Aquatic/River dependent: fish, Otter Terrestrial: vegetation, mammals and birds	A total of 4 sampling locations were selected for aquatic sampling of fishes . A total of six sampling locations were selected for observing Otter sightings and signs. A total of three sampling locations were selected for terrestrial sampling of vegetation, mammals, herpeto–fauna and birds at the proposed Project location. One trapping site for small mammals was selected.
May 2014	River, and terrestrial habitats at the proposed Project location	Aquatic/River dependent: fish Terrestrial: vegetation	A total of 9 sampling locations were selected for aquatic sampling of fishes . A total of three sampling locations were selected for terrestrial sampling of vegetation at the proposed Project location.

Figure 5-47: Aquatic Ecological Sampling Locations

Figure 5-48: Terrestrial Ecological Sampling Locations

Figure 5-49: Fish Sampling Locations for May 2014 survey



5.2.4 Aquatic Ecological Resources

398. This section presents an overview of the aquatic ecological resources in the Ecological Study Area including fish fauna and macro-invertebrates.

Fish

Regional and Historical Perspective

399. The river systems in Indian Subcontinent harbour a rich diversity of fish. However, intense anthropogenic stress is leading to degradation of the habitat and loss in fish species richness.[40] In case of Poonch River, a review of regional trends in presence and abundance of Mahaseer *Tor pitutora* which has been widely studied over time provides an indication of the status and trends in richness and abundance of the fish fauna of the river. Mahaseer was selected as one of the key indicator fish species for the purpose of assessment of impacts of the Project on ecology of Poonch River (see subsection 'Indicator Species' below).

400. The Mahaseer fish has been extirpated from various parts of Pakistan due to habitat deterioration and construction of dams causing obstructions in migration. The worse examples of extirpation are from River Ravi located about 100 km southeast of the Project site (**Figure 2-1** in **Section 2**) and Potowar area located about 80 km west of the Project site. The following is a brief discussion of the observed trends in these two areas.

River Ravi Near Lahore

401. The records of fish fauna of Lahore go back to Lahore District Gazetteer of 1916 presenting a list of 26 species including the Mahaseer. Hora (1919)[41] made a preliminary study of fish fauna of Lahore and recorded 42 species from Lahore with the record of Mahaseer. Ahmad (1943)[42] recorded 49 species of fishes from Lahore including the Mahaseer. Khan (1962)[43] reported Mahaseer fish from Marala Ravi Link Canal with an average weight of 4.5 kg and maximum weight of 9 kg, the Mahaseer being of the maximum size of all the commercially important fishes collected. He reported that during the year 1960-61, 200 maunds (8,000 kg) of fish of marketable size were caught from this canal, the maximum size being of Mahaseer. He also reported that the catch could be four times if all the resources could be exploited properly. Mirza (1970)[44] reported 65 species from Lahore including Mahaseer from River Ravi at Lahore.

402. The wide variety of fish that once swam in the Ravi has vanished as have the tiny minnows and crabs that children used to catch in the shallow waters along the banks. Even the reeds that used to line the river have gone. The river is virtually dead even when the normally dry bed carries water, such as after rains. The life that once thrived

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[40] Das M.K., Naskar M., Mondal M.L., Srivastava P. K., Dey S., Rej A. 2012. Influence of ecological factors on the patterns of fish species richness in tropical Indian rivers. Acta Ichthyol. Piscat. 42 (1): 47–58.

[41] Hora, S. L. 1919. Fishes of Lahore. M. Sc. Thesis, University of Punjab. Lahore, Pakistan.

[42] Ahmad N.. 1943. Bulletin of the Department of Zoology, Punjab University, Fauna of Lahore. 5. Fishes of Lahore, Vol.1, pp. 253-374.

[43] Khan, R. M. L. 1962. Fish and Fishery of M.R. Link Canal, West Pakistan. *Agriculture Pakistan*. 13(2): 313-321

[44] *Mirza, M. R., 1970. A contribution to the fishes* of *Lahore* including revision of classification and addition of new records. Biologia (Pakistan). 16: 71-118.

there has been harmed by industrial effluent along with huge amounts of raw sewage. The extreme pollution of the River Ravi has destroyed almost all of the fish species that once lived in the river.[45]

Soan, Haro, and Koran Rivers Near Rawalpindi and Islamabad

403. The Mahaseer Fish has also been widely distributed in the river Soan, Haro and Korang near the urban centres of Rawalpindi and Islamabad (**Figure 2-1**) in the Potowar area. The area was a hotspot for Mahaseer. Historically, Mirza and Kashmiri (1973)[46] recorded Mahaseer from the river Soan and commented that it is one of the most common fish in the area. The Mahaseer has also been recorded from various tributaries of the Salt Range (Mirza and Awan, 1976)[47], (Hora, 1923)[48] which ultimately fall into the Soan River. The fish was also common in Attock district (Naik and Ali, 1968)[49]. It was one of the most common fish in the river Haro throughout its length and was considered an excellent sports fish.[50]

404. Presently pollution and effluent from the twin cities of Rawalpindi and Islamabad, construction of Simly, Rawal and Khanpur Dams, extensive extraction of sand, gravel and stones from river beds has fragmented the habitat, created permanent obstacles for the fish for reaching its breeding grounds, and destroyed the breeding grounds as well. The adverse environmental factors have severely affected the population of Mahaseer in the Potowar area, and at present this fish is almost extirpated from this area except for few specimens near the shrines where it is treated as sacred. The suitable breeding grounds of this fish were the upper reaches of river Soan and Haro Rivers. Construction of dams has blocked the migration of this fish to these breeding grounds and the effluents from industries and municipal garbage of the twin cities has severely reduced the richness and abundance of fish species in these rivers to the point that these rivers can practically be considered devoid of fish. Last specimens of Mahaseer were seen in the Soan River during 2003 and after that this fish has not been observed in spite of frequent surveys.

Overview of Fish Fauna in Poonch River

405. The Poonch River is a warm water river and the water temperature approaches almost 30^{o} C during the summer months. A total of 37 fish species have been recorded from the Poonch River (**Table 5-15**)[51] [52]. The diversity[53] is higher in the area where the

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[45] Environment Department, City District Govt. Lahore (CGDL), 'Environmental Profile of Lahore (2007-08)'

[46] Mirza, M.R and Kashmiri, K.M. 1973. Fishes of the river Soan in Rawalpindi District, Pakistan; Biologia (Pakistan), 19: 83-86.

[47] Mirza, M.R. and Awan, M.J. 1976. Fishes of the Sonsakesar valley, Punjab, Pakistan with the description of a new sub-species. Biologies (Pakistan)22:27-49.

[48] Hora, S. L., 1923. Fishes of the Salt Range, Punjab. Rec. Ind. Mus., 25: 377-387.

[49] Naik, I. U. and S.R., Ali. 1968. An account of fishes of Attock District, West Pakistan. Pak. J. Scie. Indust. Res. 11: 114-115.

[50] Naheed, Q., Rafique, M, and Mirza, M.R. 1988. Contribution to the Fishes of the River Haro. Biologia, 34 (1): 179-191.

[51] Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

[52] HBP, November 2013, Draft Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

[53] Relative diversity or richness observed.

River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer. The reason is the topography and water temperature of the River Poonch. The Poonch flows gently in a vast and flat valley, which provides numerous breeding grounds for the reproduction of fish. High temperature and gravely, rocky and the sandy river bed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival. The completion of Mangla dam in 1967 created a barrier in the Jhelum River and isolated the Poonch River from the segment of Jhelum downstream of the dam. Mangla dam also created a barrier to movement of riffle dwelling smaller fishes such as the Kashmir Catfish *Glyptothorax kashmirensis* and the Twin–Banded Loach *Botia rostrata* between the Jhelum and Poonch rivers.

406. Of the fish species recorded from the Poonch River, 16 species are species of special importance because of their economic importance or conservation status (endemic or included in IUCN red List). These include *Barilius pakistanicus, Schistura punjabensis, Cirrhinus reba, Labeo dero, Labeo dyocheilus, Tor putitora, Schizothorax plagiostomus (richardsonii), Cyprinus carpio, Botia rostrata, Sperata seenghala, Clupisoma garua, Ompok bimaculatus, Glyptothorax naziri, Ompok pabda, Glyptothorax kashmirensis* and *Mastacembelus armatus*. The species *Glyptothorax kashmirensis,* previously only reported from Jhelum River, has been captured from the Poonch River during the October 2013 survey and May 2014 survey and is discussed below. The species recorded in Poonch River and those that are of special importance are listed in **Table 5-16**.

Table 5-15: Fish Fauna Recorded from the Poonch River

No	*Scientific Name*	Common Name	Distributional Status	IUCN Status 2013*	Commercial Value
	Cyprinidae				
1.	*Chela cachius*	Silver hatchet chela	Wide	LC	Low
2.	*Salmophasia bacaila*	Large razorbelly minnow	Wide	LC	Low
3.	*Aspidoparia morar*	Aspidoparia	Wide	LC	Low
4.	*Barilius pakistanicus*	Pakistani baril	Endemic	ND	Low
5.	*Esomus danricus*	Flying barb	Wide	LC	Low
6.	*Cirrhinus reba*	Reba carp	Wide	LC	Fairly good
7.	*Cyprinion watsoni*	Cyprinion	Wide	ND	Low
8.	*Labeo dero*	Kalbans	Wide	LC	Fairly good
9.	*Labeo dyocheilus*	Pakistani Labeo	Wide	LC	High
10.	*Osteobrama cotio*	Cotio	Wide	LC	Low
11.	*Puntius chola*	Swamp Barb	Wide	LC	Low
12.	*Puntius sophore*	Spotfin Swamp Barb	Wide	LC	Low
13.	*Puntius ticto*	Two spot Barb	Wide	LC	Low
14.	*Tor putitora*	Mahaseer	Wide	EN	Very high
15.	*Crossocheilus latius*	Gangetic latia	Wide	LC	Low
16.	*Garra gotyla*	Sucker head	Wide	LC	Low
17.	*Schizothorax plagiostomus (richardsonii)*	Snow carp	Wide	VU	High
18.	*Securicula gora*	Gora Chela		LC	Low
19.	*Cyprinus carpio*	Common carp	Exotic	VU	High

No	*Scientific Name*	Common Name	Distributional Status	IUCN Status 2013*	Commercial Value
	Noemacheilidae				
20.	*Acanthocobitis botia*	Mottled Loach	Wide	LC	Low
21.	*Schistura punjabensis*	Hillstream loach	Endemic	ND	Low
	Cobitidae				
22.	*Botia rostrata*	Twin–banded Loach	Wide	VU	Low
	Bagridae				
23.	*Sperata seenghala*	Giant river cat fish	Wide	LC	Very high
	Schilbeidae				
24.	*Clupisoma garua*	Garua bachwaa	Wide	LC	Very high
	Siluridae				
25.	*Ompok bimaculatus*	Butter catfish	Wide	NT	Low
	Sisoridae				
26.	*Glyptothorax pectinopterus*	Flat head catfish	Wide	LC	Low
	Channidae				
27.	*Chanda nama*	Elongate glass–perchlet	Wide	LC	Low
28.	*Parambasis baculis*	Himalayan glassy perchlet	Wide	LC	
29.	*Parambasis ranga*	Indian glassy fish	Wide	LC	
	Botidae				
30.	*Botia almorhae*	Pakistani Loach		LC	Low
	Chandidae				
31.	*Channa gachua*	Dwarf Snakehead		LC	Low

No	*Scientific Name*	Common Name	Distributional Status	IUCN Status 2013*	Commercial Value
	Sisoridae				
32.	*Glyptothorax cavia*	Heart Throat Catfish		LC	Low
33.	*Glyptothorax kashmirensis*	Kashmir Catfish		CR	Low
34.	*Glyptothorax naziri*	Nazirs' Catfish	Endemic	ND	Low
35.	*Gagata cenia*	Clown Catfish		LC	Low
	Siluridae				
36.	*Ompok pabda*	Pabdah Catfish		NT	Low
	Mastacembelidae				
37.	*Mastacembelus armatus*	Tire–track spiny eel	Wide	LC	High

*Note: ND: Not Determined; LC: least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; EW: Extinct in the wild; EX: Extinct.

Table 5-16: Species of Special Importance Found in the Poonch River, Azad Kashmir

No	Scientific Name	Common Name	Distributional Status	IUCN Status 2013	Commercial Value	Max. Length (cm)	Max. Weight (kg)
	Cyprinidae						
1.	*Barilius pakistanicus*	Pakistani baril	Endemic	–	–	–	–
2.	*Cirrhinus reba*	Reba carp	–	–	Fairly good	30	0.3
3.	*Labeo dero*	Kalbans	–	–	Fairly good	75	0.2
4.	*Labeo dyocheilus*	Pakistani Labeo	–	–	High	90	5
5.	*Tor putitora*	Mahaseer	–	**Endangered**	Very high	275	54
6.	*Schizothorax plagiostomus (richardsonii)*	Snow carp	–	Vulnerable	High	60	2.5
7.	*Cyprinus carpio*	Common carp	–	Vulnerable	High	110	40.1
	Cobitidae						
8.	*Botia rostrata*	Twin–banded Loach	–	Vulnerable	High	–	–
	Bagridae						
9.	*Sperata seenghala*	Giant river cat fish	–	–	Very high	150	10
	Schilbeidae						
10.	*Clupisoma garua*	Garua bachwaa	–	–	Very high	61	0.5
	Siluridae						
11.	*Ompok bimaculatus*	Butter catfish	–	Near Threatened	Fairly good	45	0.2
	Sisoridae						
12.	*Glyptothorax kashmirensis*	Kashmir Catfish	Endemic	**Critically Endangered**	Low	11.7	–
13.	*Glyptothorax naziri*	Nazirs' Catfish	Endemic	Not Evaluated	Low		

No	Scientific Name	Common Name	Distributional Status	IUCN Status 2013	Commercial Value	Max. Length (cm)	Max. Weight (kg)
	Siluridae						
14.	*Ompok pabda*	Pabdah Catfish		Near Threatened	Low		
	Noemacheilidae						
15.	*Schistura punjabensis*	Hillstream loach	Endemic	Not Evaluated	Low		
	Mastacembelidae						
16.	*Mastacembelus armatus*	Tire–track spiny eel	–	–	High	90	0.5 g

Indicator Species

407. A total of six indicator species were chosen to study the impact of Project induced changes in the river flow on the fish fauna (**Section 6,** Environmental Flow Assessment)**.** The indicator fish species were chosen on the basis of their conservation importance as well as socio–economic importance for the local communities. Also taken into consideration was the fish size and adequate representation of the major fish families recorded from the Poonch River. The following fish species were chosen as indicators:

- Mahaseer Tor putitora
- Alwan Snow Trout Schizothorax plagiostomus (richardsonii)
- Kashmir Catfish Glyptothorax kashmirensis
- Garua Bachwa Clupisoma garua
- Pakistani Labeo *Labeo dyocheilus*
- Twin–banded Loach *Botia rostrata*

Distribution and Abundance of Fish Fauna in the October 2013 Survey

408. As explained in **Section 4.1.8**, the river habitats observed in the Poonch River included pools and glides, riffles and rapids. The dominant habitat is riffles accounting for 43% to 69% of the length of the river, pools and glides constitute 15–40% of the river, with the exception of an area between LoC and Madarpur (Segment A), where pools are not very frequent. Rapids constitute less than 17% of the river between LoC and Madarpur (Segment A). However, between in Segment B, and in Segment C, rapids are significant, decreasing again in Segment D.

409. During the October 2013 survey, fish fauna were collected from the selected sampling points using cast nets. Different micro–habitats (biotopes) of the river such as pools, riffles and backwater were sampled to understand habitat preferences of the indicator species. The fish species observed in the Ecological Study Area during the October 2013 survey are listed in **Table 5-17**. Fish abundance (number of fish individuals collected) and diversity (number of fish species collected) observed during the survey is presented in **Figure 5-50.** The distribution of the indicator fish species in the river habitats at each sampling point is given in **Table 5-18** and represented in **Figure 5-51**. Photographs of some of common fish species found in the Ecological Study Area are shown in **Figure 5-52**. Principal observations of the October 2013 surveys are summarized below.

- A total of 253 fish specimens belonging to 26 fish species were collected.
- Fish abundance was highest at Sampling Point A3 (River at Borali Bridge) where 57 fish specimens belonging to 16 fish species were collected. Gangetic Latia *Crossocheilus latius* was the most abundant fish species collected at this sampling point, followed by Mahaseer *Tor putitora* and Twin–banded Loach *Botia rostrata.*
- Fish richness was highest at Sampling Point A5 (River at Billiporian Bridge, near Rajdhani) where 18 fish species were collected. Gangetic Latia *Crossocheilus latius* was the most abundant fish species collected at this sampling point, followed by Mahaseer *Tor putitora* and Pakistani Labeo *Labeo dyocheilus.*

- The most abundant fish species was the Gangetic Latia *Crossocheilus latius* with 63 specimens collected. The second most abundant fish species was Mahaseer *Tor putitora* followed by Pakistani Baril *Barilius pakistanicus* with 42 and 21 specimens collected respectively.
- The least abundant fish species collected included Dwarf Snakehead *Channa gachua,* Common Carp *Cyprinus carpio,* Elongate Glassy Perchlet *Chanda nama* and Butter Catfish *Ompok bimaculatus.*
- The fish abundance and species richness was generally higher in the main River compared to the tributaries (**Figure 5-50**).

Table 5-17: Fish Fauna Observed During October 2013 Survey of the Ecological Study Area

No		Sampling Locations	A1	A2	A3	A4	A5	A6	A7	A8	Total
		EF – Sites	EF – 1	–	EF – 2	EF – 3		–	–	–	
		Location	River at Kallar Bridge	River at Confluence with Rangar Nullah	River at Borali Bridge	River at Gulpur Bridge	River at Billiporian Bridge near Rajdhani	Rangar Nullah (Tributary)	Bann Nullah near Manil Tributary (Tributary)	Bann Nullah near Khuiratta (Tributary)	
		Location with reference to Project	Upstream Project Site	Proposed submerged area	Proposed unindated area	Downstream outlet	Downstream Project	Upstream Project Site	Upstream Inlet	Upstream Inlet	
	Scientific Name	Common name									
1.	*Tor putitora*	Mahaseer	6	4	6	4	6	11	3	2	**42**
2.	*Labeo dyocheilus*	Pakistani Labeo	2	3	3	–	4	1	–	–	**13**
3.	*Crossocheilus latius*	Gangetic Latia	5	5	10	5	9	11	7	11	**63**
4.	*Garra gotyla*	Sucker Head	2	1	2	1	1	1	2	6	**16**
5.	*Botia rostrata*	Twin–banded Loach	1	1	5	2	1	1	–	–	**11**
6.	*Botia almorhae*	Pakistani Loach	2	–	3	1	2	–	–	–	**8**
7.	*Glyptothorax pectinopterus*	Flat Head Catfish	1	1	3	–	–	1	–	–	**6**
8.	*Glyptothorax kashmirensis*	Kashmir Catfish	2	–	2	–	–	–	–	–	**4**
9.	*Glyptothorax cavia*	Heart Throat Catfish	3	2	5	2	3	–	–	–	**15**
10.	*Mastacembelus armatus*	Tire–track Spiny Eel	1	1	2	–	2	1	–	–	**7**
11.	*Barilius pakistanicus*	Pakistani Baril	–	2	3	1	3	6	2	4	**21**
12.	*Acanthocobitis botia*	Mottled Loach	–	2	–	–	1	–	–	–	**3**
13.	*Ompok pabda*	Pabdah Catfish	–	1	–	–	–	–	–	2	**3**
14.	*Channa gachua*	Dwarf Snakehead	–	1	–	–	–	–	–	–	**1**
15.	*Labeo dero*	Kalbans	–	–	2	1	–	–	–	–	**3**
16.	*Schistura punjabensis*	Punjab Loach	3	–	1	–	–	3	–	–	**7**
17.	*Glyptothorax naziri*	Nazirs' Catfish	–	–	3	–	–	–	–	–	**3**
18.	*Gagata cenia*	Clown Catfish	–	–	5	–	–	–	–	–	**5**
19.	*Clupisoma garua*	Garua Bachwa	–	–	2	–	1	–	–	–	**3**
20.	*Salmophasia bacaila*	Large Razorbelly Minnow	–	–	–	1	1	3	–	3	**8**
21.	*Cyprinus carpio*	Common Carp	–	–	–	–	1	–	–	–	**1**
22.	*Aspidoparia morar*	Chilwa	–	–	–	–	2	–	–	–	**2**
23.	*Securicula gora*	Gora Chela	–	–	–	–	3	–	–	–	**3**
24.	*Parambassis ranga*	Glassy Fish	–	–	–	–	3	–	–	–	**3**
25.	*Chanda nama*	Elongate Glassy Perchlet	–	–	–	–	1	–	–	–	**1**
26.	*Ompok bimaculatus*	Butter Catfish	–	–	–	–	1	–	–	–	**1**
	Abundance (number of fish individuals collected)		**28**	**24**	**57**	**18**	**45**	**39**	**14**	**28**	**253**
	Richness (number of fish species collected)		**11**	**12**	**16**	**9**	**18**	**10**	**4**	**6**	

Figure 5-50: Fish Abundance and Richness at Sampling Points. Surveys Conducted October 2013 Survey

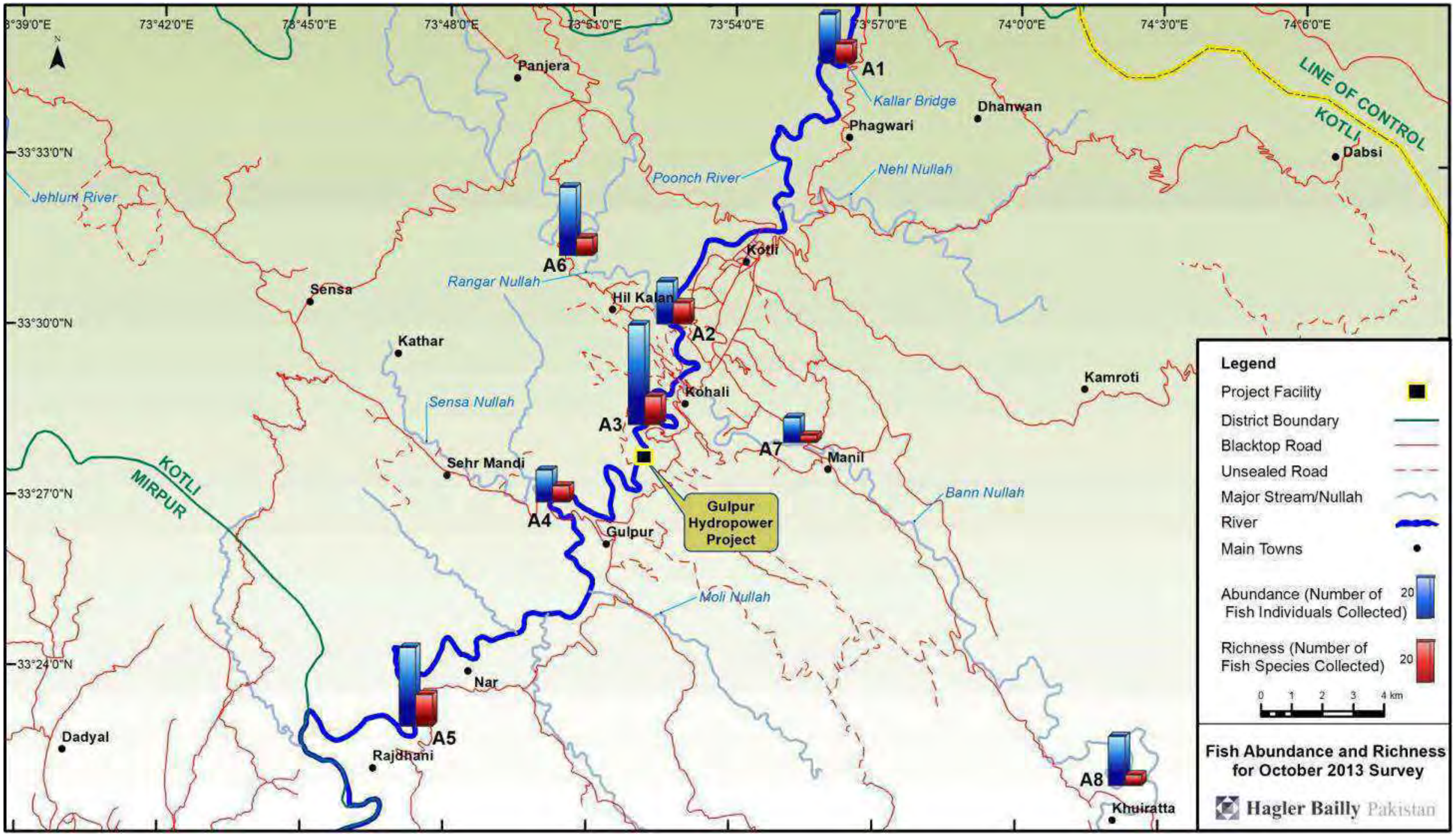


Table 5-18: Number of Individuals of Indicator Fish Species collected in October 2013 survey at Sampling Locations

No			Sampling Locations																																Total
			A1				A2				A3				A4				A5				A6				A7				A8				
		EF – Sites	EF – 1				–				EF – 2				EF – 3								–				–				–				
		Location	River at Kallar Bridge				River at Confluence with Rangar Nullah				River at Borali Bridge				River at Gulpur Bridge				River at Billiporian Bridge near Rajdhani				Rangar Nullah (Tributary)				Bann Nullah near Manil Tributary (Tributary)				Bann Nullah near Khuiratta Tributary				
		Location with reference to project	Upstream Project Site				Proposed submerged area				Proposed unindated area				Downstream outlet				Downstream Project				Upstream Project Site				Upstream Inlet				Upstream Inlet				
		Biotopes	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	
	Scientific Name	*Common Name*																																	
1.	*Tor putitora*	Mahaseer	3	2	1	6	2	2	–	4	3	3	–	6	2	2	–	4	3	1	2	6	3	5	3	11	2	1	–	3	1	1	–	2	**42**
2.	*Labeo dyocheilus*	Pakistani Labeo	–	1	1	2	2	1	–	3	1	2	–	3	–	–	–	–	1	3	–	4		1	–	1	–	–	–	–	–	–	–	–	**13**
3.	*Botia rostrata*	Twin–banded Loach	1	–	–	1	1	–	–	1	5	–	–	5	2	–	–	2	1	–	–	1	1	–	–	1	–	–	–	–	–	–	–	–	**11**
4.	*Glyptothorax kashmirensis*	Kashmir Catfish	2	–	–	2	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**4**
5.	*Clupisoma garua*	Garua Bachwa	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**3**
6	*Schizothorax plagiostomus*	Alwan Snow Trout	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
	Total Abundance		**6**	**3**	**2**	**11**	**5**	**3**	**–**	**8**	**13**	**5**	**–**	**18**	**4**	**2**	**–**	**6**	**5**	**5**	**2**	**12**	**4**	**6**	**3**	**13**	**2**	**1**	**–**	**3**	**1**	**1**	**–**	**2**	**73**

Figure 5-51: Number of Indicator Fish Species Collected in the Ecological Study Area during October 2013 Survey

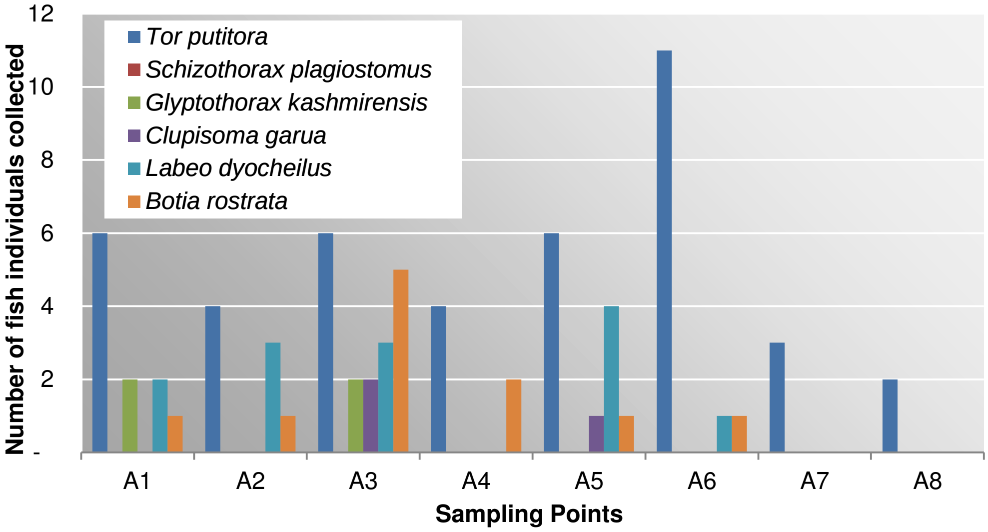


Figure 5-52: Photographs of Indicator Fish Species in the Ecological Study Area

Golden Mahaseer *Tor Putitora*

Twin–banded Loach *Botia rostrata*

Kashmir Cat fish *Glyptothorax kashmirensis*

Pakistani Labeo *Labeo dyocheilus*

Garua Bachwa *Clupisoma garua*

Alwan Snow Trout *Schizothorax plagiostomus*

December 2013 survey

410. During the December 2013 survey, sampling for fish resources was conducted at four sampling locations: EF site 1, EF site 2 (new), and EF site 3 (**Figure 5-47)**. Fish fauna observed during the December 2014 survey is listed in (**Table 5-20**)

411. No fish were found in the main River channel using cast nets. However, deep pools ranging from 10–20 m were sampled using the gill nets and some large sized fish species were collected. The results are summarized below.

- During the winter, small sized fish species such as Twin–banded Loach *Botia rostrata* move into crevices or beneath the boulders available in and on the river edges.
- Large sized species like *Labeo dyocheilus* and *Tor putitora* had moved into deep pools for overwintering and were collected by gill nets. The species *Labeo dyocheilusis* was found in the pools in the Ecological Study Area but *Tor putitora* had moved further down and was seen in the pools downstream Gulpur area.
- The main river channel was occupied by the cold water fish *Schizothorax plagiostomus* from mid–October to mid–March. This fish inhabits the upper cold reaches of the river during summer season and can be seen in the Ecological Study Area during winter season. The optimum water temperature for this fish is 15–20°C and therefore it occupies deep pools and crevices during extreme cold months.
- The commercially important species *Clupisoma garua* was not seen in the Ecological Study Area during the December 2013 survey (winter survey) as it migrates down to the Mangla Reservoir for overwintering.
- The fish *Tor putitora* occupies the main pools in the Poonch River with rocky bottoms and there is very little migration to the Mangla Reservoir for overwintering as the bed of the reservoir is highly muddy and silty and is not a favorable habitat for this fish. It is concentrated in river pools upstream the Mangla Reservoir.

412. The Poonch River becomes shallow during the low flow period in the winter season. Stones, boulders and cobbles in the river bed are clearly visible. Water temperature of the river drops to 9–11°C. Fish fauna, which mainly consists of warm water species, cannot withstand this low temperature and move to available refuges.

The river is characterized by having series of deep pools of variable sizes and rocky edges, with deep crevices serving as wintering places for fish.

413. During the winter season, fish activity in the main river channel is almost nonexistent and almost all the species migrate into refuges for over wintering. Overwintering is a surviving strategy as maintenance of the viable populations in the river system makes it necessary for the fish fauna to move away from areas where conditions become unfavorable for survival. It helps the fish to conserve their stored energy reserves and maintain fitness for enhancing growth and reproductive output when conditions become favorable. Thus, during the winter months, fish move to pools where water is deep enough to buffer the cold temperature of winter. These migrations are mainly dependent on the availability of suitable habitats. If suitable refuges are available within the fish individual’s normal home ranges, then migration is unnecessary and the fish takes refuge in locally available pools and crevices in the rocks. Therefore, with the onset of the winter season, many fishes move downstream from shallow areas that are warm and productive in summer but which are associated with low water temperature in winter, to deeper slower pools further downstream. Such migrations are not always in the downstream direction but depend on the availability of refuge habitat. These movements are not as conspicuous or concerted in time and space as compared to the breeding migrations. Metabolic activity, swimming capacity, and digestive ability of many fishes is severely reduced during low temperature of winter. Under these circumstances feeding activity may be very low or nonexistent, even when plentiful food is available.

Table 5-19: Fish Fauna Observed During December Survey

No	*Scientific Name*	*Sampling Location*				
		Sampling Location	*A-1*	*A-3b*	*A-4*	*A-5*
		EF-Site	*E-Flow site 1*	*E-Flow site 2*	*E-Flow site 3*	
		Biotopes	*Pools*	*Pools*	*Pools*	*Pools*
		Common Name				
1	*Schizothorax plagiostomus*	Snow Carp	2	0	0	0
2	*Tor putitora*	Mahaseer	2	3	5	7
3	*Labeo dyocheilus*	Pakistani Labeo	4	6	4	3

May 2014 survey

414. During the May 2014 survey, sampling was carried out at nine sampling locations, five sites that were sampled in the October 2013 survey and four additional sites – sites under consideration for future hydropower projects in the Poonch River. Results of sampling for the May 2014 survey are shown in **Table 5-21**. Fish abundance (number of fish individuals collected)and diversity (number of fish species collected) observed during the survey is presented in **Figure 5-50.**

- A total of 302 fish belonging to 21 species were collected during the May 2014 survey.

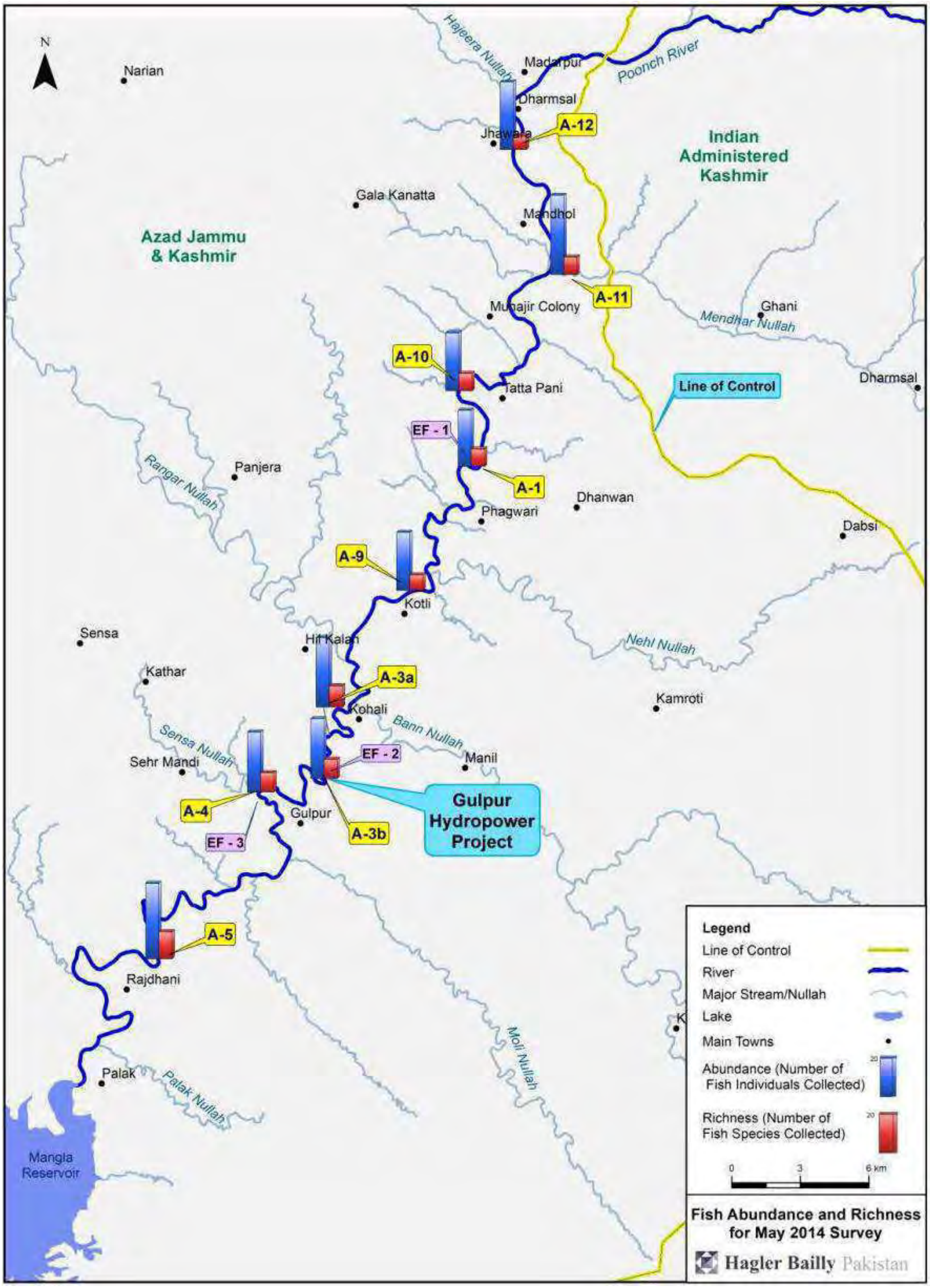
- At this time of the year, the river water was cold (15°C) as compared to tributaries (20°C) due to snow melt in the river. Moreover, there was a clear difference of turbidity between the river water and tributaries. The river water was turbid due to increase in sediment caused by snow melt while the water in the tributaries was clear.
- A higher abundance of fish fauna was observed in the river compared to the tributaries. Concentration of the fish in the river at this time of the year can be attributed to the reproductive triggers provided by snowmelt water, associated turbidity and new flow regime in the river. With the onset of the Monsoon Season (July/August), the temperature, flow and turbidity regimes will change and the fish will migrate into suitable breeding grounds in the river and the tributaries.
- Most of the fish species observed were common other than *Clupisoma garua*. It is likely that the river waters are too cold from snowmelt to allow upstream migration of this fish from the Mangla reservoir.
- The fish species caught did not show sexual maturity since it was pre-breeding season.
- *Schizothorax plagiostomus* is a cold water fish and migrates to occupy the cold water of the upper reaches of the river during summer season. It was observed only at Sampling Point A-12 **(Figure 5-49**) indicating that this fish has already left the downstream reaches of the river with the beginning of the summer season.
- Mahaseer fish was found in good numbers in almost all the sites but fish was not yet sexually fully mature. The fish was evenly distributed in all the microhabitats of the river indicating that it is actively feeding and moving towards its breeding grounds.
- Upstream migration of the fish species found in the Mangla Reservoir was not very prominent at this time of the year. With increasing temperatures in the summer season, this migration will increase.

Table 5-20: Fish Fauna Observed During May 2014 Survey

No.		*Sampling Location*	*A-12*				*A-11*				*A-10*				*A-3b*				*A-1*				*A-9*				*A-3a*				*A-4*				*A-5*			
		EF – Sites													*EF Site 2*				*EF Site 1*												*EF Site 3*				*EF Site 4*			
		Location	*Sehra Dam Site*				*Meander Nullah*				*Sehra Hydropower Project Site*				*Gulpur Hydropower Project Site*				*(Kotli Dam Site)*				*Kotli Hydropower Project Site (Kotli)*				*River at Barali Bridge*				*River at Gulpur Bridge*				*River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,*			
		Biotopes	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*	*Riffles*	*Pools*	*Backwater*	*Total*
	Scientific Name	Common Name																																				
1.	*Aspidoparia morar*	Chilwa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2
2.	*Barilius pakistanicus*	Pakistani Baril	–	–	–	–	2	4	2	8	1	2	3	6	1	–	1	2	2	3	1	6	–	–	–	–	–	–	1	1	2	2	–	4	–	–	–	-
3.	*Botia almorhae*	Pakistani Loach	4	–	–	4	3	–	–	3	2	–	–	2	1	–	–	1	1	1	–	2	3	–	–	3	3	–	–	3	3	1	–	4	2	–	–	2
4.	*Botia rostrata*	Twin–banded Loach	5	–	–	5	4	–	–	4	4	–	–	4	4	–	–	4	3	–	–	3	3	1	–	4	1	1	–	2	2	2	–	4	2	–	–	2
5.	*Chanda nama*	Elongate glass–perchlet	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3
6.	*Clupisoma garua*	Garua bachwaa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	–	2	–	2	1	1	–	2
7.	*Crossocheilus latius*	Gangetic latia	1	3	1	5	2	3	1	6	–	1	2	3	1	3	1	5	2	1	2	5	2	2	–	4	1	1	–	2	–	1	–	1	–	1	2	3
8.	*Gagata cenia*	Clown Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	3	–	9	–	–	–	–	–	–	–	-
9.	*Garra gotyla*	Sucker Head	6	–	–	6	5	–	–	5	4	–	–	4	2	2	–	4	2	1	–	3	3	1	–	4	3	–	–	3	2	–	–	2	1	–	–	1
10.	*Glyptothorax cavia*	Heart Throat Catfish	–	–	–	–	2	–	–	2	3	–	–	3	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-
11.	*Glyptothorax kashmirensis*	Kashmir Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	3	–	–	3
12.	*Glyptothorax naziri*	Nazirs' Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	-
13.	*Glyptothorax pectinopterus*	Flat head Catfish	–	–	–	–	3	–	–	3	1	–	–	1	–	–	–	–	2	–	–	2	4	–	–	4	–	–	–	–	–	–	–	–	–	–	–	-
14.	*Labeo dero*	Kalbans	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	-
15.	*Labeo dyocheilus*	Pakistani Labeo	2	3	–	5	3	1	–	4	1	2	–	3	2	2	1	5	–	3	–	3	2	4	–	6	2	2	–	4	2	2	1	5	2	1	1	4
16.	*Mastacembelus armatus*	Tire–track spiny eel	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	2	–	–	2	1	–	–	1	–	–	–	–	1	1	–	2	1	–	–	1
17.	*Parambassis ranga*	Indian glassy fish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	4

No.		***Sampling Location***	***A-12***				***A-11***				***A-10***				***A-3b***				***A-1***				***A-9***				***A-3a***				***A-4***				***A-5***				
		EF – Sites													***EF Site 2***				***EF Site 1***												***EF Site 3***				***EF Site 4***				
		Location	***Sehra Dam Site***				***Meander Nullah***				***Sehra Hydropower Project Site***				***Gulpur Hydropower Project Site***				***(Kotli Dam Site)***				***Kotli Hydropower Project Site (Kotli)***				***River at Barali Bridge***				***River at Gulpur Bridge***				***River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,***				
		Biotopes	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	***Riffles***	***Pools***	***Backwater***	***Total***	
	Scientific Name	Common Name																																					
18.	*Salmophasia bacaila*	Large razorbelly minnow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	3	
19.	*Schizothorax plagiostomus*	Snow Carp	2	2	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-	
20.	*Securicula gora*	Gora Chela	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	4	
21.	*Tor putitora*	Mahaseer	3	2	1	6	3	3	–	6	2	2	–	4	3	1	–	4	1	2	–	3	2	1	1	4	3	1	–	4	3	1	–	4	3	2	–	5	
	Total					**35**				**41**				**30**				**31**				**29**				**30**				**36**				**31**				**39**	**302**

Figure 5-53: Fish Abundance and Richness during May Survey



Macro–invertebrates

415. During the October 2013 survey, a total of eight (8) locations were sampled to determine the abundance and diversity of macro–invertebrate fauna in the Ecological Study Area. The points were located in the main Poonch River as well as the tributaries. The location of these sampling points is shown in **Figure 5-47**. The average abundance /m^2 observed during the October 2013 survey is shown in **Table 5-21.**

Table 5-21: Average Abundance/m^2 of Macro-invertebrate Taxa observed during October 2013 survey

No	*Taxa*	A1	A2	A3	A4	A5	A6	A7	A8	Total
1	*Perlidae (Neoperla)*	–	1.5	–	–	1.7	8	4.5	8	**23.66**
2	*Baetidae (Acentrella)*	11	11.5	8.5	54	10.7	6	–	–	**101.66**
3	*Baetidae (Baetis)*	18	12.5	26.5	12	42.3	21	11.5	35.5	**179.33**
4	*Baetidae (Baetiella)*	–	–	1.5	9	–	–	3.5	–	**14**
5	*Baetidae (Centroptilum)*	–	–	–	–	–	–	–	12.5	**12.5**
6	*Caenidae (Caenis)*	6	2	–	2	25.7	19	3	13	**70.66**
7	*Caenidae (Brachycerus)*	–	–	–	–	–	–	12	–	**12**
8	*Heptageniidae (Stenonema)*	24	11.5	18.5	19	91.7	64	8.5	–	**237.16**
9	*Heptageniidae (Rhithrogena)*	5	2.5	4.5	7	6.3	–	–	–	**25.33**
10	*Leptophebiidae (Choroterpes)*	13	3.5	6	17	99.3	94	26	90.5	**349.3**
11	*Ephemerellidae*	–	–	–	2	–	5	–	–	**7**
12	*Hydropsychidae (Hydropsyche)*	43	–	–	–	–	–	–	–	**43**
13	*Hydropsychidae (Chematopsyche)*	22	8	0.5	17	52.3	15	54.5	28.5	**197.83**
14	*Hydroptilidae*	–	–	–	–	–	–	–	13	**13**
15	*Philopotamidae (Chimarra)*	0	6	1.5	8	58.3	8	41	1.5	**124.33**
16	*Chironimidae*	53	32	50	50	0.0	107	123.5	164.5	**580**
17	*Tipulidae*	–	0.5	–	–	0.3	–	–	–	**0.83**
18	*Athericidae (Atherix)*	10	5	1	14	5.7	–	3	–	**38.66**
19	*Culicidae*	–	–	–	–	–	–	–	0.5	**0.5**
20	*Tabanidae (Tabanus)*	–	–	1	–	–	3	3	2	**9**
21	*Psychodidae (Psychoda)*	1	–	–	–	–	4	–	–	**5**
22	*Simulidae*	0	4	–	23	–	–	–	–	**27**
23	*Elmidae*	–	8	33	10	29.7	0	1	1	**82.66**

No	*Taxa*	A1	A2	A3	A4	A5	A6	A7	A8	Total
24	*Scirtidae*	–	0.5	–	–	–	–	–	–	**0.5**
25	*Gyrinidae*	–	–	–	–	–	2	–	2	**4**
26	*Psephenidae*	–	–	–	–	–	–	–	2	**2**
27	*Aphelocheiridae (Aphelocheirus)*	–	2	0.5	5	12.0	–	2	–	**21.5**
28	*Corixidae*	–	–	–	–	–	–	–	2.5	**2.5**
29	*Gerridae*	–	–	–	–	–	–	–	3	**3**
30	*Corydalidae (Corydalus)*	–	0.5	–	–	0.3	2	2	0.5	**5.33**
31	*Gomphidae*	1	–	–	–	5.0	–	1	7.5	**14.5**
32	*Libellulidae*	1	–	–	–	–	–	–	3	**4**
33	*Cordulidae*	–	–	1	–	–	–	–	1	**2**
34	*Potamidae*	–	0.5	–	–	–	–	0.5	–	**1**
35	*Unionidae*	–	–	–	–	–	–	–	8	**8**
36	*Enchyrtraeidae*	–	–	–	–	–	–	–	22	**22**
37	*Tubificidae*	2	0.5	0.5	–	–	–	–	–	**3**
	Average Abundance/m^2	**210**	**112.5**	**154.5**	**249**	**441.3**	**358**	**300.5**	**422**	
	Richness (no. of species observed)	**14**	**19**	**15**	**15**	**15.0**	**14**	**17**	**22**	

416. A total of 37 macro–invertebrate taxa were identified in the Ecological Study Area during the October 2013 survey. Some of these were identified up to the genus level while others could only be identified up to family / sub–family level.

417. **Figure 5-54** shows the average abundance/m^2 of macro–invertebrates seen at each sampling point during October 2013 survey. The Sampling Points A1, A2, A3, A4, A5 were located on the main Poonch River while the Sampling Points A6, A7 and A8 were located in tributaries (nullahs).

- The average abundance of macro–invertebrates was generally higher in the tributaries (with the exception of Sampling Point A5) compared to the main river. This is because the low water velocity in nullahs and streams allows better opportunities for macro–invertebrate to attach to substrates in the river. In addition, the low water velocities promote growth of algae that provide food for macro–invertebrates.
- The maximum average macro–invertebrate abundance/m^2 was seen at Sampling Point A5 (River at Billiporian Bridge) where 441 macro–invertebrate specimens/m^{2}were observed. Large cobbles of approximately 1 foot diameter were present in the riverbed at this location that provided suitable substrate for macro–invertebrate attachment. Moreover, the predominant water biotope at this location was riffles (even though some pools were present) that is the preferred biotope of macro–invertebrates.

- The second highest average abundance/m^2 was seen at Sampling Point A8 (Bann Nullah at Khuiratta) where 422 macro–invertebrate specimens/m^2 were observed. This sampling point is located on Ban Nullah. The low water velocity in nullahs and streams allow better opportunities for macro–invertebrate to attach to substrates in the river and also promote algal growth.
- The least average macro–invertebrate abundance was seen at Sampling Point A2 (River at confluence with Rangar Nullah) where 113 specimens/m^2 were observed. The likely reason for the low abundance at this sampling point is the comparatively higher pollution levels in the River due to proximity to Kotli city.
- The most abundant macro–invertebrate taxon observed during October 2013 survey was Chironimidae with average abundance/m^2 of 580 followed by *Choroterpes sp.* and *Stenonema sp* with an average abundance/m^2 of 349 and 237 respectively.

418. **Figure 5-55** shows the richness of macro–invertebrate taxa observed at each sampling point during October 2013 survey.

419. Similar to abundance, richness of macro–invertebrates observed was higher in the tributaries compared to the river due to lower water volume and velocity in the nullahs.

420. Maximum richness of macro–invertebrate taxa was seen at Sampling Point A8 (Bann Nullah near Khuiratta) where 22 taxa were seen during the October 2013 survey. Chironimidae was the most abundant taxon seen at this sampling point followed by *Choroterpes sp.* and *Baetis sp.*

421. Least richness of macro–invertebrate taxa was seen at Sampling Points A1 (Poonch River at Kallar Bridge) and A6 (Rangar Nullah) where 14 taxa were seen at each sampling point during the October 2013 survey. The low macro–invertebrate richness at Sampling Point A1 (Poonch River at Kallar Bridge) was due to the high water turbidity at this location. Sampling Point A6 (Rangar Nullah) had a low richness of macro–invertebrates but the average abundance observed was high.

Figure 5-54: Average Abundance/m² of Macro–invertebrates Observed at Sampling Points during October 2013 Survey

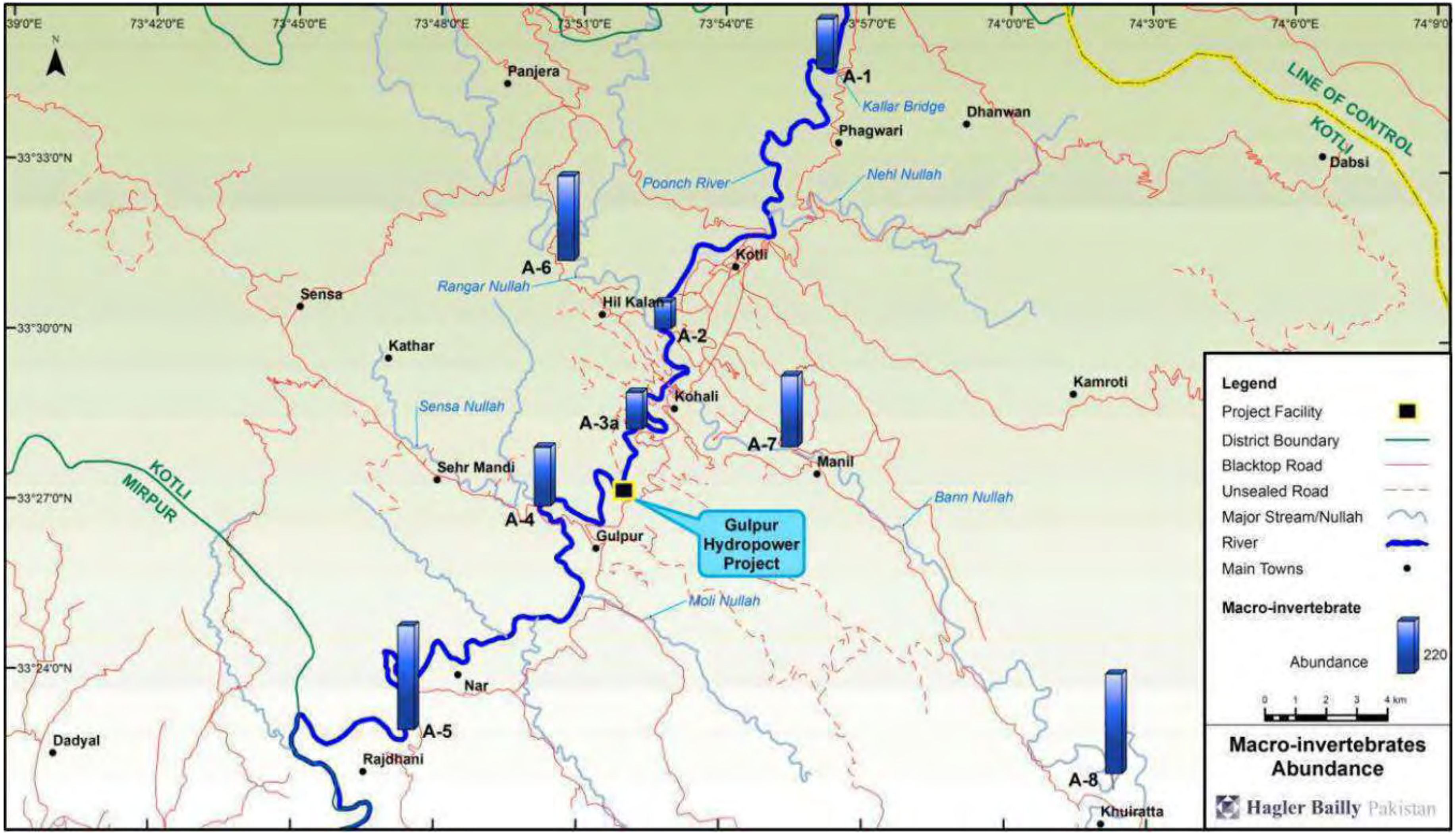
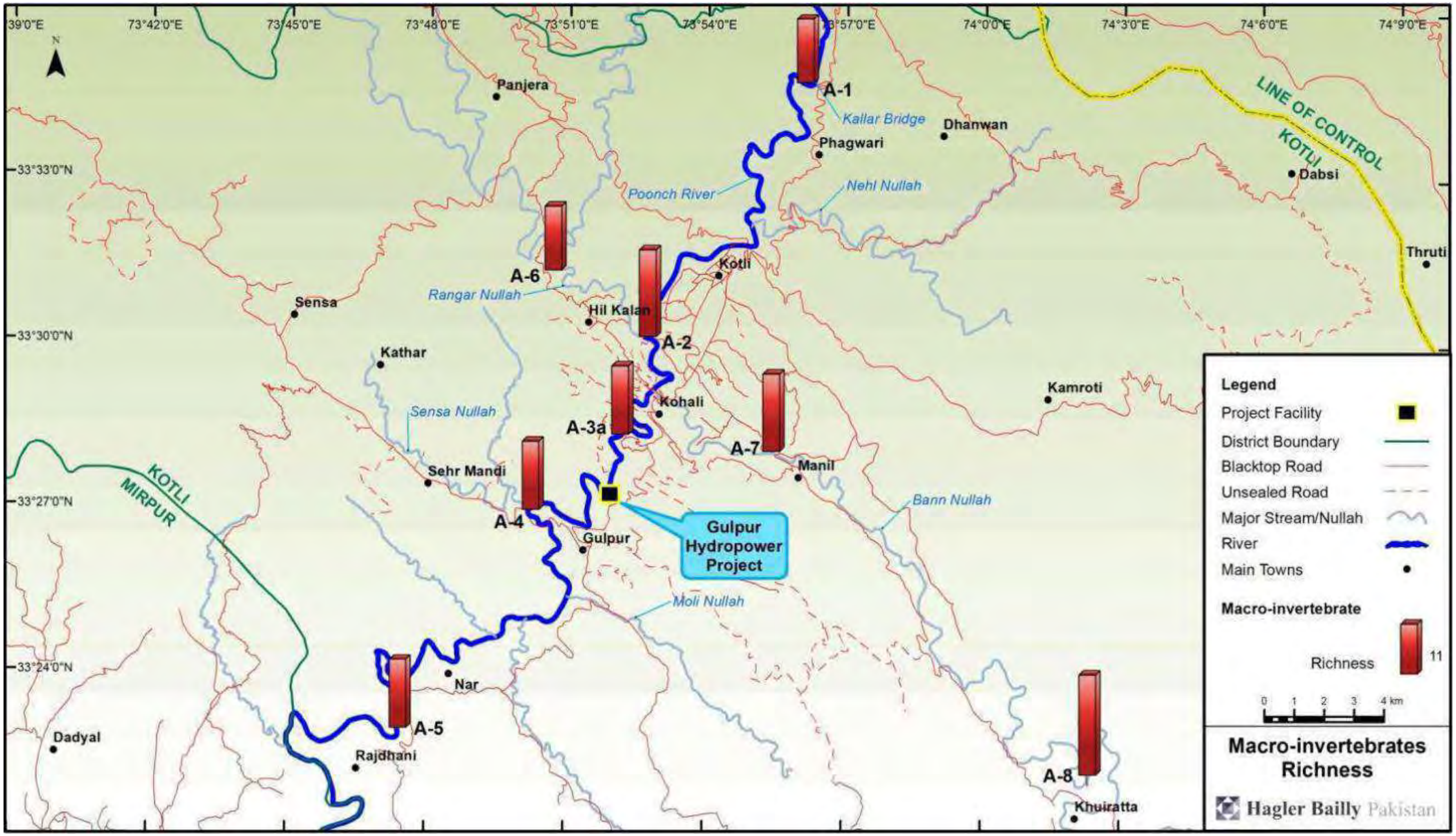


Figure 5-55: Richness of Macro–invertebrates Observed at Sampling Points during October 2013 Survey



Otters

422. Otters are the only water mammals associated with the Poonch River. Keeping in view the habitat available, the species likely to be found in the Ecological Study Area is the Common Otter *Lutra lutra*. The Otter lives in a wide variety of aquatic habitats, including highland and lowland lakes, rivers, streams, marshes, and swamps. This species is considered to be Near Threatened (IUCN Red List 2013) due to an ongoing population decline over the years. The aquatic habitats of otters are extremely vulnerable to man–made changes. Canalization of rivers, removal of bank side vegetation, dam construction, draining of wetlands, aquaculture activities and associated man–made impacts on aquatic systems are all unfavorable to otter populations[54].

423. Otter sampling was carried out at six sampling locations in the Ecological Study Area during the December 2013 survey (**Figure 5-56**). Each sampling location was surveyed for sightings as well as signs of the species including dens (holts), tracks, spraints (droppings). In addition, locals were interviewed regarding the presence of the Otter in their areas.

424. No Otter signs were observed in disturbed areas near the river, especially areas of sand and gravel extraction. Otter signs were also not observed in the areas where suitable habitat in the form of dense vegetation, deep pools and boulders or broken rocks on the river side were absent. Otters were found to be active (based on the observation of foot–prints and droppings) in the vicinity of deep and long pools in the river containing wintering fish species.

425. Otter signs were observed at the following sampling locations: A1, A3, A4 and Nar area. Otter signs were absent at D1 (Project location) and Sampling Point A5. Three Otters were sighted on 17 February, 2014 by Hagler Bailly's Socio-economic survey team, about 1 km upstream of Sampling Point A4. The otters were sitting on a rock in the River about 3 meters from the left bank (**Figure 5-56**). A summary of the survey findings are presented in **Table 5-22**.

[54] Ruiz–Olmo, J., Loy, A., Cianfrani, C., Yoxon, P., Yoxon, G., de Silva, P.K., Roos, A., Bisther, M., Hajkova, P. & Zemanova, B. 2008. *Lutra lutra*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **02 January 2014**.

Figure 5-56: Otter Sampling Locations in Ecological Study Area. Surveys Conducted in December 2013

Table 5-22: Summary of Otter Signs in Ecological Study Area. Surveys conducted December 2013

	Sampling Locations						
	A1	**A3,**	**D1(Project Location)**	**A4**	**Narr Area**	**A5**	**Upstream A4**
Otter Signs – holts (dens)	1	2	No	1 (On the right bank of River along Sensa Nullah)	2	No	No
Otter Signs – Tracks	yes	yes	No	Yes (On the right bank of River along Sensa Nullah)	yes	No	No
Otter Signs – Spraints	yes	yes	No	Yes (On the right bank of River along Sensa Nullah)	yes	No	No
Results of Interviews with Locals regarding Otter sightings and signs	3 persons – yes 1 person – No	No one was interviewed	2 persons – No	2 persons – yes	3 persons– yes	2 persons – No	No
Otter Sightings	No	No	No	No	No	No	Yes (during February 2014)
General Habitat observed	Caves, crevices, broken rocks, deep pools, disturbance level high at most places	Thick riverside vegetation, deep pools, Huge boulder piles, broken rocks, least disturbance in area one km downstream bridge	No proper otter habitat, disturbance level very high	Limited otter area along the water fall at the confluence of Sensa stream with the Poomnch River. Highly disturbed area.	The best Otter habitat with very long and deep pool reportedly full of fish, thick side vegetation, broken rocks, gentle slope, less disturbance	Disturbed area due to sand mining and monkeys habitat	Rocks present in river. Good otter habitat.

5.2.5 Terrestrial Ecological Resources

Terrestrial Habitat Classification

426. Habitat classification approaches are subjective in nature, devised to assist in the understanding of ecological systems, the functions of those systems, and the interrelationship with species. Classically, wildlife habitat is described as containing three basic components: cover, food, and water (Morrison et al 2006)[55] with vegetation as the core descriptive component.

427. Habitats in the Ecological Study Area were classified relying primarily upon geomorphology, vegetation type and soil texture. Following this classification approach, four types of habitats were defined: Riverbank/Riparian, Agricultural Fields, Scrub Forest and Pine Forest. **Google Earth™** images were used to initially delineate spatial distribution of habitat types within the Ecological Study Area and this habitat characterization was confirmed during the field surveys.

428. The spatial distribution of habitat types in the Ecological Study Area is given in **Table 5-23** and shown on the map in **Figure 5-48**. Photographs of these habitats are given in **Figure 5-57**.

Table 5-23: Spatial Distribution of Different Habitats in the Ecological Study Area

No.	Habitat Types	Area (sq km)	Habitat in Percentage
1.	Riverbank/Riparian	2	3%
2.	Agricultural Fields	24	35%
3.	Scrub Forest	19	28%
4.	Pine Forest	21	30%
5.	Settlements	3	4%
	Total	**69**	**100.0%**

Figure 5-57: Photographs of Different Habitats in the Ecological Study Area

a. *Agricultural Fields*

b. *Pine Forest*

55 Morrison, M.L, Marcot, B., Mannan, W. 2006. *Wildlife–Habitat Relationships: Concepts and Applications*. Island Press, Washington, D.C.

c. *Riverbank/Riparian*

d. *Scrub Forest*

Vegetation

429. The Ecological Study Area is mostly composed of hilly areas and riparian area along the Poonch River and tributaries. The vegetation of the area is characterized by the presence of subtropical broad leaved forest (Shaheen et al., 2011a)[56] and mainly consist of Chirpine forest type (Malik & Malik, 2004)[57].

430. According to the definition given in IFC's Performance Standard 6[58], "modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands." According to ADB's SPS – Safeguards Requirement (SR) 1 on Environment[59], a modified habitat is defined as "areas where the natural habitat has apparently been altered, often through the introduction of alien species of plants and animals, such as in agricultural areas." The Study Area lies in a modified habitat since almost 35 % of the area is used for agriculture. In addition, grazing and fuel wood collection by local communities is common at several locations.

431. A total of 32 plant species were observed in the Ecological Study Area. The vegetation at high altitude is mainly dominated by *Pinus roxburghii.* The vegetation at the lower altitude is scrub forest dominated by *Dalbergia sissoo, Ziziphus mauritiana, Dodonaea viscosa* and *Carissa opaca*. The vegetation of the riparian areas is mainly dominated by *Dalbergia sissoo, Parthenium hysterophorus, Xanthium strumarium* and *Ricinus communis.*

432. Most of the observed plant species were common and found in more than one habitat. No threatened (in IUCN Red List 2013) or endemic plant species were observed in the Ecological Study Area during the surveys or from the literature available.

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56 Shaheen H, Qureshi, R.A. & Shinwari, Z.K., 2011, Forest structure, vegetation dynamics and anthropogenic impact on lesser Himalayan Subtropical forests in Bagh District, Kashmir. Pak. J. Bot., 43(4): 1861–1866.

57 Malik, N., & Malik, Z. (2004). Present status of subtropical Chir–Pine vegetation of Kotli Hills, Azad Jammu and Kashmir. Journal of Research Science, 5(1), 85–90.

58 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

59 ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment

433. Photographs of some of common plant species found in the Ecological Study Area are shown in **Figure 5-58**.

October 2013 Survey

434. The four main habitats found during October 2013 survey are briefly discussed below:

Riverbank/Riparian

435. Riverbank/Riparian constitutes 3% of the habitat of the Ecological Study Area (**Table 5-24**). The range of vegetation cover observed in this habitat during October 2013 survey is from 0.5% to 10.9% while average plant count is 25. The floral diversity in this habitat is 2 species per sampling point (**Table 5-24**). The dominant plant species in this habitat are *Dalbergia sissoo, Parthenium hysterophorus, Saccharum sp and Dodonaea viscosa.*

Agriculture Fields

436. Agriculture Fields are the most dominant habitat, constituting 35% of the habitat of the Ecological Study Area (**Table 5-24**). The agricultural fields mostly lie in the plains. The range of vegetation cover in this habitat during October 2013 survey is from 0.5% to 16.5%, while average plant count is 33. The floral diversity in this habitat is 3 species per sampling point (**Table 5-24**). The dominant plant species in this habitat are *Broussonetia papyrifera, Parthenium hysterophorus, Dalbergia sissoo and Malvastrum coromandelianum*.

Scrub Forest

437. Scrub Forest constitutes 28% of the total habitat of the Ecological Study Area (**Table 5-24**). This habitat is characterized by vegetation dominated by shrubs with some trees, grasses and herbs. The range of vegetation cover in this habitat during October 2013 survey is from 0.4% to 15% while average plant count is 43. The floral diversity in this habitat is 3 species per sampling point (**Table 5-24**). The dominant plant species of this habitat include *Ziziphus mauritiana, Dalbergia sissoo, Parthenium hysterophorus* and Imperata cylindrica.

Pine Forest

438. Scrub Forest is the second most abundant habitat, constituting 30% of the total habitat of the Ecological Study Area (**Table 5-24**). This habitat is characterized by vegetation dominated by Pine trees. The range of vegetation cover in this habitat during October 2013 survey is from 1.9% to 25.9% while average plant count is 199. The floral diversity in this habitat is 3 species per sampling point (**Table 5-24**). The dominant plant species of this habitat include *Imperata cylindrica, Pinus roxburghii, Dalbergia sissoo* and *Dodonaea viscosa.*

December 2013 Survey

439. During the December 2013 survey, three locations in Scrub Forest were sampled. A total of 13 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 1.5% to 4.3% while average plant count was 36. The floral diversity in this habitat was 4 species per sampling point (**Table 5-23**). The dominant plant species of this habitat include *Dalbergia sissoo, Dodonaea viscosa* and *Acacia Modesta.*

Figure 5-58: Photographs of Common Plant Species of the Ecological Study Area

a. *Dodonaea viscosa*

b. *Ricinus communis*

c. *Parthenium hysterophorus*

d. *Ipomea carnea*

e. *Xanthium strumarium*

f. *Euphorbia hirta*

Table 5-24: Vegetation Cover, Plant Count and Diversity by Habitat Type Surveys Conducted October 2013 and December 2013

Habitats	Plant Cover			Plant Count			Diversity
	Average	Maximum	Minimum	Average	Maximum	Minimum	
October 2013 Survey							
Riverbank/Riparian	4.3%	10.9%	0.5%	25	30	17	2
Agricultural Fields	8.4%	16.5%	0.5%	33	49	23	3

Habitats	Plant Cover			Plant Count			Diversity
	Average	Maximum	Minimum	Average	Maximum	Minimum	
Scrub Forest	5.5%	15.0%	0.4%	43	129	24	3
Pine Forest	13.5%	25.9%	1.9%	199	844	35	3
December 2013 Survey							
Scrub Forest	2.5%	4.3%	1.5%	36	49	28	4

Mammals

440. A total of 26 locations were sampled in the October 2013 survey to study mammalian abundance and diversity in the Ecological Study Area while 3 locations were sampled during the December 2013 survey to study mammalian abundance and diversity at the proposed project location. The location of these sampling points is shown in **Figure 5-47** and **Figure 5-48** respectively.

441. **Table 5-25** provides a summary of sampling points by habitat type. It presents the signs and sightings data for mammals (excluding rodents), abundance and diversity by habitat type for the October 2013 and December 2013 survey.

Table 5-25: Signs/Sightings Data for Mammals (excludes Rodents) Abundance and Diversity by Habitat Type Surveys Conducted October 2013 and December 2013.

Habitat	No. of Sampling Points	Total Signs/ Sightings	Signs/ Sightings Per Sampling Point (Density)	No. of Species
October 2013				
Pine Forest	5	14	2.8	9
Scrub Forest	8	11	1.3	5
Agricultural Fields	5	11	2.2	6
Riverbank/Riparian	8	71	8.8	11
Total	**26**	**107**		
December 2013				
Scrub Forest	3	16	5.3	3
Total	**3**	**16**		

October 2013 Survey

442. The highest density of signs/sightings was seen in Riverbank/Riparian habitat while no significant difference in mammalian density was evident in the other three habitats.

443. The mammal most commonly observed was the Rhesus Monkey *Macaca mulatta*. A total of 50 Rhesus monkeys were seen at Sampling Point A5 near Rajdhani. Four specimens of the Common Red Fox were observed. Also sighted was the Indian Grey Mongoose *Herpestes edwardsii.*

444. Signs of the following mammals were observed: Asiatic Jackal *Canis aureus,* Indian Crested Porcupine *Hystrix indica,* Common Red Fox *Vulpes vulpes* and a cat species *Felis sp*. None of these mammals are included in the IUCN Red List 2013.[60]

445. The Common Leopard *Panthera pardus* was not observed during the October 2013 survey. However, locals report that it is present in the vicinity of the Ecological Study Area. The abundance of this species in the area has not been assessed. The Common Leopard *Panthera pardus* is listed as Near Threatened in the IUCN Red List 2013.

December 2013 Survey

446. During December 2013 survey, 3 locations were sampled in Scrub Forest habitat. Signs and sightings of three mammal species were observed.

447. One specimen each of the Indian Grey Mongoose *Herpestes edwardsii* was seen at Sampling Points D–1 and D–3. One specimen of the Asiatic Jackal *Canis aureus* was sighted at Sampling Point D–3.

448. Signs of Asiatic Jackal *Canis aureus* and Fox *Vulpes sp.* were seen at all three sampling points, while the signs of Indian Grey Mongoose *Herpestes edwardsii* were only seen at Sampling Point D–1.

May 2014 Survey

During the May 2014 survey, three locations in Scrub Forest were sampled. A total of 9 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 3.9% to 10.1% while average plant count was 50. The floral diversity in this habitat was 3 species per sampling point. The dominant plant species in this habitat were *Dalbergia sissoo, Dodonaea viscosa* and *Nerium oleander.*

Small Mammals

449. Seven trapping sites were selected for trapping of small mammals (rodents) in the Ecological Study Area during the December 2013 survey and these are indicated on a map in **Figure 5-48**.

450. **Table 5-26** provides the results for small mammals trapped in the Ecological Study Area (using Sherman Live Traps)[61].

451. For the October 2013 survey, the House Mouse *Mus Musculus* is the most common species with a trapping success of 33% followed by Indian Field Mouse *Mus Booduga* (28% of trappings), House Shrew *Suncus Murinus* (22% of trappings) and House Rat *Rattus rattus* (17% of trappings).

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[60] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on **21 October 2013**.

[61] EIAO Guidance Note No. 10/2004. Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys, Environment Protection Department, Hong Kong.

Table 5-26: Trapping Success for Rodents in the Ecological Study Area, Survey Conducted October 2013

Scientific Names	Common Names	Captured/100 Trap Nights	Percent of Trapping
October 2013			
Mus booduga	Indian Field Mouse	1.79	28%
Mus musculus	House Mouse	2.14	33%
Rattus rattus	House Rat	1.07	17%
Suncus murinus	House Shrew	1.43	22%
Total			**100%**

452. During the December 2013 survey, small mammal trapping was carried out only at Sampling Point D2 located in Scrub Forest. Two specimens of House Shrew *Suncus Murinus* were trapped.

Herpeto–fauna

453. A total of 26 locations were sampled in the October 2013 survey to study herpeto–fauna abundance and diversity in the Ecological Study Area. The location of these sampling points is shown in **Figure 5-47** and **Figure 5-48**. In addition, nocturnal trapping of reptiles was conducted at Sampling Point S6. No herpeto–faunal sampling was carried out in December 2013.

454. **Table 5-27** provides a summary of sampling points by type of habitat, number of sightings, and the number of species sighted.

Table 5-27: Herpeto–fauna Abundance and Diversity by Habitat Type, Survey Conducted October 2013

	No. of Sampling Points	Total Sightings	Density (Sightings per sampling Point)	No. of Species
October 2013				
Pine Forest	5	36	7.2	8
Agricultural Fields	5	66	13.2	9
Riverbank/Riparian	8	102	12.7	10
Scrub Forest	9	84	9.3	13
Total	**27**	**288**		

455. A total of 288 reptile and amphibian specimens belonging to 18 species were observed in the Ecological Study Area during the October 2013 survey (**Table 5-27**). The greatest density of herpeto–fauna was observed in the Agricultural Fields (13 sightings per sampling point), while the greatest diversity of herpeto–fauna was seen in Scrub Forest where 13 herpeto–faunal species were seen.

456. The maximum abundance of herpeto–fauna was observed at Sampling Point S13 where 38 specimens of herpeto–fauna were observed. The most abundant amphibian seen here was the Skittering Frog *Euphlyctis cyanophlyctis*. The second highest abundance was seen at Sampling Point A4 where 23 specimens of herpeto–fauna were observed. The Skittering Frog *Euphlyctis cyanophlyctis* was also the most abundant herpeto–faunal species seen at this location.

457. The highest herpeto–faunal diversity was recorded at Sampling Points A3 in River–bank/Riparian habitat and Sampling Point S9 in Scrub Forest as well as during the nocturnal survey at Sampling Point S6. A total of five herpeto–faunal species were observed at each of these locations.

458. Five herpeto–faunal species were observed during the nocturnal survey at Sampling Point S6. These included Rohtas Fort Gecko *Cyrtopodion rohtasfortai,* Asian Grass Frog *Fejervarya limnocharis,* Agror Valley Agama *Laudakia agrorensis,* Swat Green Toad *Pseudepidalea p. pseudoraddei* and Indian Burrowing Frog *Sphaerotheca breviceps.*

459. Except for *Cyrtopodion rohtasfortai* and *Fejervarya limnocharis* which have not yet been assessed for the IUCN Red List (IUCN 2013), the rest of the taxa are categorized as LC in IUCN Red List.

460. Photographs of some of common reptile species found in the Ecological Study Area are shown in **Figure 5-59**.

Figure 5-59: Photographs of Common Reptilian Species of the Ecological Study Area

a. *Striped Grass Mabuya Eutropis dissimilis*

b. *Punjab Snake Eyed Lacerta Ophisops jerdonii*

c. Rohtas Fort Gecko *Cyrtopodion rohtasfortai*

d. Bengal Monitor *Varanus bengalensis*

Birds

461. A total of 26 locations were sampled in the October 2013 survey to study bird abundance and diversity in the Ecological Study Area while 3 locations were sampled during the December 2013 survey to study bird abundance and diversity at the proposed Project location. The location of these sampling points is shown in **Figure 5-47** and **Figure 5-48** respectively.

462. **Table 5-28** provides a summary of Sampling Points by habitat type. It presents the bird abundance and diversity by habitat type for the October 2013 survey and December 2013 survey.

Table 5-28: Bird Abundance and Diversity by Habitat Type, Surveys Conducted October 2013 and December 2013

Habitat	No. Sampling Points	Total Sightings	Density	No. of Species
October 2013				
Agricultural Fields	5	252	50.40	22
Pine Forest	5	203	40.60	19
Riverbank/Riparian	8	197	24.63	24
Scrub Forest	8	323	40.38	31
Total	**26**	**975**		
December 2013				
Scrub Forest	3	165	55	23
Total	**3**	**165**	**55**	

October 2013 Survey

463. A total of 975 birds belonging to 45 species were observed in the Ecological Study Area. Maximum abundance of the birds was seen in the Agricultural Fields.

464. The maximum abundance of birds was observed at Sampling Point S10 located in Agricultural Fields. Abundant bird species observed at this location included the Common Myna *Acridotheres tristis* and Himalayan Bulbul *Pycnonotus leucogenys*. The maximum diversity of bird species was observed at Sampling Point S16 in Scrub Forest where 16 bird species were observed.

465. Abundant bird species of the Ecological Study Area included Jungle Babbler *Turdoides striata* followed by House Sparrow *Passer domesticus*, Common Myna *Acridotheres tristis*, Jungle Crow *Corvus macrorhynchos* and Himalayan Bulbul *Pycnonotus leucogenys.*

466. Two of the bird species recorded from the Ecological Study Area are included in the IUCN Red List 2013. These are the White–backed Vulture *Gyps bengalensis* and Egyptian Vulture *Neophron percnopterus.* They are listed as Critically Endangered and Endangered respectively due to a rapid population decline in India and Pakistan resulting from poisoning by the veterinary drug Diclofenac combined with several long–term declines in Europe and West Africa (BirdLife International 2011)[62].

467. A total of 17 specimens of the White–backed Vulture *Gyps bengalensis* were seen in the Ecological Study Area at Sampling Points A2, S17 and S18 while 65 specimens of the Egyptian Vulture *Neophron percnopterus* were seen mostly at Sampling Points S17 and S18. The vultures were concentrated near Kotli city's waste

[62] BirdLife International and Durham University (2011) Species factsheet: *Neophron percnopterus*. Downloaded from http://www.birdlife.org on 18th October 2011.

dumping site and the waste outlet of Kotli slaughter house, both of which are located near Sampling Point S18 **(Figure 5-60**). According to information provided by the locals, the breeding area for most of the vulture population is inside the Pir Lasura National Park located about 12 km from the Ecological Study Area. However, many of them feed and rest on the hills in the vicinity of the Ecological Study Area particularly near Sampling Point S18, at the confluence of Poonch River and Ban Nullah. The main resting and feeding area for vultures near the Ecological Study Area is shown in **Figure 5-60**.

468. A total of two (02) vulture nests were found in the Ecological Study Area at Sampling Point S1 and S18. The spatial distribution of these nests is shown in **Figure 5-60**. Photographs of vultures and their nests seen in the Ecological Study Area are shown in **Figure 5-61.**

December 2013 survey

469. During December 2013 survey 3 locations were sampled in Scrub Forest habitat. A total of 23 birds species were seen during the survey. Maximum bird abundance was seen at Sampling Point D2, while the minimum bird abundance was seen at Sampling Point D3 (**Figure 5-48**).

470. Abundant bird species of observed during the December 2013 survey included Jungle Babbler *Turdoides striata* followed by Common Myna *Acridotheres tristis,* Himalayan Bulbul *Pycnonotus leucogenys* Great Tit *Parus major* and Red–vented Bulbul *Pycnonotus cafer.*

Figure 5-60: Spatial Distribution of Vultures in the Ecological Study Area, Surveys Conducted October 2013

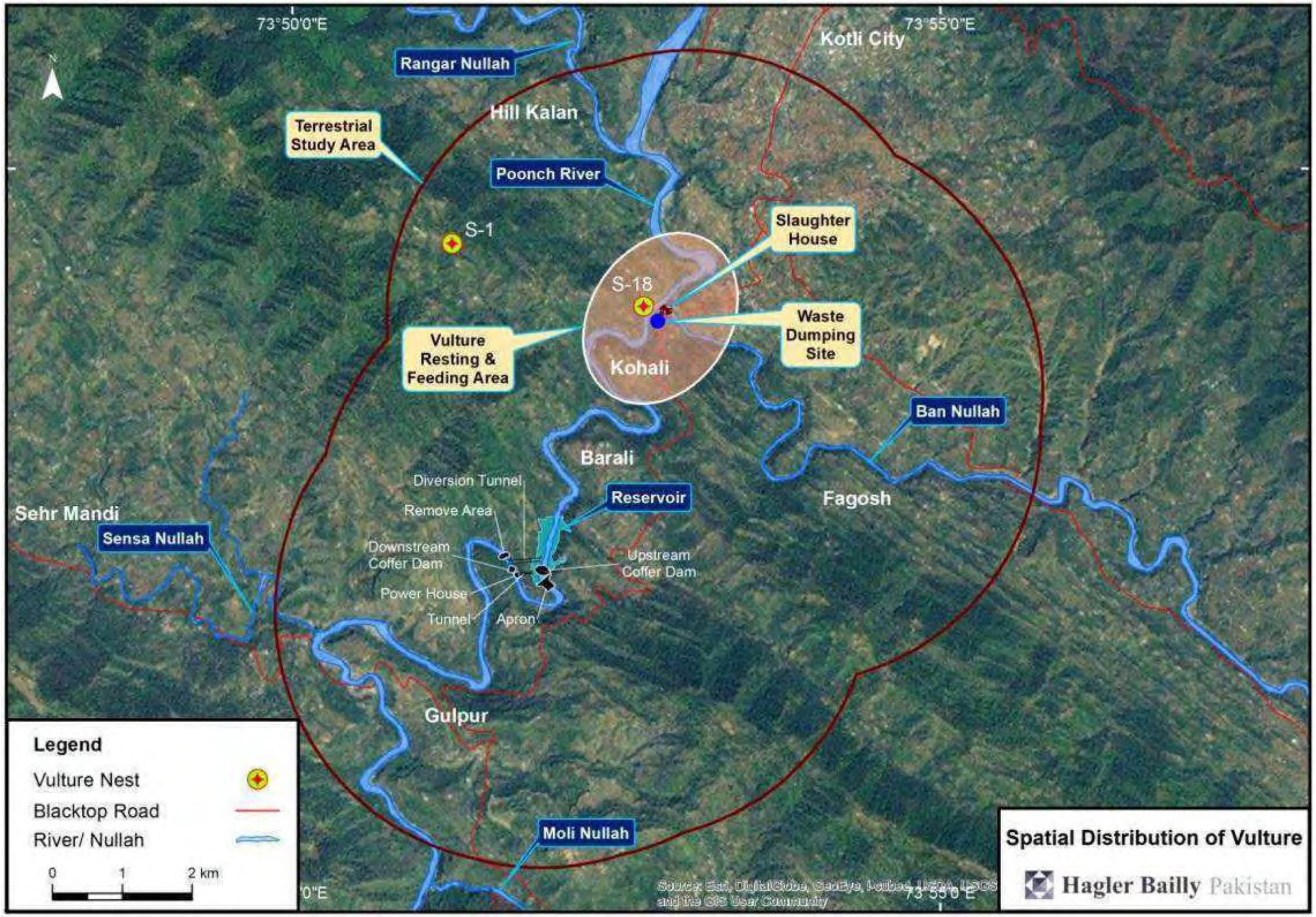


Figure 5-61: Photographs of Vultures and Vulture Nests in the Ecological Study Area Survey conducted October 2013

Vulture Nest on a Pine Tree at Sampling point S1

Egyptian Vulture Neophron percnopterus at Sampling Point S18

Egyptian Vulture Neophron percnopterus at the Garbage dumping site near S18

White–backed Vulture Gyps bengalensis near Sampling point S17

5.2.6 Poonch River Mahaseer National Park

471. The entire stretch of the Poonch River along with its tributaries has been declared as Mahaseer National Park in a notification issued by the President of AJK in December 2010. (**Figure 2-23** in **Section 2)** Poonch River is unique in having warm water in its lower and middle reaches and cold water in its upper reaches. It ends at Mangla Reservoir which is one of the major fish producing water body in the country. Many channels join it in its way giving the fishes a lateral access for breeding and feeding.

472. The Poonch River was declared as a national park due to its high fish diversity and importance of supporting fish of both conservation and economic importance particularly the Endangered fish species (IUCN Red List 2013) Mahaseer *Tor putitora* that is important both from the conservation and commercial viewpoint. The *Tor putitora* has undergone a dramatic decline in population in the last few years and the largest stable population of this fish in the country is found in the Poonch River that also provides a breeding ground for it. In addition, the Poonch River provides a breeding ground for the commercially important fish species of the Mangla Reservoir.

473. As discussed in **Section 2.2**, while the Poonch River was notified as a national park in 2010, a number of activities such as unregulated and illegal sand and gravel mining and fishing are still taking place in and close to the river. The Fisheries and Wildlife Department in collaboration with Himalayan Wildlife Foundation is building up management and protection systems and engaging the communities in protection of the

national park. However, the AJKFWD has a limited number of protection staff at its disposal and the funds for operational for operational expenses are also very limited (See Biodiversity Action Plan, **Appendix L**, for further details). The support for protection provided by HWF also remains limited as funding available to HWF tends to be intermittent. While adequate levels of protection are achieved for durations of three to six months when HWF has the resources to fund the protection activities, considerable damage is done when HWF withdraws its support and the gain achieved is practically wiped out by recurrence of illegal fishing and unregulated sediment extraction.

5.2.7 Mining in the Poonch Basin

474. River sediments in the Poonch Basin are both a valuable environmental and economic resource. Apart from the provision of habitats for riverine biota, the sediment is mined from the river for use in building, road construction and other related activities. Sands and silts are used directly, and cobbles and boulders are crushed to create aggregate material. As such the sediments of the Poonch River and its tributaries are Valued Environmental Components.

Extraction methods used

475. The mining techniques used range from crude, labour intensive methods to larger scale mechanical methods. Smaller scale operations involve shovels and spades (**Figure 5-62**), but larger mechanized operations (**Figure 5-63**) are increasingly evident, particularly near urban areas.

Figure 5-62: Extraction of fine Sands (Left) and Cobbles (Right) on the Poonch River Downstream of Proposed Dam Location

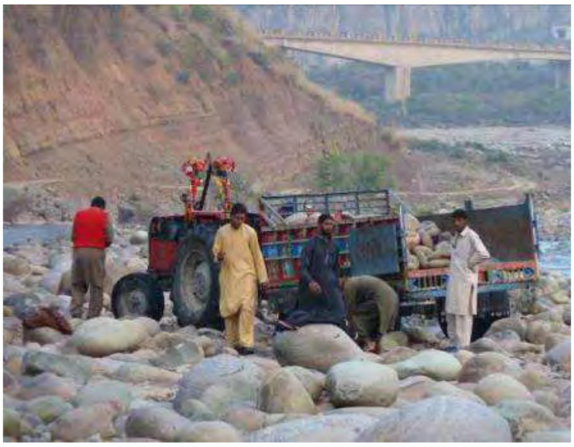


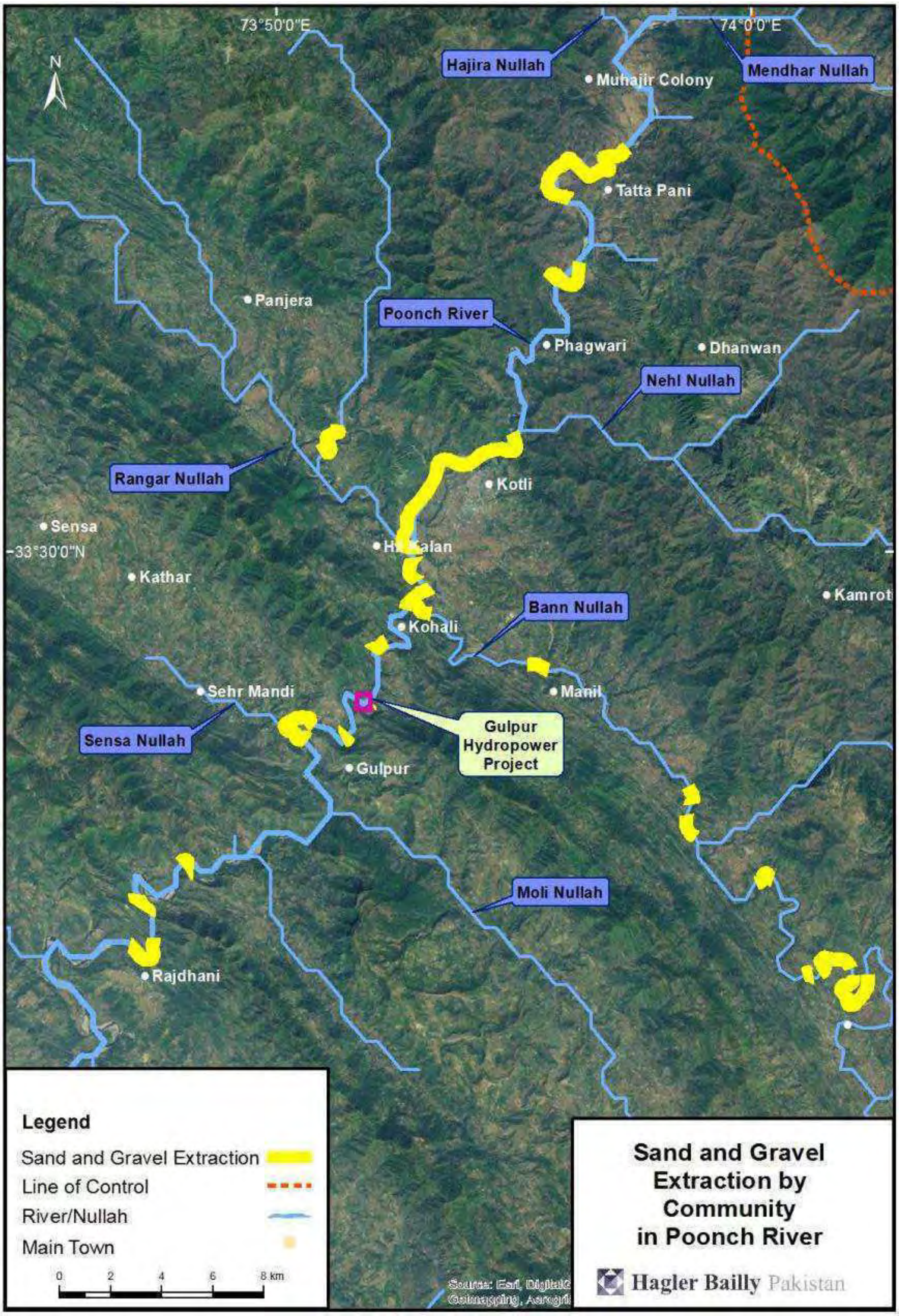
Figure 5-63: Mining Operation in the Bed of the Bann Nullah near its Confluence with the Poonch River

Locations and timing

476. Mining of river sediment in the Poonch Basin is limited by access to the rivers. The locations where mining currently (2013) takes place are shown in **Figure 5-64**. Historically, mining was localized around major settlements, such as near the towns of Tatta Pani, Kotli, Barali, Gulpur and Radjhani, but this is no longer the case. The expansion of the road network and increased political stability and accessibility has led to an increase in construction activities in the region over the last 10-20 years. At the same time, the improved road network has opened up additional access to the river for mining, and thus both the quantities of sediment removed and spatial areas affected by mining have expanded. Of particular concern in this regard is the increase in mining in the Bann Nullah and Rangar Nullah (**Figure 5-64**), as both of these tributaries represent important breeding areas for the indigenous fish.

477. Sand mining and gravel extraction are usually undertaken in the winter (September to March), since during this low flow period more of the river bed and banks are exposed. During the high flow summer months, particularly in the monsoon period, the rivers tend to flow bank to bank, and access to exposed sediment is limited.

Figure 5-64: The Extent of Sand and Cobble Mining Operations in the Poonch Basin in the Vicinity of the Proposed Gulpur HPP



Ecological impacts associated with mining

478. River mining destroys aquatic habitats at the point of mining activities (**Figure 5-65**) but also reduces the size and amount of sediment that is distributed downstream, which can smother aquatic habitats in the downstream reaches. Changes to aquatic habitats as a result of mining have knock-on effects on the fish and other biota.

479. The ecological impacts associated with mining in the Poonch River include:

- complete destruction of in-stream and riparian habitat within the mined reach;
- lateral bank instability leading to erosion of the river banks and lateral bars, as well as any floodplain pockets;
- bed coarsening leading to a loss of gravel habitats, decreased bed mobility and overall poorer in-channel habitat conditions;
- elevated fines in the downstream areas, and smothering of downstream habitats and seeds, eggs, etc.;
- erosion of the bed and banks downstream of the site as the river "replaces" the sediment removed from the mined reach; and
- bed and bank erosion upstream of the mined reach, if the nick point of the lowered bed erodes upslope. Such incision can migrate for kilometers upstream and erode into tributaries. The lowered river bed can also result in the abandonment of secondary channels.

Figure 5-65: Sediment Mining Degrades the In-channel and Riparian (Banks) Environment Through Direct Disturbance, Vegetation Removal and Washing of Fine Sediment in to the Channel and Downstream

Source: http://www.fdb.org.pk/documents/mnp.pdf, accessed February 2013).\

5.2.8 Basis for Determination of Conservation Status of Species and Performance Standard for Preparation of the Baseline

480. The conservation status of the species identified were determined using criteria set by the IUCN Red List of Threatened Species (IUCN Red List, 2013) [63] , Pakistan's Mammals National Red List 2006[64], the Convention on International Trade in Endangered Species (CITES) appendices (as of November 2013) (CITES, 2013)[65]. The baseline was developed to address the requirements of the Equator Principles[66] , Safeguards Requirement (SR) 1 of ADB's SPS[67], and International Finance Corporation (IFC) Performance Standards[68].

5.2.9 Endangered and Threatened Species

Vegetation

481. No endangered or threatened plant was determined to be present in the Ecological Study Area.

Large Mammals

482. Two large mammals reported from the Ecological Study Area are included in IUCN Red List 2013. These are the Common Leopard *Panthera pardus* and Common Otter *Lutra lutra*, both of which are listed as Near Threatened in the IUCN Red List 2013. There are some species that are included in the CITES Species List and in the Pakistan Mammals National Red List 2006. However, none of the mammal species observed or reported from the Ecological Study Area are endemic, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Small Mammals

483. None of the small mammals observed or reported from the Ecological Study Area are included in the IUCN Red List 2013. No threatened small mammals or endemics were determined to be resident on the Ecological Study Area. There are some species of limited conservation concern, but their distribution is widespread.

Herpetofauna

484. One of the reptile species recorded from Ecological Study Area is included in the IUCN Red List 2013. This is the Indian Rock Python *Python molurus* that is listed as Near Threatened. Of the herpeto–fauna species observed in the Ecological Study Area, four are endemic to Pakistan. These include Rohtas Fort Gecko *Cyrtopodion rohtasfortai,* and Kashmir Torrent Frog *Allopaa barmoachensis.* The two species included in CITES Appendix II are Central Asian Cobra *Naja oxiana* and Indian Rat

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63 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 26 October 2013.

64 Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan

65 UNEP–WCMC. 14 November 2013. UNEP–WCMC Species Database: CITES–Listed Species

66 The Equator Principle. June 2006. Adopted by The Equator Principles Financial Institutions, www.equator–principles.com, Accessed 11 October, 2011.

67 ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment

68 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

Snake *Ptyas mucosus*, while *Varanus bengalensis* Bengal Monitor is included in CITES Appendix I.

Birds

485. Two bird species found in the Ecological Study Area are included in the IUCN Red List 2013. These include the Oriental White–backed Vulture *Gyps bengalensis* and Egyptian Vulture *Neophron percnopterus* listed as Critically Endangered and Endangered respectively. Both these species are placed in Appendix II of the CITES Species List. Two bird species, Black Kite *Milvus migrans* and White eyed Buzzard *Butastur teesa* are included in CITES Appendix II. The vultures observed in the Ecological Study Area were concentrated near Kotli city's waste dumping site and the waste outlet of Kotli slaughter house, both of which are located near Sampling Point S18 (**Figure 5-60**). However, these vulture feeding and resting areas are located at least 2 km from the area where the Project facilities will be constructed. According to preliminary investigations, most of the vultures breed in the Pir Lasura National Park located about 12 km from the Ecological Study Area. Therefore, it was determined that the Ecological Study Area is not critical to the survival of these vulture species.

Fish

486. Six fish species observed in the Ecological Study Area are listed in IUCN Red List. Kashmir Catfish *Glyptothorax kashmirensis* is listed as Critically Endangered in IUCN Red List. Mahaseer *Tor putitora* is listed as Endangered while Pabdah Catfish *Ompok pabda* and Butter Catfish *Ompok bimaculatus* are listed as Near Threatened. Moreover, Common Carp *Cyprinus carpio,* Snow Carp *Schizothorax plagiostomus* and Twin–banded Loach *Botia rostrata* are listed as Vulnerable.

487. The endemic fish species in the Ecological Study Area include Pakistani Baril *Barilius pakistanicus*, Punjab Loach *Schistura punjabensis*, Kashmir Catfish *Glyptothorax kashmirensis* and Nazir's Catfish *Glyptothorax naziri*.

488. It was determined that the aquatic habitat in the Ecological Study Area is important for survival of Kashmir Catfish *Glyptothorax kashmirensis* listed as Critically Endangered and Mahaseer *Tor putitora* listed as Endangered in IUCN Red List.

5.2.10 Critical Habitat Assessment

489. The Critical Habitat Assessment of the Project was completed in September 2013[69]. Given below is a brief summary of this Critical Habitat Assessment as defined by the IFC's PS6[70] and paras 28-29, SR1, ADB SPS. [71]

Critical habitat is described as having a high biodiversity value, as defined by:

- Areas protected by the International Union for Conservation of Nature (Categories I-VI) [72],
- wetlands of international importance (according to the Ramsar convention);[73]

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[69] HBP, January 2014, Critical Habitat Assessment of Gulpur Hydropower Project, Hagler Bailly Pakistan.
[70] Guidance Note 6, January 2012, Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group
[71] ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment,
[72] IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.

- important bird areas (defined by Birdlife International);[74] and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;[75]

490. The following additional characteristics are used in Critical Habitat Assessment.

- Habitat of significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted–range species;
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

491. The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision would be evaluated on a case–by–case basis.

Aquatic Study Area

492. The Project Site for the Gulpur Hydropower Project is located on the Poonch River and the Aquatic Study Area was determined to be located in a Critical Habitat on the basis of two criterion outlined in the Performance Standard 6.

493. Criterion 1: Habitat of significant importance to Critically Endangered and/or Endangered species

494. A complete list of the species of conservation importance reported from the terrestrial and aquatic Ecological Study Area are outlined in **Section 10** of **Appendix B**, Biodiversity Baseline. The Poonch River provide habitat for two fish species: Kashmir Catfish *Glyptothorax kashmirensis* listed as Critically Endangered and Mahaseer *Tor putitora* listed as Endangered in IUCN Red List.

495. In addition, fish species Common Carp *Cyprinus carpio,* Snow Carp *Schizothorax plagiostomus (richardsonii)* and Twin–banded Loach *Botia rostrata* listed as Vulnerable in the IUCN Red List have also been observed in the Poonch River.

496. According to IFC's Guidance Note 6, Tier 1 sub-criteria for Criterion 1 are defined as follows[76]:

- Habitat required to sustain ≥ 10 percent of the global population of an IUCN Red-listed CR or EN species where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species.

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73 Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

74 Birdlife International, UK

75 Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

76 Guidance Note 6, January 2012, Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group

- Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.

497. Tier 2 sub-criteria for Criterion 1 are defined as follows:

- Habitat that supports the regular occurrence of a single individual of an IUCN Red-listed CR species and/or habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species.
- Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species.
- As appropriate, habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent national/regional listing.

498. Concerning the Endangered Mahaseer *Tor putitora*, the Poonch River triggers Critical Habitat based on the first and third criterion of the Criterion 1, Tier 2 i.e. "*habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species; and habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent national/regional listing."* This is because the largest population of Mahaseer fish *Tor putitora*, in Pakistan is found in the Poonch River (approximately 80%) and the Poonch River and its tributaries serve as an important breeding ground for this fish species.[77] However, the Mahaseer *Tor putitora* does not fulfill the second criterion in Criterion 1, Tier 2 i.e. *habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species.* This is because according to the IUCN Red List,[78] *Tor putitora* is a widely distributed species in south and south-east Asia, with a restricted area of occupancy. The species has been reported from across the Himalayan region and elsewhere in south Asia and south-east Asia, ranging from Afghanistan, Pakistan, India (Darjeeling to Kashmir), Nepal, Bangladesh, Bhutan, Sri Lanka, Myanmar, western Iran to eastern Thailand. Moreover, the Mahaseer *Tor putitora* does not trigger Critical Habitat based on Criterion 1 Tier 1 since according to information available, it is widely distributed in south and south-east Asia even though the area of occupancy is limited (IUCN Red List) and more than 10% of the global population of this species is not found in the Poonch River.

499. Kashmir Catfish *Glyptothorax kashmirensis* is a rare and Critically Endangered (IUCN Red List 2013) fish. According to IUCN Red List it is reported only from the Jhelum River. However, specimens of this fish species have been caught from the Poonch River during the October 2013 survey (**Section 5.2.4**). It triggers Critical Habitat based on Criterion 1 Tier 1. This is because the fish has a very restricted range of occupancy (Jhelum and Poonch River) and is endemic to Kashmir. Keeping in view the predominantly riffle habitat of the Poonch River, which are the preferred habitat of this fish as well as the shallow waters particularly in the winter season, it is likely that more than 10% of the population of Kashmir Catfish *Glyptothorax kashmirensis* is found in the

[77] Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

78 Jha, B.R. & Rayamajhi, A. 2010. Tor *putitora*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **08 April 2014**.

Poonch River. In addition, there are fewer than 10 management sites of this species globally. Thus it fulfills the requirements of Criterion 1 Tier 1. In addition, the Kashmir Catfish *Glyptothorax kashmirensis* also fulfills all three requirements to trigger Criterion 1 Tier 2 of Critical habitat since the Poonch River provides habitat containing regionally important concentrations of this Critically Endangered fish and loss of such a habitat could potentially impact the long term survivability of the species.

500. The other species of special importance are listed in **Table 5-16**. None of these species are listed as Endangered or Critically Endangered in the IUCN Red List 2013. The six indicator fish species selected to study the impact of Project impacts on the aquatic resources of the Poonch River are listed in **Section 5.2.4**. Details of expected impacts and mitigation measures are outlined in **Section 6, Environmental Flow Assessment**.

501. **Criterion 2:** Areas that meet the criteria of the IUCN's Protected Area Management Categories Ia, Ib and II, although areas that meet criteria for Management Categories III–VI may also qualify depending on the biodiversity values inherent to those sites[79]

[79] IUCN Protected Areas Categories System

IUCN protected area management categories classify protected areas according to their management objectives. The categories are recognized by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

Ia Strict Nature Reserve

Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring

Ib Wilderness Area

Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park

Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

III Natural Monument or Feature

Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area

Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape

A protected area where the interaction of people and nature over time has produced an area of distinct charcter with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources

Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in

502. The Poonch River and tributaries was declared a national park in a letter from the AJK Secretariat Forest/AKLASC/Fisheries (ref no: SF/AV 11358-7/2010 dated 15 December 2010). Even though the official notification does not specify the basis for the designation, the objective for declaring the Poonch River as a national park was to protect the aquatic ecological resources of the Poonch River. The ecological and socio-economic significance of the Poonch River is outlined in the Ecological Baseline Study of the Poonch River[80] and summarized in **Appendix B,** Draft Biodiversity Baseline.

503. The Poonch River was declared a National Park based on the definitions given in the AJK Wildlife Act 2010[81]. It has not been designated any official protected area category by IUCN. However, it also seems to fit the IUCN category II definition which is "*Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.*"

504. It was therefore concluded that the Aquatic Study Area of the Project lies in a Critical Habitat as designated by IFC's Performance Standard 6. Mitigation measures for minimizing Project related impacts protecting the ecological resources of the Poonch River basin are outlined in **Section 6, Environmental Flow Assessment**. An outline of the Biodiversity Action Plan is presented in in **Section 11, Environmental Management and Monitoring Plan.**

505. **Determination**: The Aquatic Study Area lies in a Critical Habitat.

Terrestrial Study Area

The Terrestrial Study Area does not meet any of the following criteria of a Critical Habitat.

- Areas protected by the International Union for Conservation of Nature (Categories I-VI);[82]
- wetlands of international importance (according to the Ramsar convention);[83]
- important bird areas (defined by Birdlife International);[84] and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;[85]

The following additional characteristics were used in the Critical Habitat Assessment

506. **Habitat integral to the survival of critically endangered or endangered species:** Two of the bird species recorded from the Ecological Study Area are included in the IUCN Red List 2013. These are the White–backed Vulture *Gyps bengalensis* and

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a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

[80] Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

[81] Azad Jammu and Kashmir Wildlife (Protection, Preservation and Management) Act 2010.

[82] IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.

[83] Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

[84] Birdlife International, UK

[85] Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

Egyptian Vulture *Neophron percnopterus* listed as Critically Endangered and Endangered respectively. Even though these birds use the Terrestrial Study Area for feeding and resting, their main breeding areas are at least 10 km away from the Project site. There is nothing in the literature reviewed nor in the information gathered that would imply that the Study Area habitat is integral to the survival of these vulture species;

507. A list of the species of conservation importance reported from the Study Area and the locations where sighted is included in the Biodiversity Baseline of Gulpur Hydropower Project.[86]

508. **Areas having special significance for endemic or restricted-range species:** The habitats found on Study Area are homogenous and widespread. Even though some endemic herpeto-faunal species have been reported from the Terrestrial Study Area, their distribution is not limited to any specific site or habitat type, and their distribution is widespread. Therefore, the Study Area does not hold any significance for the survival of endemic or restricted range species; or

509. **Areas critical for the survival of migratory species:** Even though there are some migratory birds reported from the Study Area, the major staging ground for these birds is the Mangla Lake or Mangla Reservoir. According to investigations, most of the migratory birds do not use the Study Area as a breeding and nesting area but merely as a resting ground on their way to the Mangla Lake where greater food and habitat is available. Moreover, no mammal species depends on the area for its migration.

510. Areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services. This situation is not present on the Study Area. While all species are functioning components of ecosystems, there are no unique assemblages of species or association of key evolutionary processes in the Terrestrial Study Area; or

511. **Areas having biodiversity of significant social, economic or cultural importance to local communities.** Although the area is of importance to residents in terms of ecosystem services (such as water, vegetation for grazing and fuel wood), it has no unique biodiversity value of social, economic or cultural importance to the community.

512. **Determination**: The Terrestrial Study Area does not lie in a Critical Habitat.

5.2.11 Present Ecological Condition

513. The categories used to describe the Poonch River's present ecological condition are based on modification from the natural, with the natural condition seen as the reference condition (**Table 5-29**). Based on these definitions, the specialist team from Hagler Bailly Pakistan were requested to estimate the Present Ecological State (PES) of the three sites selected for assessment as natural (Category A), slightly changed (Category B), moderately changed (Category C), or extensively changed (Category D) using expert judgement (**Table 5-30**), and provided explanations as to why these scores were given (**Table 5-31**). Details are provided in **Section 6,** Environmental Flow Assessment and **Appendix H,** Environmental Flow Assessment Report.

[86] Hagler Bailly Pakistan (HBP 2014), Biodiversity Baseline, Final Report, Gulpur Hydropower project

Table 5-29: Definitions of the Present Ecological State Categories

Ecological Category	PES % Score	Description of the Habitat
A	90–100%	Still in a Reference Condition.
B	80–90%	Slightly modified from the Reference Condition. A small change in natural habitats and biota has taken place, but the ecosystem functions are essentially unchanged.
C	60–80%	Moderately modified from the Reference Condition. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40–60%	Largely modified from the Reference Condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	20–40%	Seriously modified from the Reference Condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0–20%	Critically/extremely modified from the Reference Condition. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

Table 5-30: Summary of Present Ecological Status (PES) of EF Site 2 (Project Site)

Driver Components	Component PES	Present Ecological status of EF Site 2
Hydrology	A	C
Hydraulics	A	
Geomorphology	B	
Water Quality	B	
Riparian Vegetation	D	
Algae	B	
Macro–invertebrates	C	
Fish	C	
River dependent Wildlife	D	

Table 5-31: Explanations for the Present Level of Ecological Health Assigned to Each Ecosystem Component

Ecosystem Component	Present Ecological State	Explanation
Hydrology	A	No storage has been constructed as yet on either the main Poonch River or any of its tributaries. River flows are thus largely unobstructed and natural.
Hydraulic	A	No Dams or obstructions have been constructed as yet on either the main Poonch River or any of its tributaries. River hydraulics and sediment movement are thus largely natural.
Geomorphology	B	Sand and gravel extraction from river bed and banks has resulted in geomorphology degradation

Ecosystem Component	Present Ecological State	Explanation
Water Quality	B	While there is no industrial activity and the population and vehicular traffic levels are low, domestic discharges and limited use of artificial fertilizers may have had some impact on the quality of the water in the main Poonch River.
Riparian Vegetation	D	There has been extensive clearing and extraction by communities. These changes are unrelated to flow
Algae	B	There has been a decline in water quality and increase in non–selective fishing
Aquatic macro–invertebrates	C	Non–selective fishing in the Poonch River has negative impact on aquatic macro–invertebrates
Fish	C	Fish resources have declined due to over harvesting, selective and non–selective fishing pressures, decline in water quality as well as sand and gravel extraction from the river bed and banks.
River dependent Wildlife	D	Illegal hunting and habitat degradation has resulted in decline in the abundance of river dependent animals such as Otter.

5.2.12 Limitations of Survey

514. The limitations for the ecological baseline are as follows:

515. Large carnivore species (e.g. Common Red Fox *Vulpes vulpes* Asiatic Jackal *Canis aureus,* cats *Felis sp.,* etc) are highly elusive and predominantly nocturnal, which make their detection difficult. These species also have large home ranges and exist in sparse populations (or primarily individually), which further reduce chances of encountering them or their signs. Intensive sign surveys were conducted and local informants were consulted to evaluate survey findings. However, it is recognized that sign surveys have limitations; for example, tracks are especially difficult to determine on hard substrates making it confusing to differentiate between signs of related species.

5.2.13 Ecosystem Services

516. Humankind benefits from a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as ecosystem services[87]. These include the following

- **Provisioning services:** the products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.
- **Regulating services:** the benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.
- **Cultural services**: the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.

[87] Farber, S., Costanza, R., Childers, D.L., Erickson, J., Gross, K., Grove, M., Hopkinson, C.S., et al. (2006). Linking Ecology and Economics for Ecosystem Management. Bioscience, 56(2), 121

- **Supporting services**: ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.

517. The local communities in the Study Area and its vicinity utilize the natural resources available to them in various ways and benefit from the ecosystem services provided. Some of these are briefly outlined below. Agriculture in the Poonch River valley depends mainly on rainfall. The river water is not used for agriculture as given the topography of the river valley the cost of pumping water from the river makes utilization of river water uneconomic.

- Sediment is extracted from the river bed and river banks and used in construction. This sediment mining[88] is common in most parts of the Poonch River basin. Out of 417 households interviewed in 11 villages during the socio-economic survey, 28 reported engagement in sediment mining as a business (**Section 5.3**).
- Subsistence fishing from the Poonch River provides food for the local communities. Fish consumption was observed throughout the Socioeconomic Study Area. Out of 421 households interviewed in 11 villages during the socio-economic survey, 259 reported fish consumption from Poonch River (**Section 5.3**). The most common fish consumed include Pakistan Labeo (70% of total consumption) and Mahaseer (30% of total consumption). Total quantity of fish caught from Poonch River consumed in the stretch of the river downstream of the LoC to the Mangla Reservoir is estimated at 25,000 kg per year.
- The River provides opportunities for recreation to the local communities. The most common recreation activities of the rural population on Poonch River include swimming, walking along the river banks and children playing on river banks. Occasionally, locals catch fish in the river for recreation but this activity is not frequent. There is a park in Kotli located on the river bank that is a popular recreation spot.
- Some of the plants in the Poonch River basin have medicinal properties and are used by the locals for treatment of ailments. *Berberis sp., Dodonaea viscosa,* and *Nerium oleander* are the medicinal plants commonly found in the Study Area, while *Solanum nigrum* and *Traxicum sp* are rare in the Study Area but have good medicinal value. (**Appendix B,** Biodiversity Baseline). Of these plants, *Berberis sp., Dodonaea viscosa* and *Nerium oleander* have been recorded from the habitats that will be occupied by Project infrastructure (Area of Habitat Loss defined in **Section 7.3**, Impact Assessment.). However, all three these species are abundant and common in the entire Poonch River basin.
- Locals graze their livestock on the riparian shrubs and bushes. Some of these include *Acacia modesta, Berberis sp., Carissa opaca, Dalbergia sissoo* that are common species of the Study Area.

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[88] In this case, sediments include sand, gravel and large boulders which are mined and then crushed in stone crushing machines.

- Riparian bushes and shrubs provide a source of fuel and firewood for the local communities. Some of these include *Acacia modesta, Cassia fistula, Dodonaea viscosa, Lantana camara.*
- Some plant species such as Fig *Ficus carica* and Walnut *Juglans regia* provide edible fruit and dry fruit. They have not been reported from the habitats that will be occupied by Project infrastructure (Area of Habitat Loss defined in **Section 7.3**, Impact Assessment.)
- Vultures found in the Study Area are keystone species and perform an essential ecological role in South Asia by consuming dead livestock. Since vultures are scavengers, they play a role in the control of important livestock diseases e.g. anthrax, tuberculosis, brucellosis, foot and mouth disease, rinderpest and contagious pleuropneumonia by rapid disposal of infected animals and inactivation of pathogens. Other scavengers such as fox and jackals are scavengers that play a role in disposal of dead carcasses of livestock (**Section 5.2.5**).

5.3 Socioeconomic Baseline

518. The purpose of this section is to provide an understanding of the existing socioeconomic conditions and activities of the communities that can be influenced by or can benefit from the Project.

5.3.1 Socioeconomic Study Area

519. The administrative boundaries of Kotli District and its neighboring districts are shown in **Figure 5-66**. Kotli District is one of the ten districts of AJK. It has a population of 517,142 and constitutes 14% of the total area of AJK.[89] There are five administrative sub–divisions of Kotli District known as Tehsils. These are Kotli, Sensa, Dulya Jattan, Charohoi and Fatehpur Thakyala. The Socioeconomic Study Area falls within the Kotli, Sensa, Dulya Jattan and Charohoi tehsils of Kotli District.[90]

520. The Socioeconomic Study Area was defined in view of the possible impacts of the Project on settlements located upstream and downstream of the Project site. Examples of such impacts that extend upstream as well as downstream of the dam include reduced availability of fish in the river, and variations in availability of sand and gravel in the riverbed which is mined by the community for use as construction material. Settlements located at a distance of less than two km from the Poonch River were included in the Socioeconomic Study Area. The total length of the river segment, included in the Socioeconomic Study Area was 65 km, extending to about 35 km downstream of the dam to the Mangla Reservoir, and about 30 km upstream of the dam (**Figure 5-67**). A distance of 3 km on either side of the river was included in the Socioeconomic Study Area. Communities in the Socioeconomic Study Area thus defined have direct access to the river and are more likely to be impacted by the construction and operation of the Project. Settlements located further away and at higher elevations in the Valley were not included in the Socioeconomic Study Area, as the direct impact on

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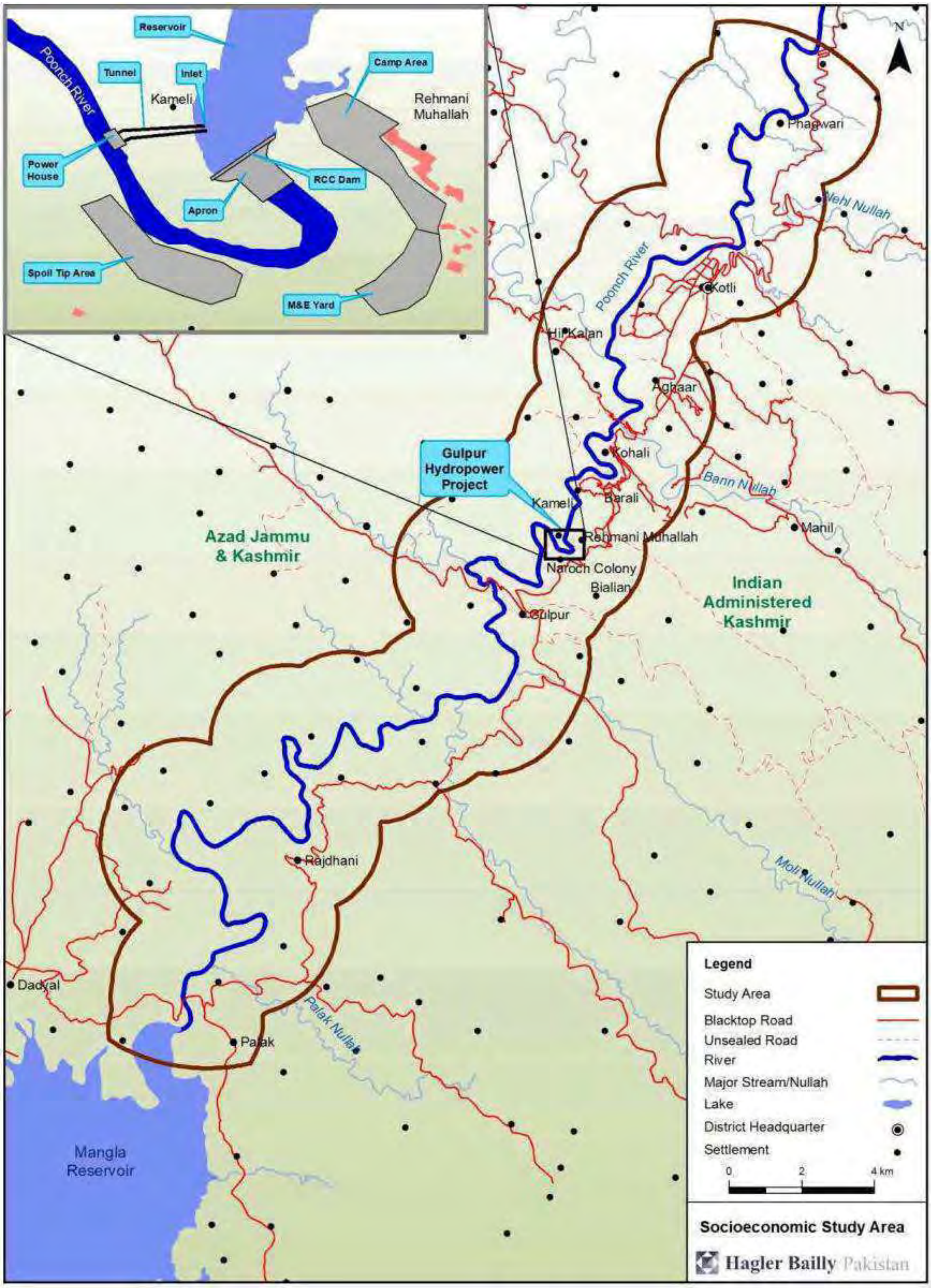
89 Source: http://www.ajk.gov.pk/index.php?option=com_content&view=article&id=28&Itemid=11. Accessed March 2014.

90 There are four tiers of administrative divisions in Azad Jammu and Kashmir, starting with the central government at the top. The second tier under this system is the 'district'. Each district is then divided into 'tehsils', which are in turn divided into 'union councils'.

them is expected to be marginal in comparison to the settlements located closer to the river.

Figure 5-66: Socioeconomic Study Area Administrative Boundaries

Figure 5-67: Socioeconomic Study Area



5.3.2 Methodology and Sampling Framework

521. Surveys for collection of socioeconomic data were conducted at the settlement and at the household level in the manner outlined below.

- The settlement and household level surveys were conducted during a 14 day period from 7 February 2014 to 21 February 2014, in parallel with community consultations.
- Due to their familiarity with the area and language advantage, three persons from the project area were hired to assist HBP team in conducting the surveys. During the briefing, prior to the survey activity, the questionnaires were explained to the team and objectives behind conducting the survey were revisited. Data collection, recording and management were also covered in this briefing.
- Residents of settlements were given advance notice of the HBP team's visit. Settlement survey for each rural settlement was conducted before the household surveys. The key respondents were male members who either held important leadership positions in the community or had insight on the settlement due to age or nature of work.
- All respondents were first briefed about the purpose of the team's visit and their confirmation to willingly respond to the questionnaires was verbally taken. Although, women did not participate in the settlement survey in any of the rural settlements, however they were separately briefed about the purpose of HBP team's visit.
- Household survey respondents were mostly men. However women, especially those who did not have any male members in the household, were surveyed, where possible.

522. The information gathered through settlement and household surveys is discussed in the sections that follow.

Settlement Survey

523. In the first stage, settlement profile questionnaires were used to collect information at the settlement level in order to prepare a socioeconomic profile of the settlements located in the Socioeconomic Study Area. Settlements were of two types: rural and urban. Information collected at the settlement level focused on demographics, available infrastructure and facilities, incomes and livelihoods, and migration patterns. A copy of the questionnaire used is included in **Appendix C.**

524. **Table 5-32** gives details of the settlements surveyed. Location of the surveyed settlements is shown in **Figure 5-68**. Coverage of the surveys conducted is summarized in **Table 5-33**. Overall, 11 rural settlements and one urban settlement were surveyed in the Socioeconomic Study Area. A larger number of settlements were selected closer to the Project site where the dam, power house, offices and residential colony are located, and where the reservoir upstream of the dam will be created. The 11 rural settlements surveyed were 25% of the total of 44 settlements in the Socioeconomic Study Area.

525. Kotli city's (hereinafter referred as 'Kotli') population was estimated based on figures from the District Commission Report of AJK (DCR AJK). The population of Kotli Municipal Corporation (Kotli MC) was 32,047 in 1998 and suburban regions had an

estimated population of 24,011 people in 1998.[91] Both the MC and suburban regions are included in the definition of Kotli in this report. The national urban growth rate is 2.9% in Pakistan[92]. The growth rate for Kotli was estimated at twice the national average at 5.8% in view of rapid expansion of the city in the last decade or so likely driven by remittance incomes and the fact that this is the only major urban centre in the district and absorbs most fo the urbanization pressure in the area. This gives the current population of Kotli to be 113,000 persons. The estimated population of the surveyed rural settlements is 49,095.

Table 5-32: Settlements Surveyed in the Socioeconomic Study Area

District	Tehsil	Union Council	Name of Settlement	Total House-holds	Estimated Population of Settlement	House-holds Surveyed	Surveyed H/holds as % of total H/holds
Rural							
Kotli	Kotli	Phagwari	Phagwari	150	900	57	38%
Kotli	Kotli	Kotli	Aghaar (Gulhar)	450	3,600	37	8%
Kotli	Kotli	Barali	Kohali	45	350	26	58%
Kotli	Kotli	Barali	Barali	4,000	24,000	56	1%
Kotli	Kotli	Barali	Rehmani Muhallah	30	240	26	87%
Kotli	Charohoi	Throchi	Bialian	50	400	20	40%
Kotli	Charohoi	Throchi	Naroch Colony	80	600	36	45%
Kotli	Charohoi	Throchi	Gulpur	800	6,400	61	8%
Kotli	Kotli	Bunair	Hill Killan	80	480	29	36%
Kotli	Sensa	Ser Mandi	Kameli	15	125	12	80%
Kotli	Dulya Jattan	Rajdhani	Rajdhani	600	3,000	57	10%
Urban							
Kotli	Kotli	Kotli	Kotli city	17,656	113,000	98	1%
			Total:	**23,959**	**153,095**	**515**	**2%**

91 Population Census Organization. *District Census Report of AJK.* Islamabad: Government of Pakistan, 1998.

92 Source: http://www.tradingeconomics.com/pakistan/urban–population–growth–annual–percent–wb–data.html Accessed March 2014.

Table 5-33: Coverage of the Surveys

	Rural	Urban
Coverage of the Settlement Survey		
Total Number of Settlements in Socioeconomic Study Area	44	1
Settlements Surveyed	11	1
Settlements Surveyed as % of Total	25%	100%
Coverage of the Household Survey		
Estimated Total Population in Surveyed Settlements	40,095	113,000
Population Surveyed	2,835	630
Population Surveyed as % of Total	7%	0.5%
Estimated Total Number of Households in Surveyed Settlements	6,300	17,656
Households Surveyed	417	98
Households Surveyed as % of Total	6.6%	0.5%

Household Survey

526. In the second stage, detailed household level information was collected for the 11 selected settlements in the rural area and one settlement in the urban area. A copy of the questionnaire used is included in **Appendix C.**

527. Overall, 515 households were interviewed using household questionnaires. The household questionnaire focused on the present–day household demographics, education, health, assets, livelihood activities, and on the perceived loss in income, water quality or cultural values that could occur due to change in the flow of Poonch River water. Considering the relatively expansive total area of Kotli, settlements chosen for the household survey were scattered through the city so that a representative sample could be obtained.

5.3.3 Demography and Household Characteristics

Size of Settlements

528. As tabulated in **Table 5-32,** the size of the surveyed rural settlements varied, ranging from 15 households in the smallest settlement (Kameli) with an estimated population of 125, to 4,000 households in the largest settlement (Barali) with an estimated population of 24,000. On the average there are 573 households and 3,645 persons per rural settlement. The largest rural locality, Barali, has a population of 24,000 persons, compared to a population of 113,000 in Kotli city.

Figure 5-68: Surveyed Settlements

Household Demographics

529. **Table 5-34** gives the population breakdown for rural and urban settlements in the Socioeconomic Study Area. The average household size in Kotli District is 7.3,[93] which is equal to the estimated household size of 7.3 for the surveyed settlements.

Table 5-34: Household Size in the Surveyed Settlements

Area	No. of Settlements Surveyed	Estimated HH Size	Population Distribution
Rural	11	7.3	26%
Urban	1	6.4	74%
Surveyed Settlements	**12**	**7.0**	**100%**

Dependency Ratio

530. The dependency ratio is an age based population ratio between those typically in the working age groups that form the labor force and those in age groups that typically depend on the labor force. Dependents include children below 15 years of age and the geriatric above 65 years, and the labor force is the population between ages 15 and 65. It is expressed as the ratio of dependents to every 100 members of labor force. This may not accurately specify dependency in the population, as it does not incorporate handicapped people or cases of child labor. Dependency ratio greater than 100% shows an imbalance between the income earning members and dependents in a given population sample. The dependency ratio was estimated at 51% in rural settlements and 50% for Kotli. This indicates the presence of adequate labor–force to provide for the economically dependent. During field survey, it was observed that almost every family had at least one or two members working overseas and contributing to household expenses. This may be the reason for lower dependency ratios compared to the rest of the country. Dependency ratios for surveyed rural and urban settlements are given in **Table 5-35**.

Table 5-35: Dependency Ratio in Surveyed Households

	Rural	Urban	Overall
Below 15	874	202	1,076
15 to 64	1882	420	2,293
65 and Above	79	8	96
Dependency Ratio	**51%**	**50%**	**51%**

Sex Ratio

531. Sex ratio is defined as the number of males per 100 females. The sex ratio of the surveyed population was 115, compared to 101 for AJK as a whole, which indicates the presence of a larger male population as compared to females. This could indicate migration towards the river amongst males or a higher mortality rate amongst females.

93 Source: http://pndajk.gov.pk/glance.asp. Accessed March 2014.

Age and Gender Composition

532. The population pyramid for the surveyed rural population is given in **Figure 5-69**. The broader base of the age–pyramid indicates a younger population. The median age of the surveyed population was 22 years. The age structure shows a relatively large number of children of ages between 10 and 20 years, accounting for approximately 25% of the population. Population above 60 years was found to be only 5%, which suggests a lower life expectancy in the rural households of the Socioeconomic Study Area.

533. The age and gender composition of the urban population is shown in **Figure 5-70** and is similar to that observed in the rural areas. The median age is 22 years and a relatively large fraction of the population is children of ages between 10 and 20 years, accounting for 26% of the population. Population above 60 years was found to be only 4%, which suggests an almost equal life expectancy in comparison to the rural households of the Socioeconomic Study Area

534. Primary data collected from the field also shows a higher tendency towards in–migration than out–migration in the Socioeconomic Study Area, especially in Kotli. The migrants are mainly from Nakyal, Poonch, Bhimber, Baloch and Indian Administered Kashmir.

Figure 5-69: Age and Gender Composition of Surveyed Rural Population

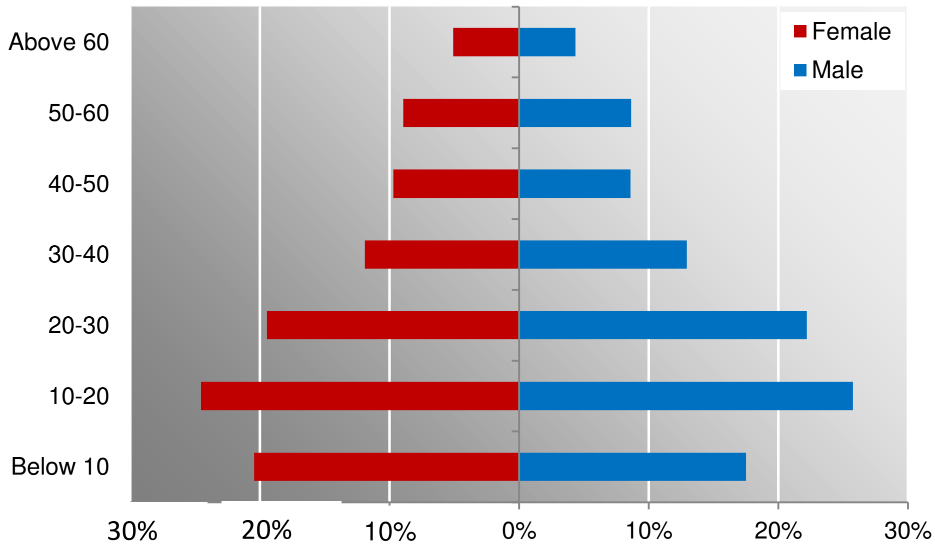
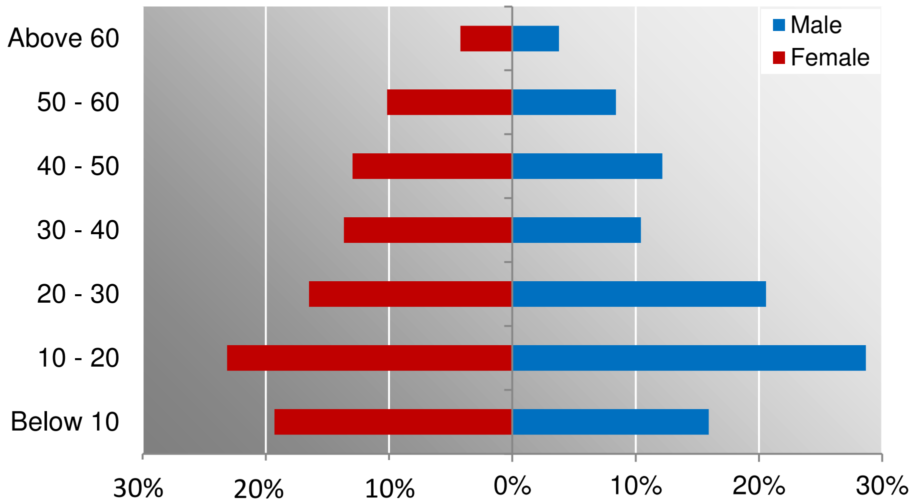


Figure 5-70: Age and Gender Composition of Surveyed Urban Population



5.3.4 Ethnicity and Religion

535. About 99% of the population of Kotli is Muslim (which includes a 2% Shia minority). The other 1% population is Christian. Almost 100% of the rural segment of the Socioeconomic Study Area's population is Muslim. Only one Christian household was seen in Gulpur.

536. The influence of spiritual leaders is widespread in the Socioeconomic Study Area. People are into saint veneration and often undertake pilgrimage to the graves of their saints. During field survey, a large number of Masjids were spotted in Kotli and the rural settlements. Some of these are shown in **Figure 5-71.**

537. Ten ethnic castes were reported in the Socioeconomic Study Area. The largest caste in Kotli is the Butt or Kashmiri caste, which form 40% of Kotli's population. In rural settlements, trend varies from village to village. Ethnic/sectarian violence does not exist in the Socioeconomic Study Area. Inter–caste marriages and other social exchanges amongst the castes are common.

538. The main languages spoken in Kotli District are Urdu and Pahari. Within the Socioeconomic Study Area, majority of the population speaks Pahari.

Figure 5-71: Mosques in the Socioeconomic Study Area

Masjid in rural area

Masjid in Kotli

5.3.5 Crime Incidence, Law Enforcement and Conflict Resolution

539. There is one City Police Station in Kotli. The area is generally peaceful. The occurrence of disputes and conflicts is minimal in the area. In the rural areas, the village *Panchayat*[94] and the spiritual leaders hold influence in resolving conflicts and maintaining peace. Most of the rural areas did not report any conflicts but stated that if a conflict were to arise, the *Panchayat* would be approached to resolve it.

5.3.6 Physical Infrastructure

540. Physical infrastructure comprises of the communication network, housing and water supply system in the Socioeconomic Study Area.

Communication Network

541. Kotli being the hub of all economic, political, religious and district government activities of Kotli District, has relatively well developed infrastructure in comparison to the other settlements in the Socioeconomic Study Area. In rural settlements, the roads are narrow and usually unpaved. Views of roads in the Socioeconomic Study Area are shown in **Figure 5-72**. Most respondents in the rural settlements of Hill Killan, Bialian, Kameli and other small settlements stated that road communication was an issue as existing roads and bridges were either unavailable or not in good condition. Kotli has one post office called the General Post Office (GPO) and two main telephone exchanges. Internet access is available in the entire socioeconomic area. Road Network in the Socioeconomic Study Area is shown in **Figure 5-73**.

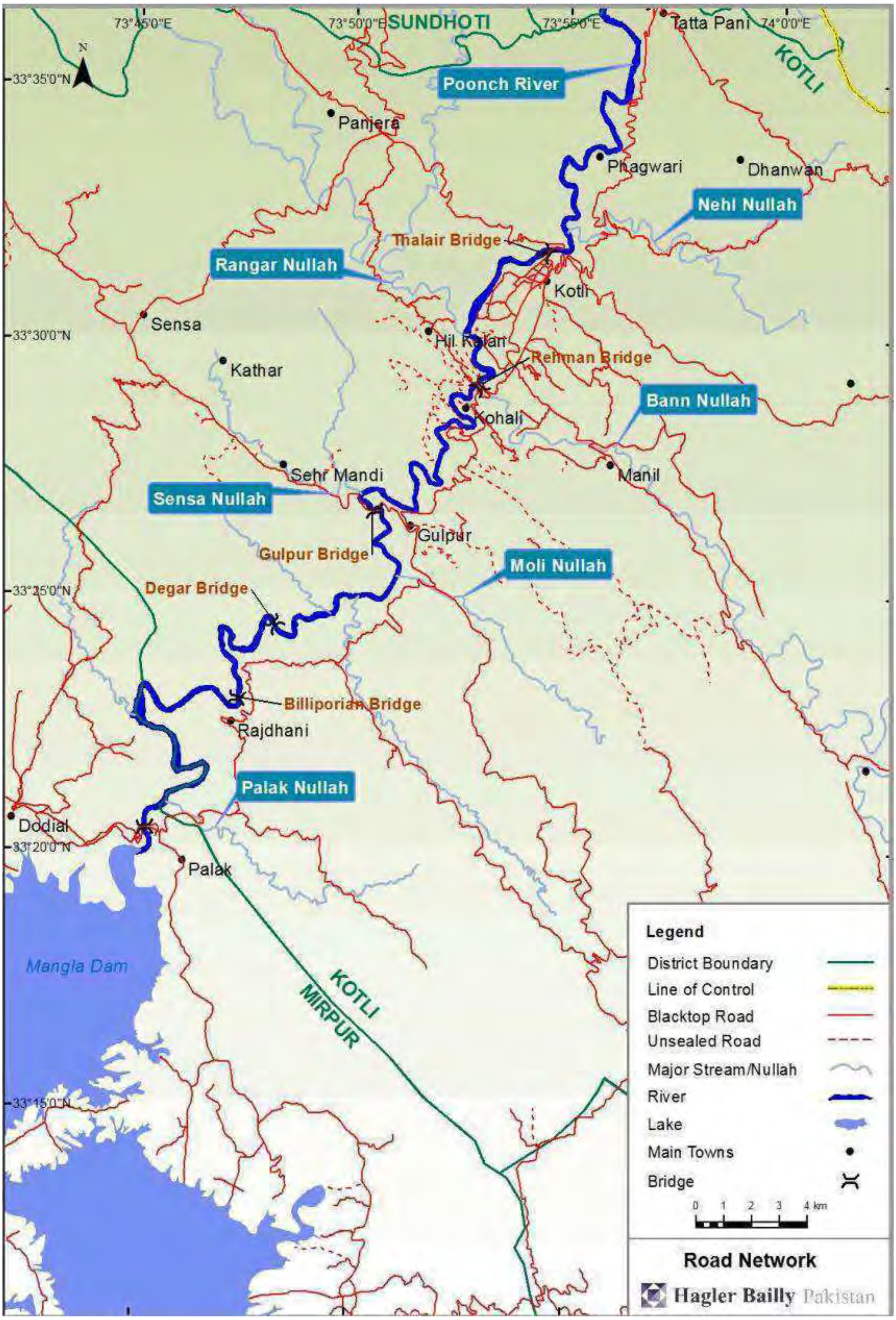
Figure 5-72: Views of Roads in Socioeconomic Study Area

View of blacktop road in Rajdhani

View of dirt road in Barali

94 Panchayat is a form of self–government, usually found in villages and small towns, which is constituted of a body of villagers (usually elderly people). In case of a village conflict, the Panchayat hears the argument of both parties and takes decision.

Figure 5-73: Road Network in the Socioeconomic Study Area



Housing

542. The majority of the surveyed rural households live in *Pakka* (masonry) houses. *Katcha* (adobe) houses, made of mud, account for 16% of the dwellings, while 84% of the houses are *Pakka* (masonry), made of bricks and concrete (**Figure 5-73**). According to the District Census Report of AJK, there are 91% masonry dwellings and 9% adobe households in Kotli (**Figure 5-74**). Photographs of the types of dwellings in rural households are shown in (**Figure 5-75**).

Figure 5-74: Surveyed Rural Households by Construction Type

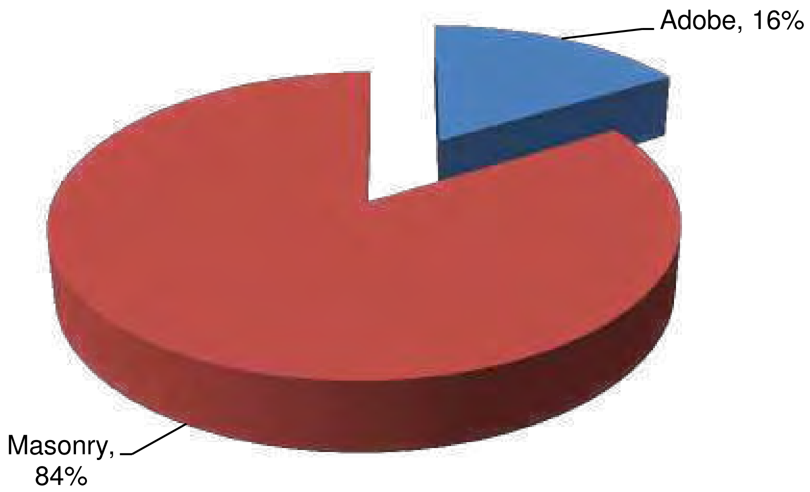


Figure 5-75: Urban Households by Construction Type

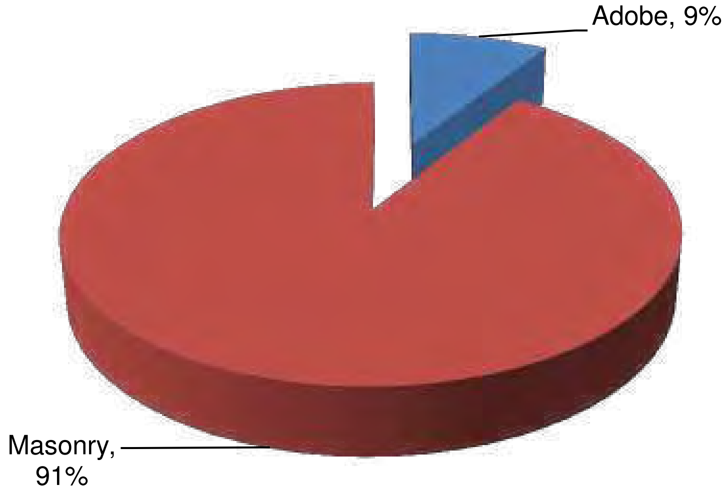


Figure 5-76: Photographs of Household Types in Rural Settlements

Masonry house in Barali

Mud house in rural area

Water Supply and Sanitation

543. The main sources of drinking water in Kotli are tap water and tube wells, while in rural settlements most common sources include tap water sourced from mountain springs, tube wells, hand pumps and groundwater wells. About 43% households have access to tap water, 42% use water from mountain springs and 16% rely on groundwater wells. Some households have more than one sources of drinking water. The distribution of drinking water supply sources in rural area is shown in **Figure 5-77** and photographs of some of the various types of drinking water systems in rural settlements are shown in **Figure 5-78**.

544. The Municipal Corporation of Kotli has provided waste disposal bins in the city however, instances of open dumping of solid waste were observed during field survey. Due to lack of proper drainage infrastructure and storm water management system, rainwater was seen to have accumulated on roads as shown in **Figure 5-78**. There is no effluent disposal and treatment system reported in the surveyed settlements. According to the findings of the field survey, pit latrine system was available in most rural areas and septic tank facility was reported in some villages.

Figure 5-77: Drinking Water Supply Sources in Rural Settlements

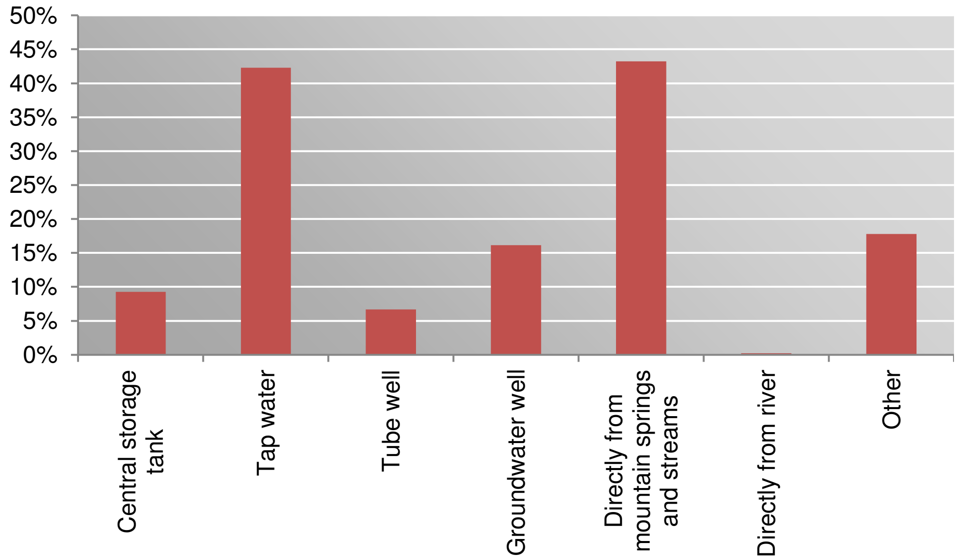


Figure 5-78: Water Supply Systems in Socioeconomic Study Area

Groundwater well in village

Water tank in Kotli

Solid waste mismanagement in Kotli

Lack of proper drainage infrastructure in Kotli

River and Drinking Water Quality

545. The Poonch River currently serves as the ultimate drain for wastewater and contaminated seepage associated with the household water use in the area. Contamination levels increase during the winter, as the capacity of the river to flush the contaminants reduces in this season. Poonch River water is used for domestic livestock and household purposes in some villages.

546. Water quality parameters of the surface/spring water which is the main source of water in the project area have been studied to evaluate its suitability for drinking purpose along with anticipated impacts of the proposed project on water environment. Twenty five water samples (composite) were collected and analyzed as per the procedure specified in standard methods for examination of water and wastewater. Representative samples from source and household use water were also taken at various points, considering its importance during project activities. To establish the ground water quality, samples major springs in nearby villages were also collected. Important physico–chemical attributes as well as microbiological parameters were analyzed for all the 25 samples collected. The results of the analysis are summarized in **Table 5-36** and **Table 5-37** and are discussed below. Chloride and Arsenic contamination results are shown in the graph in **Figure 5-79**.

547. E. coli or thermo tolerant coliform bacteria must not be detected in all water intended for drinking, but the microbiological analysis of the sample in the project area show that nearly every sample has some biological contamination. Drinking water in

Aghaar Colony and Hill Killan has highest microbial count. By and large, the water used by the communities is not suitable for drinking purposes.

548. Total dissolved solids and pH level in all samples were observed to be within normal limits. The analysis shows that hardness in all the samples ranged from 346 to 515 mg/l. Total hardness of water as $CaCO_3$ is within acceptable limits in most of the samples except for one. Chloride $(Cl)^{-1}$ and Sulfate $(SO4)^{-2}$ ranged from 19 to 132 mg/l and 20 to 171 mg/l respectively. The values are well within the permissible NEQS limits. Lead (Pb) and Arsenic (As) concentration ranged from 0.01 to 0.101 mg/l and 0.005 to 0.034 mg/l respectively for the analysis. There were four sample with lead concentration above acceptable limits and two samples with arsenic concentration above acceptable limits. Both these elements are highly toxic and carcinogenic. This indicates poor quality of water.

Table 5-36: Microbiological Contamination in Drinking Water

Parameter	Total Colony Count	Total Coli Forms	Faecal Coli Forms (E.Coli)	Faecal Streptococci/ Enterococci
Procedure	APHA: 9215 B	APHA: 9222 B	APHA: 9222 D	APHA: 9230 C
Permissible Limits	< 500 cfu / ml	0 cfu / 100ml	0 cfu / 100ml	0 cfu / 100ml
Barali Spring	$2.9x10^5$	56	41	Absent
Barali (Spring Neeara)	$4.2x10^4$	49	Absent	2
Hill Killan (Spring Water)	$1.1x10^5$	70	12	48
Hill Killan (Spring Water)	$6.2x10^4$	74	Absent	18
Hill Killan (Spring Water)	$1.4x10^5$	65	6	12
Hill Killan (Spring Water)	$1.1x10^5$	55	4	14
Hill Killan (Spring Water)	$9.5x10^4$	57	Absent	40
Hill Killan (Spring Water)	$8.3x10^4$	63	18	22
M. Asif S/O M. Sadiq (Aghaar Colony)	$2.9x10^5$	8	Absent	4
Mr. Abdullah S/O M. Hussain (Aghaar Colony)	$1.6x10^3$	2	Absent	Absent
Mr. Waseem S/O Abdul Karim (Aghaar Colony)	$2.1x10^4$	6	Absent	2
Mr. Irshad S/O M. Nazir (Aghaar Colony)	$1.7x10^5$	7	Absent	1
Mr. Afaq S/O Mr. Haider (Aghaar Colony)	$3.9x10^4$	58	Absent	Absent
Aghaar Colony	$3.9x10^4$	TNTC	Absent	16
Aghaar Colony	$4.3x10^4$	14	Absent	62
Aghaar Colony	$4.9x10^4$	TNTC	24	50
Aghaar Colony	$6.5x10^4$	TNTC	40	68
Aghaar Colony	$4.2x10^4$	TNTC	34	44
Aghaar Colony	$4.3x10^4$	TNTC	58	30

* Source, physical baseline survey, sampling, testing and analysis conducted in August 2013

Note: 'Colony Forming Unit' or CFU is the count of viable or active microorganisms in the sample that are capable of living and reproducing under proper circumstances. The term 'TNTC' implies 'Too Numerous to Count'.

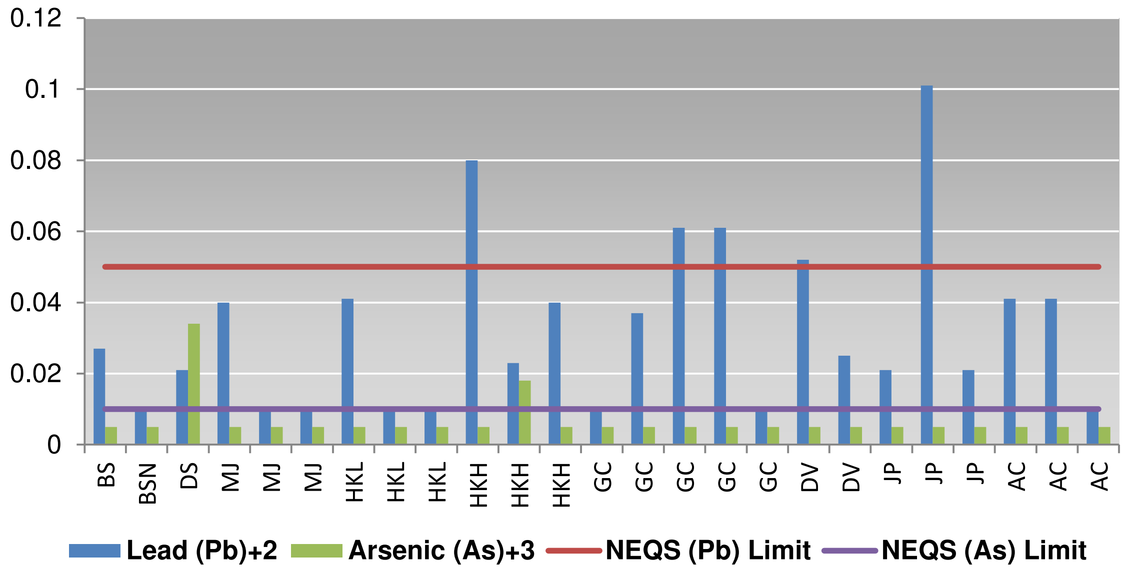
Table 5-37: Chemical Analysis of Drinking Water

Parameters	pH @ 25 °C	Solids, Total dissolved (TDS)	Hardness, Total as $CaCO_3$	Alkalinity, Total as CaCO3	Chloride $(Cl)^{-1}$	Sulfate $(SO4)^{-2}$	Lead $(Pb)^{+2}$	Arsenic $(As)^{+3}$	Total Iron as $(Fe)^{+3/+2}$	Sodium $(Na)^{+1}$	Potassium $(K)^{+1}$
Method	APHA–4500H^{+} B	AP HA–2540 C	APHA–2340 B & C	APHA–2320 B	APHA–4500Cl^{-} B	APHA–4500–SO_4 C	APHA–3111 B	APHA–3120 B	APHA–3111 B	APHA–3111 B	APHA–3111 B
Unit	–	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LDL	0.10	5	0.5	0.5	0.5	5	0.01	0.005	0.02	1	0.2
Limits As Per NEQS	6.5–8.5	<1000	<500	NS	<250	NS	≤0.05	0.01	NS	NS	NS
Barali Spring	7.66	640	406	486	19.6	41.6	0.027	< 0.005	0.03	83.8	3.87
Barali (Spring Neeara)	7.70	618	426	508	19.6	47.3	<0.01	< 0.005	0.04	83.6	3.81
Hill Killan (Spring Water)	7.72	601	485	351	44.0	56.4	0.04	< 0.005	0.03	48.2	4.80
Hill Killan (Spring Water)	7.80	580	436	340	44.0	52.3	<0.01	< 0.005	0.55	47.8	4.75
Hill Killan (Spring Water)	7.80	590	505	335	39.1	51.5	<0.01	< 0.005	0.03	47.7	4.76
Hill Killan (Spring Water)	7.45	589	485	351	44.0	46.5	0.08	< 0.005	0.02	48.5	4.78
Hill Killan (Spring Water)	7.62	866	347	362	132.1	171	0.02	0.018	0.33	191	6.36
Hill Killan (Spring Water)	7.67	602	485	351	44.0	51.5	0.04	< 0.005	0.03	47.5	4.77
M.Asif S/O M. Sadiq (Aghaar Colony)	7.57	427	346	324	29.4	27.2	<0.01	< 0.005	0.02	31.1	2.52
Mr. Abdullah S/O M. Hussain (Aghaar Colony)	7.61	410	356	313	24.5	23.9	0.04	< 0.005	0.02	31.9	2.52
Mr. Waseem S/O Abdul Karim (Aghaar Colony)	7.64	424	366	324	29.3	27.2	0.06	< 0.005	0.03	32.8	2.62
Mr. Irshad S/O M. Nazir (Aghaar Colony)	7.58	726	515	486	53.8	53.5	0.06	< 0.005	<0.02	82.1	9.28
Mr. Afaq S/O Mr. Haider (Aghaar Colony)	7.55	701	475	464	48.9	61.2	<0.01	< 0.005	0.05	81.3	8.72
Aghaar Colony	7.83	498	386	324	24.5	25.5	0.02	< 0.005	0.03	31.1	2.71

Parameters	pH @ 25 °C	Solids, Total dissolved (TDS)	Hardness, Total as $CaCO_3$	Alkalinity, Total as CaCO3	Chloride $(Cl)^{-1}$	Sulfate $(SO4)^{-2}$	Lead $(Pb)^{+2}$	Arsenic $(As)^{+3}$	Total Iron as $(Fe)^{+3/+2}$	Sodium $(Na)^{+1}$	Potassium $(K)^{+1}$
Aghaar Colony	7.52	494	406	329	24.5	22.6	0.10	< 0.005	0.03	32.3	2.71
Aghaar Colony	7.67	508	366	313	29.3	24.3	0.02	< 0.005	0.04	32.2	2.71
Aghaar Colony	7.63	508	396	324	19.6	23.9	0.04	< 0.005	0.04	33.9	2.69
Aghaar Colony	7.80	506	386	335	29.3	20.6	0.04	< 0.005	0.03	31.2	2.67
Aghaar Colony	7.81	494	386	335	24.5	23.5	<0.01	< 0.005	0.05	31.5	2.69

* Source, physical baseline survey, sampling, testing and analysis conducted in August 2013 (LDL: Lowest Detection Limit NS: Not Specified)

Figure 5-79: Lead and Arsenic Concentration in the Drinking Water



Power Supply and Fuel Consumption

549. The three major fuel sources in Socioeconomic Study Area include electricity, firewood and liquefied petroleum gas (LPG). All settlements in the Socioeconomic Study Area are connected to the national grid. In rural settlements, 95% of the surveyed population pays electricity bills while the other 5% people are either refugees who migrated to Pakistan in 1947 and were granted free electricity supply by the Government of Pakistan (GoP). Almost all of the population in rural settlements uses firewood for cooking and water heating purposes. About 53% of this population buys fuel wood from local vendors and markets while the other 47% uses wood from their own land. Average monthly bill for the three major fuel sources is given in **Table 5-38**. It can be observed that firewood and LPG are relatively costlier for users, compared to electricity. Access to natural gas is not available in AJK. **Figure 5-80** shows the wood used for domestic purposes in rural areas.

Table 5-38: Average Monthly Fuel Bill per Household in Rural Areas

Fuel Type	*Average Monthly Bill Per HH (PKR)*
Electricity	1,679
Fuel Wood	2,255
LPG	2,122

Figure 5-80: Fuel Use in Rural Areas

Firewood being used for cooking in a rural household

Firewood stored at a rural household

5.3.7 Social Infrastructure

550. Social infrastructure comprises of the health and educational service provisions in the Socioeconomic Study Area.

Health

551. There is one District Headquarter (DHQ) hospital in Kotli. Dispensary was reported in Barali settlement; and Basic Health Units (BHUs) exist in settlements of Rajdhani and Gulpur whereas smaller settlements such as Rehmani Muhallah, Kameli, and Bialian are dependent on these larger settlements or Kotli for health services. Some health facilities seen in the Socioeconomic Study Area are shown in **Figure 5-81**.

552. Most of the people in rural settlements reported that they visit Kotli, Gulpur or Barali for health care. In Kotli, most people rely on the DHQ hospital for treatment and cure. At times private doctors are also consulted.

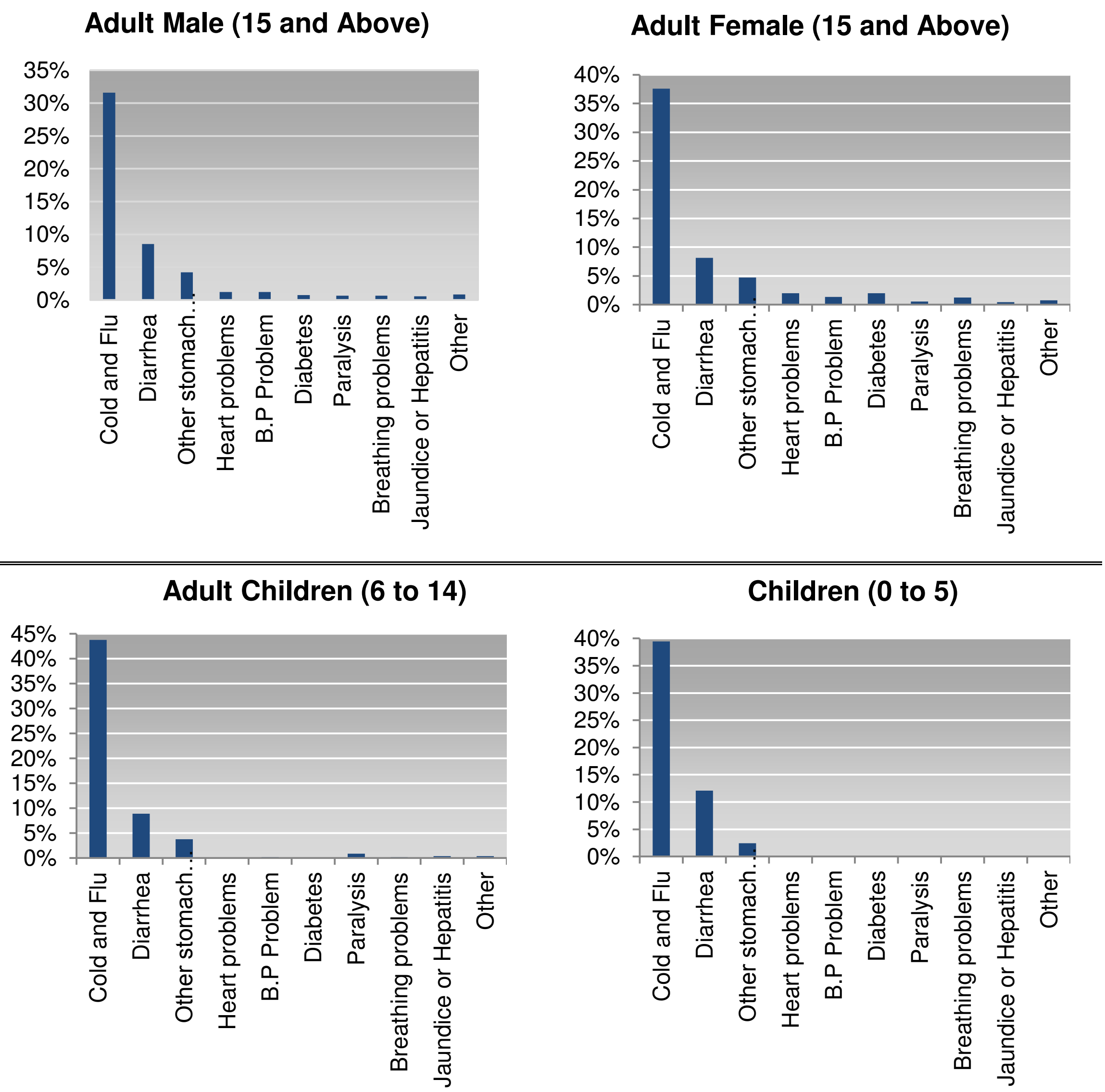
553. Common health problems identified in the rural households are shown in **Figure 5-82**. Flu and Diarrhea are the most common health problem among all age groups and gender. Some cases of stomach illnesses were reported for all age groups. Respiratory illnesses including allergies were noted in adult women.

Figure 5-81: Health Infrastructure in the Socioeconomic Study Area

District Headquarter (DHQ) Hospital in Kotli

A health center in rural area

Figure 5-82: Common Health Problems Reported in the Surveyed Rural Households (% of Respondents)



Education

554. The literacy rate refers to the ability of the population aged 10 years and above to read and write a simple message. According to 1998 census, literacy rate in AJK was 60%. The observed literacy rate in surveyed rural population was 85% in males and 61% in females (**Figure 5-83**). According to the District Census Report of AJK, the overall literacy rate in Kotli in 1998 was estimated 72.9%. Survey results showed that in Kotli, the literacy rate was 88% for men and 79% for women in Kotli. The literacy rate among women was higher in the city due to better living standards and conveniently located educational institutions. School enrolment amongst the surveyed population, as illustrated in **Figure 5-84** and **Figure 5-85** reveals that nearly 80% of the educated population in rural settlements was enrolled in primary and secondary schools, while

only 7% in higher levels[95] compared to 20% in Kotli, which indicates a high dropout at primary and middle education levels in rural areas. **Figure 5-86** shows the educational infrastructure observed in Socioeconomic Study Area.

555. Results of the settlement survey show that the number of boys enrolled at primary and middle level, is higher as compared to girls in the overall Socioeconomic Study Area.

Figure 5-83: Male–Female Literacy in Surveyed Households

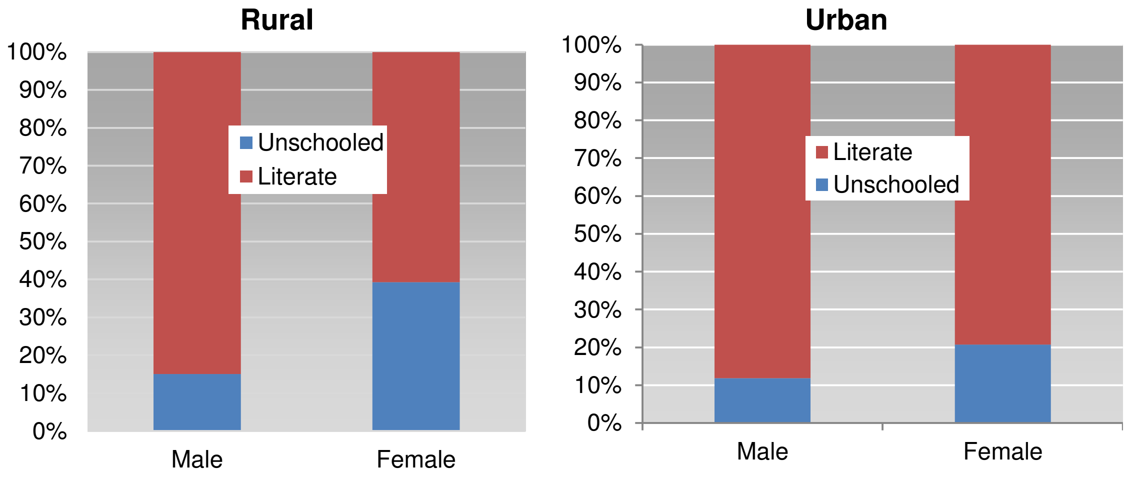
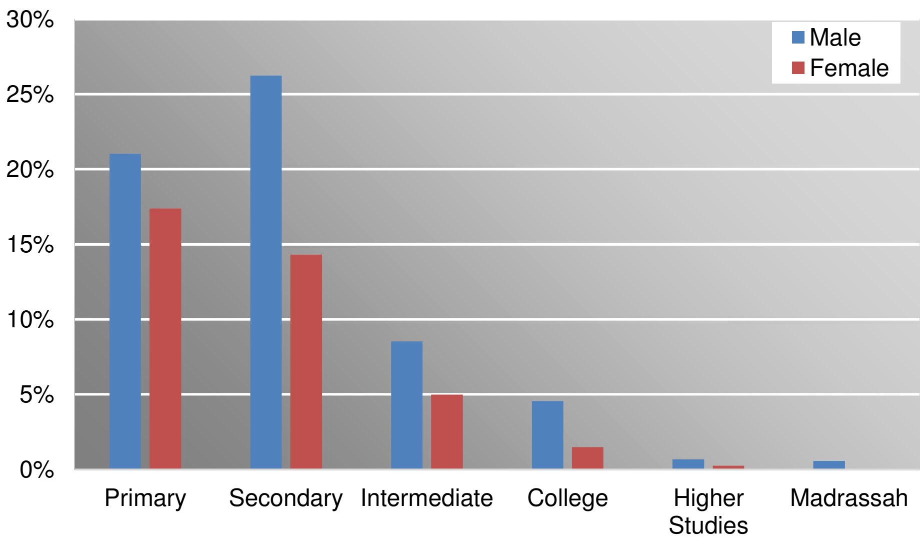
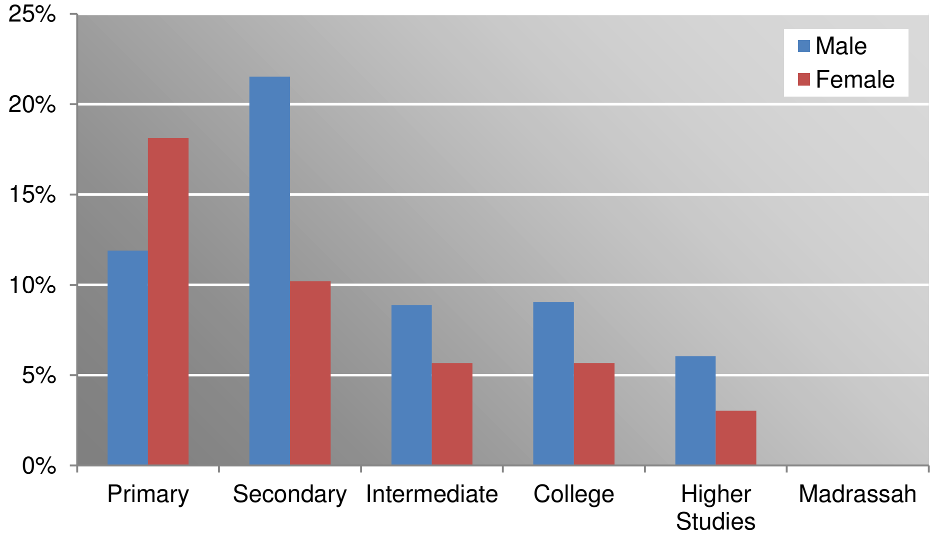


Figure 5-84: Enrolment in Rural Settlements



[95] Grade 12 and above is categorized as Higher Level studies in this report.

Figure 5-85: Enrolment in Kotli



Note: 'Others' include drivers, tailors, electricians, woodcutters or carpenters, etc.

Figure 5-86: Education Infrastructure in Socioeconomic Study Area

Government Higher Secondary School for Boys in Gulpur

Government Higher Secondary School for Girls Rajdhani

5.3.8 Economy and Income Levels

556. Economic infrastructure includes the type of occupations, household incomes and other income generating activities in the Socioeconomic Study Area.

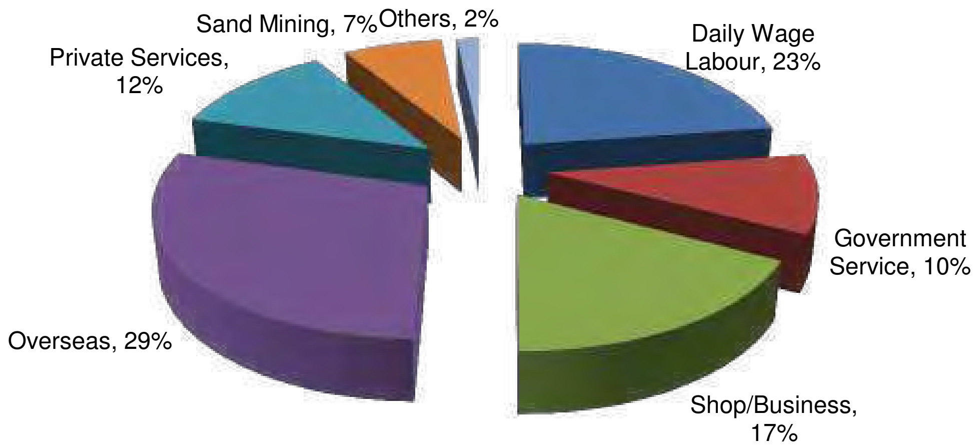
Occupation

557. **Figure 5-87** and **Figure 5-88** illustrate the occupational structure of the earning household members in the sampled population. Overseas employment constitutes the largest occupation amongst the surveyed rural population at 29%, most of which were employed in daily wage labours in countries including UK, United Arab Emirates (UAE), Dubai and Saudi Arabia (KSA). In Kotli, businesses and shop owners dominate the market. Women have limited opportunities to work outside their homes, and the share of women in the employed workforce is negligible.

558. Linkages of the people's livelihoods to the Poonch River were limited to river–based sand and gravel mining and fishing. No other subsistence level use of river–based resources was observed in the Socioeconomic Study Area.

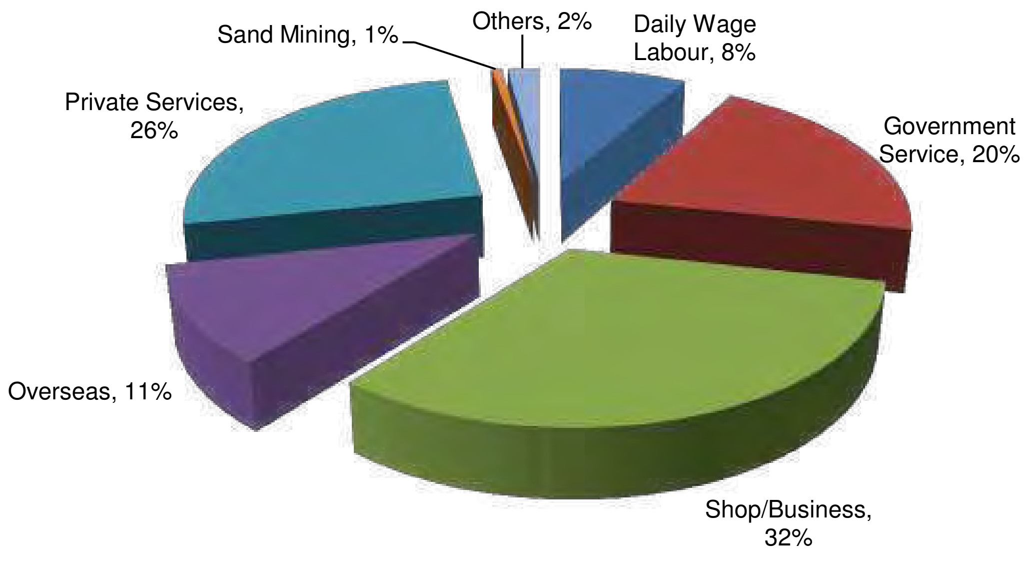
559. Compared to the urban centres in AJK such as Muzaffarabad, infrastructure and facilities available for tourism in the rural areas in Kotli are relatively limited. The main reason for this is the military conflict environment and proximity to the Line of Control (LoC).

Figure 5-87: Occupations Reported in the Surveyed Rural Population



Note: 'Others' include drivers, tailors, electricians, woodcutters or carpenters, etc.

Figure 5-88: Occupations Reported in Kotli



Note: 'Others' include drivers, tailors, electricians, woodcutters or carpenters, etc.

Household Incomes

560. **Table 5-39** shows the average number of earning members per household and income per capita observed in the surveyed households in rural settlements compared to Kotli. Mean (arithmetic average) monthly household income in rural areas was Rs 24,534 (USD 245) and in urban areas was Rs 32,075 (USD 321). The figures are relatively higher than other parts of Pakistan, especially rural settlements because a large fraction of population from the Socioeconomic Study Area worked overseas.

561. Average incomes of earners by profession are displayed in **Table 5-40**. The highest monthly income was for overseas individuals at Rs 40,551 (USD 406). A relatively higher wage profile was observed in Kotli compared to the rural settlements.

562. Agricultural activities were observed to be performed mainly for supplementing food resources and did not generate income. Linkages of the people's livelihoods to the Poonch River were limited to sand mining and fishing. No other subsistence level use of river–based resources was observed in the Socioeconomic Study Area.

Table 5-39: Monthly Household Income Profile

Zone	HH	Earner/HH	Total HH Income (Rs.)		Income (Rs.) per Capita	
			Mean	Median	Mean	Median
Rural	417	4.7	24,534	20,000	3,662	2,985
Urban	98	4.5	32,075	26,000	5,011	4,063

Table 5-40: Average Monthly Incomes by Profession

Occupation/Profession	Monthly Income (Rs.)	
	Rural	Urban
Business/Shop	24,015	26,750
Govt. Servant	22,292	36,233
Overseas	40,551	52,875
Private Servant	13,623	30,579
Daily Wage Labour	12,499	11,583
Sand Mining	24,151	50,000
Others	15,642	36,333
Overall	**24,534**	**32,075**

Sediment Mining

563. Sediment mining[96] was observed throughout the Socioeconomic Study Area (**Section 5.2.7**). Out of 417 households interviewed in 11 villages in the Socioeconomic Study Area, 28 reported engagement in sediment mining as a business. A typical

96 In this case, sediments include sand, gravel and large boulders which are mined and then crushed in stone crushing machines.

extracted load in a trolley pulled by a tractor is 150 cubic feet (cuft) or 4.3 m^3. Out of these seven transported the mined sediments to areas outside their locality. On an average, each person engaged in this activity extracted an average of 189,600 cuft per year, or 5,370 m^3 per year.[97] Applying this average on the sample Socioeconomic Study Area as a whole, total annual volume of sediment extracted in the Socioeconomic Study Area is estimated at 324,500 m^3. Assuming that sediment mining is practiced uniformly on the entire stretch of the river, total quantity of sediment extracted in the stretch of the river downstream of the LoC to the Mangla Reservoir is estimated at 434,400 m^3.

564. Sediment mining businesses were classified into large, medium and small categories. The classification of these categories is given in **Table 5-41** and the proportion of businesses falling in each of these categories is shown in **Figure 5-89**. Medium scale businesses extracting 30,000 to 50,000 cuft (930 to 1,420 m^3) of sediment per year form 39% of the total sediment mining community. About 67% of the surveyed rural population used sand and 61% used gravel for household construction and renovation purposes. Average annual household sand use reported by the surveyed rural community was 440 cuft and 320 cuft (12.5 and 9.0 m^3) gravel mostly used for renovation of house and construction of new structures. A 14% population reported that they were involved in self–mining and did not purchase sand or gravel from vendors. Average rate of sand sold by vendors in the market is approximately Rs 2,500/100 cuft (Rs 882/ m^3, or USD 8.82/ m^3) and of gravel is Rs 2,700/100 cuft (Rs 953/m^3 or USD 9.53/m^3). At this rate, the total financial value of the sediment excavated per year in entire stretch of Poonch River downstream of the LoC to the Mangla Reservoir is estimated at Rs 400 million (USD 4 million).

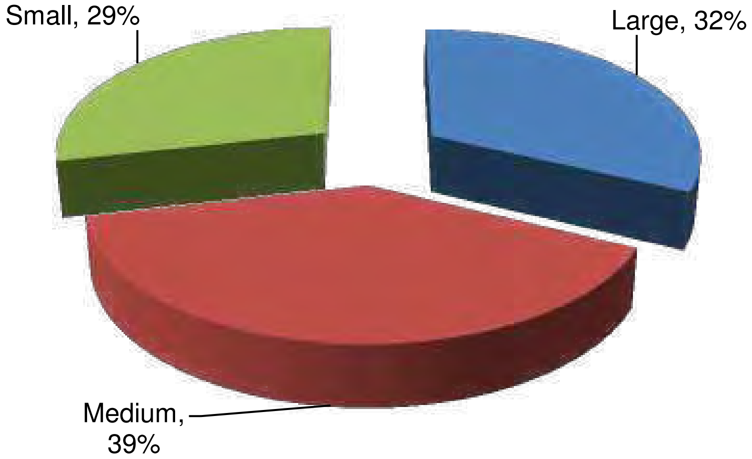
565. The mining techniques are crude, involving use of labor for sand dredging. The sand mined using shovels and spades and is loaded onto a trolley–cart and donkeys, by means of which it is transported and sold within the locality. Sand miners who own tractor trolleys transport the sand to Kotli, Nakyal, Gulpur, Rajdhani and other big settlements in the Socioeconomic Study Area.

Table 5-41: Classification of Sand Mining Business in Socioeconomic Study Area

Business Category	*Category Definition (sekras/year)*	*Category Definition (m^3/year)*
Large	0 – 300	0 – 8.5
Medium	301 – 500	8.6 – 15.5
Small	501 and above	15.6 and above

[97] Sekra is a local unit used to quantify volume. One sekra is equal to 100 cubic feet.

Figure 5-89: Sand Mining Businesses in the Socioeconomic Study Area



Fishing

566. Fish consumption was observed throughout the Socioeconomic Study Area. Out of 421 households interviewed in 11 villages in the Socioeconomic Study Area, 259 reported fish consumption from Poonch River. The most common fish consumed include Pakistan Labeo (70% of total consumption) and Mahaseer (30% of total consumption). Total quantity of fish caught from Poonch River consumed in the stretch of the river downstream of the LoC to the Mangla Reservoir is estimated at 25,000 kg per year. Market rate of fish is almost equal in summers and winters and on the average one kg of fish costs Rs 300 in the Socioeconomic Study Area. At this rate, the total financial value of the fish caught per year in entire stretch of Poonch River downstream of the LoC to the Mangla Reservoir is estimated at Rs 7.5 million (USD 75,000). Following the notification of Poonch River as a national park in 2010, the Fisheries and Wildlife Department with support from the Himalayan Wildlife Foundation has moved to establish protection and management systems and there are indications that the fish catch is gradually declining. Further details on this aspect are provided in the Biodiversity Action Plan prepared for the project.

Livestock

567. Based on field survey data, cattle are the most common livestock in rural settlements in the Socioeconomic Study Area and were observed in 64% of all households (**Figure 5-90**). In Kotli, 60% households owned poultry while 40% owned cattle. There were no established livestock markets (**Figure 5-91**). Photographs of different types of livestock seen in rural settlements are shown in **Figure 5-92**.

Figure 5-90: Livestock Ownership in Surveyed Rural Households

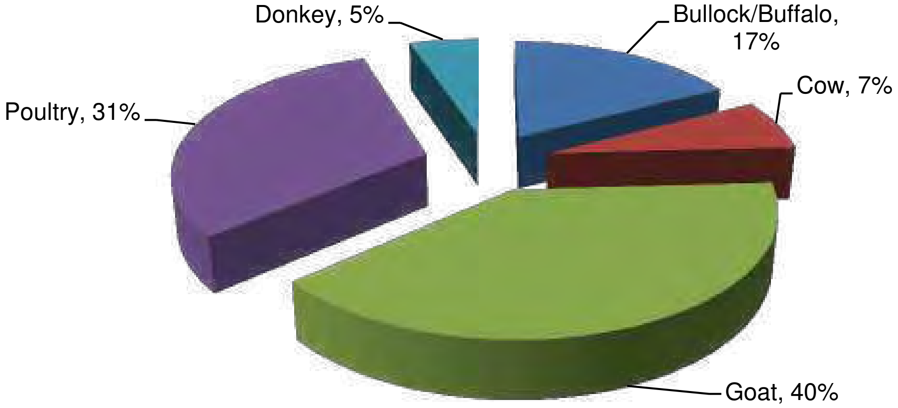


Figure 5-91: Livestock Ownership in Surveyed Urban Households

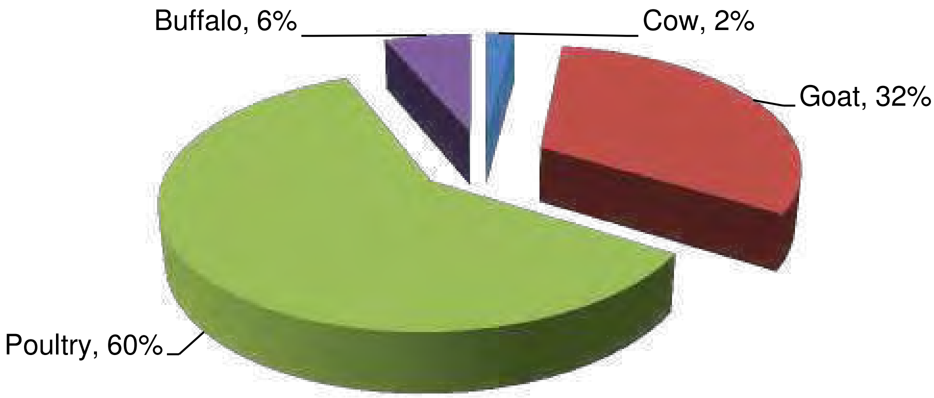


Figure 5-92: Types of Livestock in Rural Settlements

Buffalos in village area

Goat in village area

5.3.9 Recreation on the River

568. Respondents in the rural community were asked whether decrease in the flow of river will impact them in any way. 75% people responded that there will be no significant impact while 23% people said the decrease in flow will have a negative impact

(**Figure 5-93**). The most negative impact identified by the respondents included loss of recreational activities especially swimming. The most common recreation activities of the rural population on Poonch River include swimming, walking along the river banks and children playing on river banks. Occasionally, locals catch fish in the river for recreation but this activity is not frequent.

569. More than 40% respondents said that their dependence on the river is in the range of 0% to 25% and is mostly limited to recreational activities and livestock. Only 8% people reported more than 75% reliance on river in terms of livestock and recreation (**Figure 5-94**).

Figure 5-93: Effect of Change in Poonch River Flow on Recreation

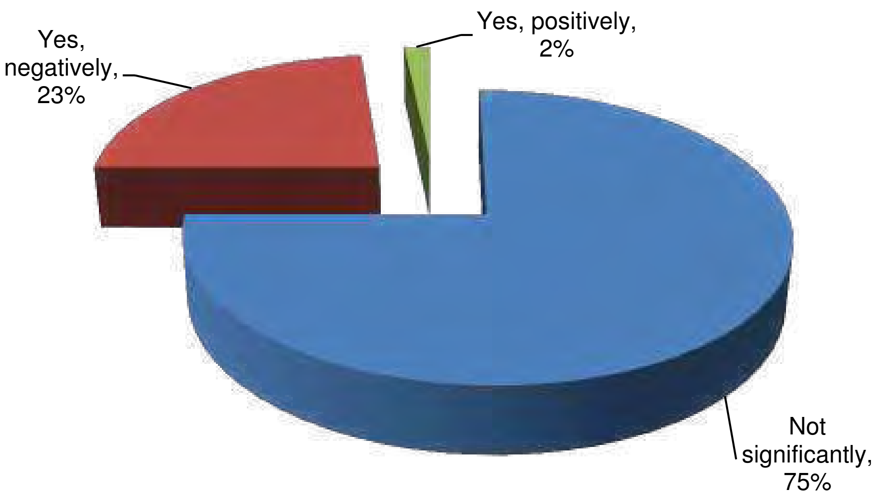
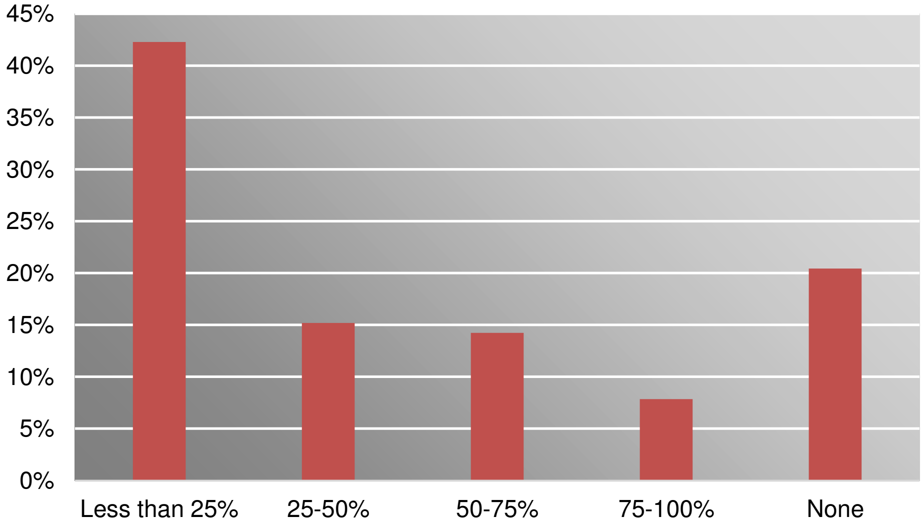


Figure 5-94: Reliance of Households on River for Recreation



6. Environmental Flow Assessment

570. This section summarizes the Impact Assessment of the Gulpur Hydropower Project (HPP) on the aquatic ecological resources of the Study Area. The specialist report on the basis of which this section has been prepared[1] (EFlow Report) is presented in **Appendix H**.

6.1 Introduction

571. Hagler Bailly Pakistan appointed Southern Waters to assist with an Environmental Flow (EFlow) assessment for the Poonch River upstream and downstream of the proposed Gulpur HPP in AJK. The objectives of the EFlow assessment were to evaluate:

- the present day condition (i.e. the present structure and functioning) of the Poonch River from upstream of Gulpur HPP to Mangla Dam; and
- how the condition of the river could change under different operational scenarios for the proposed Gulpur HPP.

572. The proposed Gulpur HPP is a run–of–the–river (RoR) type facility with a 35–m dam[2] on the Poonch River. The Draft EFlow Report[3] was prepared for Option 1 as described in (**Section 8**)**,** Analysis of Alternatives when this option was the basis of Project design. The design was later modified for both environmental and economic reasons, and Option 3 was defined as the basis of Project design. As stated in (**Section 2.1**) of the EFlow Report included in **Appendix H**, the results of simulations for Option 1 are equally applicable to Option 3 selected for the Project design for the following reasons:

- Impacts of the Project in segment of the river upstream of the dam and downstream of the powerhouse will be similar under the two options.
- The worst impacted segment of the river will be immediately downstream of the dam where the flows will be low due to diversion of the water from upstream of the dam to the power generation tunnel. The distance between the weirs under the two options is only about 7 km.
- The low flow sections under both the options are located in a single long steep reach of the river. Hydrological and land-use impacts are ubiquitous in this region and the geomorphological character of in the low flow sections under the two options are thus considered to be comparable. An analysis of the proportional representation of habitat types shows that the habitat types are similar under both options. The flow of water and the hydraulic conditions in the river under the two options are almost identical. There is no major inflow of water from tributaries in the 7 km stretch of the river between the locations of the dam under the two options.

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1 Environmental Flow Assessment Technical Report, Gulpur Hydropower Project, Southern Waters in Association with Hagler Bailly Pakistan, March 2014

2 In fact a 35–m high wall, with release structures, is a dam. We have retained the term 'dam' in line with other project literature.

3 Environmental Flow Assessment, Gulpur Hydropower Project, Summary of Draft Technical Report for Stakeholder Consultation, Southern Waters in Association with Hagler Bailly Pakistan, December 2013

6.1.1 The EFlow Assessment Process

573. DRIFT (Downstream Response to Imposed Flow Transformations) adopted for EFlow assessment is a holistic EFlow assessment approach that, in this project, was applied at the level of the Poonch River basin in Pakistan. An overview of the DRIFT methodology is provided in the EFlow Report. The objective is to describe the present condition of the river ecosystem and then, through scenarios, to predict how this could change with different design and operation of the Gulpur HPP. DRIFT was used to evaluate different water management scenarios for the Poonch River upstream and downstream of Gulpur HPP for, ***inter alia***, the following reasons:

- It is a holistic interactive method, which provides the biophysical consequences for the downstream river for various scenarios of flow change. These scenarios can then be used to determine the impact of proposed operating rules for the dam, and possible mitigation thereof.
- It is a published method, and as such is has been peer reviewed.
- It has been widely applied in the Southern African Development Community, such as Lesotho, Mozambique; Namibia, Peru, South Africa, Tanzania, Zimbabwe and Sudan. It was used as the basis of a basin–wide EFlow assessment in the Okavango River Basin (Angola, Namibia and Botswana; King and Brown 2009), and has been used in Pakistan on the Neelum–Jhellum Rivers.
- It is based on Response Curves constructed from any relevant knowledge including expert opinion and local wisdom and as such is suitable for use in regions where there are few biophysical data available for the flow–related aspects of the rivers, as was the case for the Poonch River
- It aims to provide an objective and transparent assessment of the effects of changes in flow on the downstream environment based solely on structured consideration of the biophysical aspects thereof.
- DRIFT is a data–management tool, allowing data and knowledge to be used to their best advantage in a structured way. Within DRIFT, each specialist, to derive the links between river flow and river condition, uses discipline–specific methods. The central rationale of DRIFT is that different aspects of the flow regime of a river elicit different responses from the riverine ecosystem. Thus, removal of part or all of a particular element of the flow regime will affect the riverine ecosystem differently than will removal of some other element.

6.1.2 Team

574. All of the local and international EFlow team members visited the Poonch River upstream and downstream of the proposed Gulpur HPP on the 9th and 10th November 2013. Thereafter (11th –13th November 2013), the initial population of data into the DRIFT Decision Support System was completed in a workshop situation in Islamabad. EFlow Team members are listed below in **Table 6–1**.

Table 6–1: The EFlow Team Members

Name	Organisation	Position on team
Mr Vaqar Zakaria	Hagler Bailly Pakistan	Project Director
Dr Cate Brown	Southern Waters	EFlow Task Leader
Dr Alison Joubert	Southern Waters	DRIFT DSS
Dr Mehr Ali Shah	NESPAK	Hydrology
Dr Andrew Birkhead	Streamflow Solutions	Hydraulic and scenario modeling
Dr Mohammed Rafique	Sub Hagler–Bailly Pakistan[4]	Fish ecology
Mr Mark Rountree	Fluvius Consultants	Geomorphology
Ms Fareeha Irfan Ovais	Hagler–Bailly Pakistan	Manager
Mr Mishkatullah	Sub Hagler–Bailly Pakistan	Macroinvertebrates
Mr Hussain Ali	Hagler Bailly Pakistan	Field work and data collation
Dr Jackie King	Water Matters	Quality control

6.2 EF Sites

575. The Gulpur HPP assessment concentrated on three EF Sites on the Poonch River[5] (**Figure 6–1**). The sites were selected on the basis of a catchment delineation exercise specifically considering:

- geomorphologically different river reaches;
- biological variations along the length of the river;
- different social uses of the river;
- different types and levels of impacts likely to be incurred as a result of Gulpur HPP operation; and
- access and safety.

576. The flow regimes at the EF Sites will be affected by Gulpur HPP in three main ways:

- EF Site 1 flow regime will not be affected, but the river ecosystem at this point will be affected by the barrier effect of Gulpur dam. This will stop or reduce the movement of plants and animals along the river, as explained further below.
- EF Site 2 will be affected by a decrease in river flow as a result of the upstream diversion of water into a tunnel to the power house. It will also be affected by the barrier effect of Gulpur dam, which will have consequences as mentioned

4 Subconsultant to Hagler–Bailly Pakistan

5 The Environmental Flow Assessment Technical Report covered assessment of four sites, including a Site 4 located about 20 km downstream of Site 3. The principal reason for simulating Site 4 was to assess the impact under peaking scenarios where the hydraulic wave gets buffered flowing downstream and the impact on the ecosystem due to peaking reduces. The results of simulations show that under non-peaking operation selected for this project the differences in the resulting ecosystem integrity between Site 3 and Site 4 are not discernable. A discussion on Site 4 was therefore not included in this ESIA.

above and will also alter the thermal, sediment and physicochemical regimes along the river downstream of the dam.

- EF Sites 3 will be affected by releases from the Gulpur tailrace and by the barrier effect of Gulpur dam. These two sites will be used to predict any anticipated recovery of the river ecosystem from the peaking flow releases from the tunnel.

577. The categories used to describe the Poonch River's present ecological condition are based on modification from the natural, with the natural condition seen as the reference condition (**Table 6–2**).

578. The Present Ecological Status of the sites is also provided in **Table 6–3**. In summary, the Present Ecological State of the Poonch at the EF Sites studied is mostly Category C (moderately modified from natural condition).

6.3 The Use of Indicators

579. In the DRIFT process, the hydrological simulations form the foundation upon which the biophysical and social predictions of change are built. The EFlow team chose a range of hydrological indicators, and biophysical indicators that respond to flow changes shown in **Table 6–4**.

Figure 6–1: Selected EF Sites on Poonch River

Table 6–2: Definitions of the Present Ecological State (PES) Categories

Ecological category	Description of the habitat
A	Unmodified. Still in a natural condition.
B	Slightly modified. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically / Extremely modified. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

Table 6–3: Sites for Gulpur Project EFlow Assessment

EF Site No.	*EF Site*	*Description*	*Coordinates*	*Present Ecological State*
1	Kallar Bridge	Situated upstream of the full supply level of the reservoir.	33°34'43.81"N; 73°56'05.04"E	C
2	Borali Bridge	Situated between the dam and the tailrace	33°28'20.99"N; 73°52'09.63"E	C
3	Gulpur Bridge	Situated about 7 km downstream of the tailrace.	33°26'58.25"N; 73°50'13.81"E	C

Table 6–4: Discipline Indicators Used in the DSS

Discipline	Indicators
Hydrology[6]	Mean annual runoff
	Median annual runoff
	Dry season onset
	Dry season minimum 5–day discharge
	Dry season duration
	Wet season onset
	Wet season peak 5–day discharge
	Wet season duration

6 These are the principal hydrology indicators for which the response curves for the biota were developed. The full range of hydrological indicators used in the DRIFT process are listed in EFlow Report included in **Appendix H** to this report.

Discipline	Indicators
Hydraulics	Minimum 5–day dry season fish breeding habitat[7]
	Depth
	Minimum 5–day average velocity (across the cross–section)
Geomorphology	Active channel width
	Area of silt/mixed bars (regardless of level of inundation)
	Area of cobble bars (regardless of level of inundation)
	Median bed sediment size (armouring)[8]
	Depth of pools
	Area of secondary channels and backwaters
	Suspended sediment load.
Water quality	Nutrient concentration
	Temperature
Riparian vegetation	Dry bank trees and shrubs
Algae	Periphyton biomass
Macroinvertebrates	Simuliidae
	EPT biomass
Fish	Pakistani Labeo
	Mahaseer
	Twin–banded Loach
	Kashmir Catfish
	Garua Bachwaa
	Snow Trout
Wildlife	Fish–eating wildlife (Otter, common leopard)
	Wildlife that drink from the main river (Barking deer)
	Riverine insectivores (White–capped redstart)
Management issues (non–flow related)	Selective fishing pressure
	Non–selective fishing pressure
	Mining – sand and gravel
	Mining – cobble and boulder
	Water quality

7 Fish breeding habitat was the number of meters of the cross–section where depth is between 0.25 and 0.75 m, and velocity is between 0 and 0.5 m^3s^{-1}.

8 Bed sediment type (armouring; as % of 2013):

0 surface dominated by sand and silt
15 interstitial spaces filled with sand, silt and some gravel
50 some infilling of interstitial spaces by fines
100 2013 conditions (cobble bed with open interstitial spaces, little gravel)
150 cobbles (open) and boulders
200 Boulders and bedrock
250 Bedrock channel base

580. The criteria used for selection of fish as indicator species included the conservation status of the species as determined in the IUCN Red List of Threatened Species, economic value of the species, and the extent to which the changes in the flow regime and dam as a barrier would impact the species. The Mahaseer and Kashmir Catfish are classified as Endangered and Critically Endangered in the IUCN Red List of Threatened Species, while Pakistani Labeo, Garua Bachwaa, and the Snow trout are important food fishes in the Poonch River. The Mahaseer being larger in size and spread throughout the stretch of the river in AJK would be impacted by the changes in depth of the river, particularly the riffle habitat where it breeds and feeds, and changes in depth of pools where it takes refuge in winter. The Garua Bachwaa, the Pakistani Labeo, and Snow Trout would be impacted similarly, except for the barrier effect of the dam. The Garua Bachwaa prefers warmer waters and prefers the downstream segments closer to the Mangla reservoir, while the Snow Trout prefers colder waters and prefers the upstream segments of the river. Both the fish migrate along the length of the river through the seasons as the temperature of the water changes. Both the Twin Banded Loach and the Kashmir Catfish are found through the length of the river in riffle dwelling fishes where they feed, breed, and take refuge in crevices in boulders. These fish are not migratory in nature. The Twin Banded Loach is a prized aquarium fish and is vulnerable to commercial exploitation.

581. Response curves were compiled that described the relationships between the driving (flow) and responding (biophysical) indicators. The full system of links between driver and responding indicators is a complex web of response curves within the DRIFT Decision Support System (DSS).

582. Each response curve describes the expected impact of a single type of flow or other driving change on the abundance of a single responding biophysical indicator, on a response scale of 0 (no response) to 5 (critically high response). In total, about 106 response curves were created per site for the project and housed in the custom–built Poonch River DSS. The response curves for EF Site 2 are presented in **Appendix H** of Eflow Report**.**

6.3.1 Indicators Excluded from the Calculation of the Overall Integrity Score

583. Overall ecosystem integrity is predicted for each site/scenario as a measure of how far the scenarios would move each indicator away from or back toward the natural situation. It is usually calculated as a function of all the values of all the indicators but for the Gulpur HPP project certain indicators were excluded.

- The algal indicators, because is difficult to assign a consistent score for algae that indicates whether a change in abundance is a move toward or away from natural. While small variations in the abundance algae are natural, both a large increase and a large decrease in their abundance represent a move away from natural for the system.
- The terrestrial wildlife indicators, because they have an indirect link to the river ecosystem. They may be affected by changes in the river, but also by a wide range of impacts that have little or nothing to do with the river. They were thus not considered in this study.

6.4 Construction and Selection of Scenarios

584. Operation of Gulpur HPP will result in releases down the Poonch River from the reservoir at the dam, and releases into the river from the tailrace[9] downstream of EF Site. Scenarios were constructed (see Section 4 of the EFlow Report, **Appendix H**) to assess the impact of the following independent variables:

585. Flow Scenarios: Varying levels of minimum dry season release from the dam were simulated. The minimum releases in each scenario were constant releases through the year. In addition, it was assumed that floods that cannot be harnessed by the dam will spill into the downstream river during the wet season. With the current design parameters, discharges greater than 198 cumec will result in spills from the dam.

586. Management Scenarios: (**Section 5.2.6** and **Section 5.2.7)** summarize the prevailing level of threats to the ecology of Poonch River from unregulated and illegal fishing and sediment mining practices respectively. The protection levels incorporated into the scenarios addressed these pressures on the river ecosystem that are not related to flow changes. Each scenario had a ‘protection’ (Pro) and a ‘Business as Usual (BAU) option, which referred to the influence of non–flow related impacts on the integrity of the riverine ecosystem. These impacts are related primarily to fishing and mining of sand, gravel, and boulders. ALL of the scenarios, with the exception of the No Dam options incorporated the design operating rules. Three protection levels were used:

- Protection Level 1 (Pro 1) or Moderate Protection = maintain 2013 levels of non–flow–related pressures on the river; i.e., no increase in human–induced catchment pressures over time. As described in (**Section 5.2.6)**, this level of protection corresponds to protection with limited resources and intermittent availability of funds that the AJKFWD is presently achieving with assistance from the Himalayan Wildlife Foundation. Experience from the past five years from this level of protection indicates that the fish richness and abundance has remained practically stagnant.
- Protection Level 2 (Pro 2) or Enhanced Protection = reduce 2013 levels of non–flow–related pressures by 50%, i.e., decline in pressures (relative to 2013) over time. The increase in fish abundance under this scenario will be of the order of 50%[10] over a 50 year period. The protection measures and the human and financial resources required to achieve this level of protection form the basis of the Biodiversity Action Plan included in **Appendix L**.
- Business as Usual (BAU) or Poor Protection = increase non–flow–related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years. Drawing on the discussion in (**Section 5.2.4,** Aquatic Ecological Resources), based on a literature review of long term regional trends in fish richness and abundance in absence of protection and with anthropogenic factors, fish populations over a fifty year period are expected to reach a fraction of Present Day levels with Mahaseer population declining to about 10% of Present Day level (90% decline).[11]

[9] The outlet back into the river after power generation.

[10] As shown in (**Section 6.9)**, the predicted increase in abundance of individual fish species over Present Day levels will vary somewhat above and below 50%. The reason for this is the predator-prey relationships, where increase in abundance of predator fish may lead to decline in that of the prey fish.

[11] As shown in (**Section 6.9)**, the predicted decrease in abundance of individual fish species over Present Day levels will vary above and below 90%. The reason for this is the predator-prey relationships,

587. Peaking Scenario: One scenario was assumed where the plant was operated in a peaking mode[12] where the turbines are shut down for an extended period in a day to store water the in the dam, and then released through the turbines to generate power in the peak power demand period in the evening (see **Section 8.4**, Peaking vs Non-Peaking Operation for further details).

588. Turbine Configurations and Operating Rules: Two turbine design configurations with associated operating rules were studied to account for EFlow and limitations of turbines in terms of minimum operating capacity (see **Section 8.3**, Options for Project Location and Layout for further details).

589. The EFlow assessment was conducted in the following two phases:

- **Initial Scenarios:** Ten scenarios with varying levels of EFlows were simulated in the initial phase. A constant flow through the turbines on a given day to avoid peaking was assumed for nine scenarios. A peaking scenario was simulated to assess the impact of a peaking operation on river ecology.
- **Additional Scenarios:** Ten additional scenarios with varying levels of EFlows were simulated assuming a non-peaking operation. A modified turbine configuration and corresponding operating rules were adopted to reduce impact on power generation associated with EFlow release.

6.4.1 Initial Scenarios

590. The base flow release scenarios for the EFlow study assumed average annual power generation and an average daily CONSTANT flow from the turbines (***i.e.*** no minimum cutoff discharge) and 90% turbine efficiency irrespective of the discharge passing through them. Power generation linked with each scenario was calculated using an efficiency curve for Francis turbines from the literature, where the efficiency drops sharply below a discharge ratio (actual to installed) below ***c***. 0.5. Power generation linked with each scenario was expressed as a reduction (%) from a baseline condition of zero EFlow-release.

591. There remained some uncertainties around the baseload operation of the HPP, however. The EFlow scenario modeling suggested that constant releases of c. 4, 8 or 16 cumec are not realistic given the design of Gulpur HPP as they would result in seriously sub-optimal efficiencies and would put a strain on the turbines. The design reports imply that the discharge through one of the three 33.33-MW Francis turbines could be in the range 33-66 (where 66 cumec is the installed capacity). This being the case, shut-off of the turbines for part of the day could be expected when the inflow is less than ***c.*** 33 cumec. This could then result in sudden discharge pulses from the tailrace outfall that propagate downstream. It was therefore strongly recommended that analysis of additional, more realistic, baseload scenarios be considered (see **Section 6.4.2,** Additional Scenarios).

592. For peaking flow scenarios a variable efficiency curve for the turbines was applied, with a minimum discharge ratio of 0.5 (consistent with what is inferred in the design reports: 33-66 cumec per turbine; three turbines with a maximum generation

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resistance to pollution, and differential impact of anthropogenic factors on individual species. For example, the decline will be higher in fish that have a food or recreational value.

[12] In a peaking operation the flow through the turbines is stopped during on a daily basis in the low flow months to accumulate water in the reservoir, and then released for a limited period in the day to generate power to match the period of peak demand which typically occurs in the early evening.

capacity of 198 cumec). This resulted in lower absolute power generation values than for the baseload scenarios with 90% efficiency.

6.4.2 Additional Scenarios

593. As discussed above, the preparation for the initial EFlow scenarios raised concerns as to whether or not constant EFlow releases were realistic given the design of Gulpur HPP as they would result in sub-optimal efficiencies that would put a strain on the turbines.

594. Subsequent analysis of the operation of the HPP using daily hydrology confirmed that this was the case, and led to a change in turbine selection to two 50-MW Kaplan units each with a 20 cumec minimum operating discharge (see **Section 4.2.3** and **Section 9.3**). However, at times inflows to Gulpur reservoir flows drop below 20 cumec. Thus, the turbines would have to be switched off until sufficient water was available to turn them back on. This led to a decision to explore additional scenarios that included this possibility when river flows drop below minimum turbine capacity.

595. Ten additional scenarios were evaluated for Option 3 using the DRIFT DSS set up as described in (**Section 6.4)** and EFlow Report included in **Appendix H**. The scenarios differed from one another in terms of the minimum EFlow release from the Gulpur dam, but were identical in terms of the HPP operating rules applied and/or protection level. The HPP operating rules applied are described in (**Section 4.2.5**, Turbine operating Mode and Rule).

6.4.3 Scenarios Selected for Final Assessment

596. The results of the following combination of initial and additional scenarios were used for the final EFlow assessment:

597. **Results used from Initial Scenarios:** These included No-Dam scenarios, scenarios related to Site 1, and a peaking scenario. The No-Dam DRIFT simulations were identical for the initial and additional scenarios as changing the turbine design and configuration does not apply in the No-Dam situation. The DRIFT simulations for Site 1 were also identical under the initial and additional scenarios as the changing the operating rule associated with turbine design has no impact on the conditions upstream of the dam. In case of peaking scenario, the impacts were so significant that it was considered unnecessary to repeat the scenario with an altered turbine design.

598. The following scenarios from the initial set of scenarios were therefore retained for EFlow assessment:

1. ND[13]Pro1: No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level 1.
2. NDBAU: No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level BAU.
3. NDPro2: No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level 2.
4. G8PeakBAU: An 8.0 cumec minimum release from the Gulpur dam and PEAKING-power releases at the tailrace Protection level BAU.

[13] ND = No dam; Pro 1, 2 and BAU refer to protection levels

599. **Results used from Additional Scenarios:** EFlow levels of 4, 6, 8, 12, and 16 cumec were simulated for BAU and Pro 2 protection levels. The following scenarios from the additional set of scenarios were retained for the EFlow assessment:

G4OR[14]BAU: A 4 cumec minimum release from the Gulpur dam. Protection level BAU.

G4ORPro2: A 4 cumec minimum release from the Gulpur dam. Protection Level 2.

G6ORBAU: A 6 cumec minimum release from the Gulpur dam. Protection level BAU.

G6ORPro2: A 6 cumec minimum release from the Gulpur dam. Protection Level 2.

G8ORBAU: An 8 cumec minimum release from the Gulpur dam. Protection level BAU.

G8ORPro2: An 8 cumec minimum release from the Gulpur dam. Protection Level 2.

G12ORBAU: A 12 cumec minimum release from the Gulpur dam. Protection level BAU.

G12ORPro2: A 12 cumec minimum release from the Gulpur dam. Protection Level 2.

G16ORBAU: A 16 cumec minimum release from the Gulpur dam. Protection level BAU.

G16ORPro2: A 16 cumec minimum release from the Gulpur dam. Protection Level 2.

600. To keep the number of scenarios to manageable level, Protection Level 1 and peaking scenario were not run for the additional release scenarios.

6.5 Examples of Scenario Flow Regimes

601. **Figure 6–2**: shows the ND (No-Dam) flow regime at EF Site for the first two years of the period modeled (1960–1961). These two years are fairly typical of the flow regime. **Figure 6–3** shows the same two years for the G16BAU and G16Pro2 Scenarios (minimum release of 16 m^3s^{-1}).

602. **Figure 6–4** is an example of the flow regime at EF Site 3 associated with the G16 (minimum release of 16 m^3s^{-1}) and baseload power generation. This shows the recovery to close to the No-Dam flow regime shown in **Figure 6–2:**

603. The hydrological record for the Poonch River suggests that this is a flashy system, with two periods where floods are frequent. The seasons for the EFlow assessment were:

- Dry season
- Transitional season 1 (which may incorporate some of the snow–melt season)
- Wet season (which incorporates the monsoon floods, but may also incorporate snow–melt)
- Transitional season 2

[14] OR = Operating Rule assumed for the design configuration of two Kaplan turbines.

Figure 6–2: Flows at EF Site with no Dam in Place

Average T1/Wet Season Threshold (Green Line) and Average Dry/T1 Threshold (Orange)

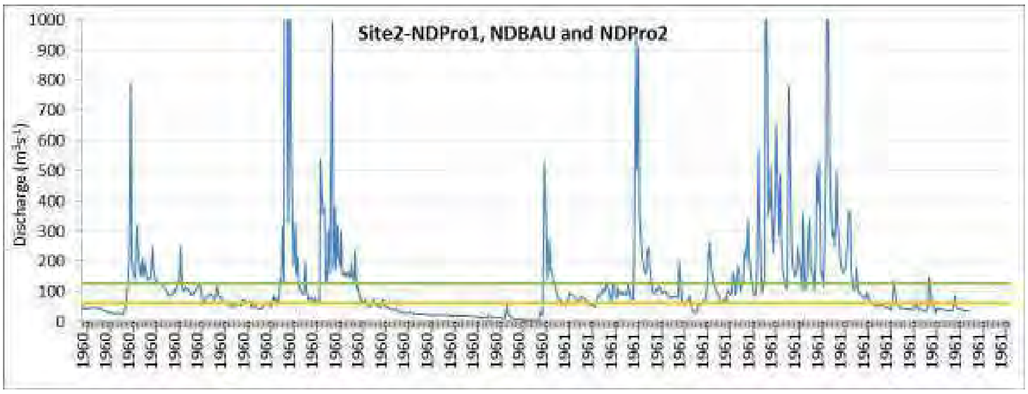


Figure 6–3: Flows at EF Site with Gulpur HPP in Place

A Dry–season Release of 16 m^3s^{-1} and Spills, with the Average T1/Wet Season Threshold (Green Line) and Average Dry/T1 Threshold (Orange)

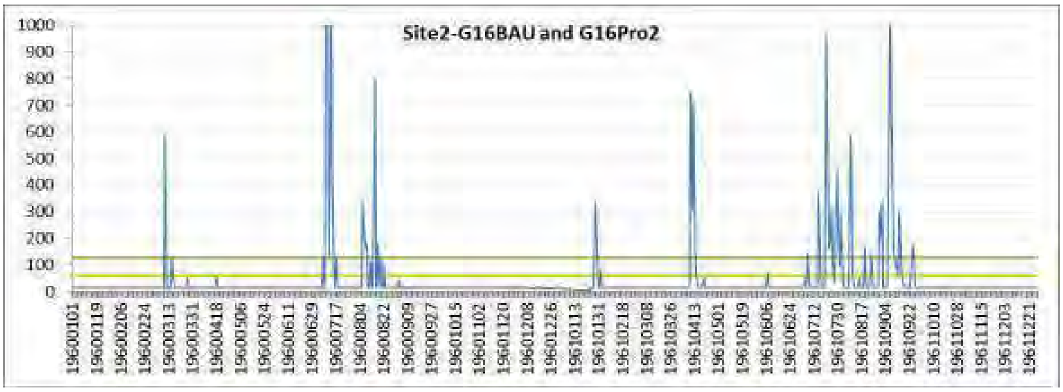
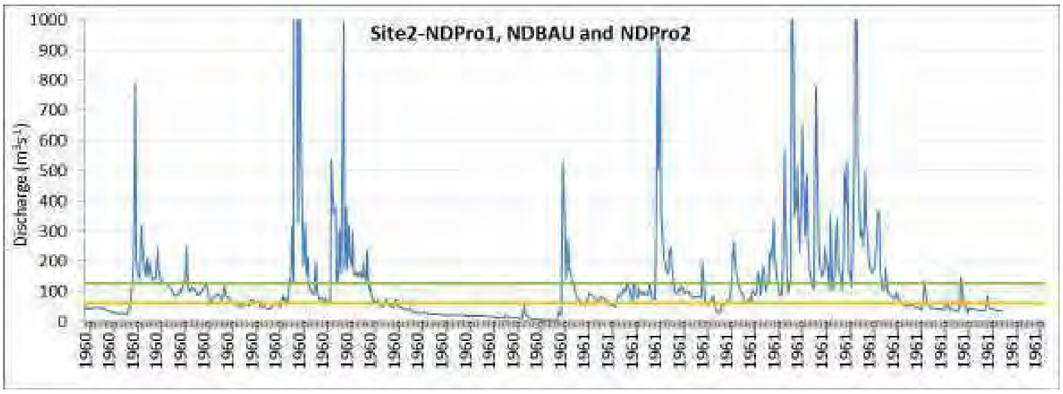


Figure 6–4: Flows at EF Site 3 with Gulpur HPP in Place

Base–load Power Production, a Dry–season Release of 16 m^3s^{-1} and Spills, with the Average T1/Wet Season Threshold (Green Line) and Average Dry/T1 Threshold (Orange)



6.6 Consideration of Non–flow Related Impacts on the Riverine Ecosystem

604. There are numerous non–flow related pressures on the Poonch River that negatively affect the ecological integrity of the system. Of these, the following were included in the DRIFT DSS:

- **River mining:** Mining of river sediment is limited by accessibility of mining locations. The locations where mining takes place are shown in **Figure 6–5**. The demand for river sediments is driven by the construction of roads (boulders and cobbles), and new homes (building sand). The expansion of the road network and increased stability and accessibility has led to increased mining activities in the last 10–20 years. The improved road network is also opening up additional areas for access for sand and cobble mining. River mining destroys aquatic habitats at the point of mining activities but also changes the size and amount of sediment that is distributed downstream, which can affect aquatic habitats in the downstream reaches. Changes to aquatic habitats as a result of mining have knock–on effects on the fish and other biota.
- **Fishing:** The preferred fishing areas comprise mainly of segments where there are pools and the relatively deeper provides refuge to the larger fish that are the preferred catch. Fishing is also limited by accessibility of locations. The locations where fishing takes place are shown in **Figure 6–5**. The impact of fishing pressure on the river ecosystem is dependent on the methods used, number of fishermen, and the location and timing of the fishing activities. In general, fishing in the tributaries, in particular during breeding migrations, is more harmful to fish populations than fishing at other locations and other times of the year. For the purposes of this study, two fishing methods have been incorporated as non–flow pressures:
    - ***Selective fishing pressure***: fishing using selective gear such as cast nets and fishing rods. This type of fishing tends to target specific species and the adult populations.
    - ***Non–Selective fishing pressure***: fishing using non–selective methods such as explosives and poisons. This type of fishing tends to result in large collateral losses of non–target fish and other species, as well as

indiscriminant loss of early life stages (fry, fingerlings, eggs and larvae). It may also cause localized habitat destruction. Gills nets have been included under non–selective fishing.

- **Nutrient enrichment:** Nutrient levels 30 years ago would have been about 23% of what they are now (using a 5% annual rate of increase based on a population growth rate of about 2%, urban growth rate of 5%, and income growth rate of about 5%). Use of products that generate nutrients are related to income growth rate. No water treatment to meet this expansion was put in place. It was assumed that if the trend continues forward at the same rate, the increase will be by a factor of 4.32 in 30 years.
- **Removal of riparian bushes and trees:** The communities cut the vegetation on the river banks and on the flood plains to meet their requirements for fuel wood and fodder. Grazing by livestock also degrades the riparian vegetation. Alien invasive species such as ***Lantana camara*** have also occupied areas that have suffered a high level of disturbance. If the past trends of usage were to continue, which is highly likely given non–availability of natural gas as household fuel and rising prices of commercial fuels such as kerosene and LPG (bottled gas), the vegetation cover along the riverbanks would be expected to reduce to half of the present levels over the next 52 years.

605. Typically fishing pressure particularly recreational fishing will taper off once the target fish populations decline to the point where the catch does not justify the effort of fishing. This phenomenon has not been included in the DSS, as there are no data available to suggest at what level this occurs at in the Poonch River.

606. For mining, these levels of protection could be achieved through redirecting mining activities to the coarse sediments trapped in the backup zone of Gulpur dam, and barring the collection of sediment for commercial uses at other sites within a 10–km radius of the backup zone of Gulpur dam. This could reduce the area affected by sediment mining in the Poonch River and its tributaries by 40–60%.

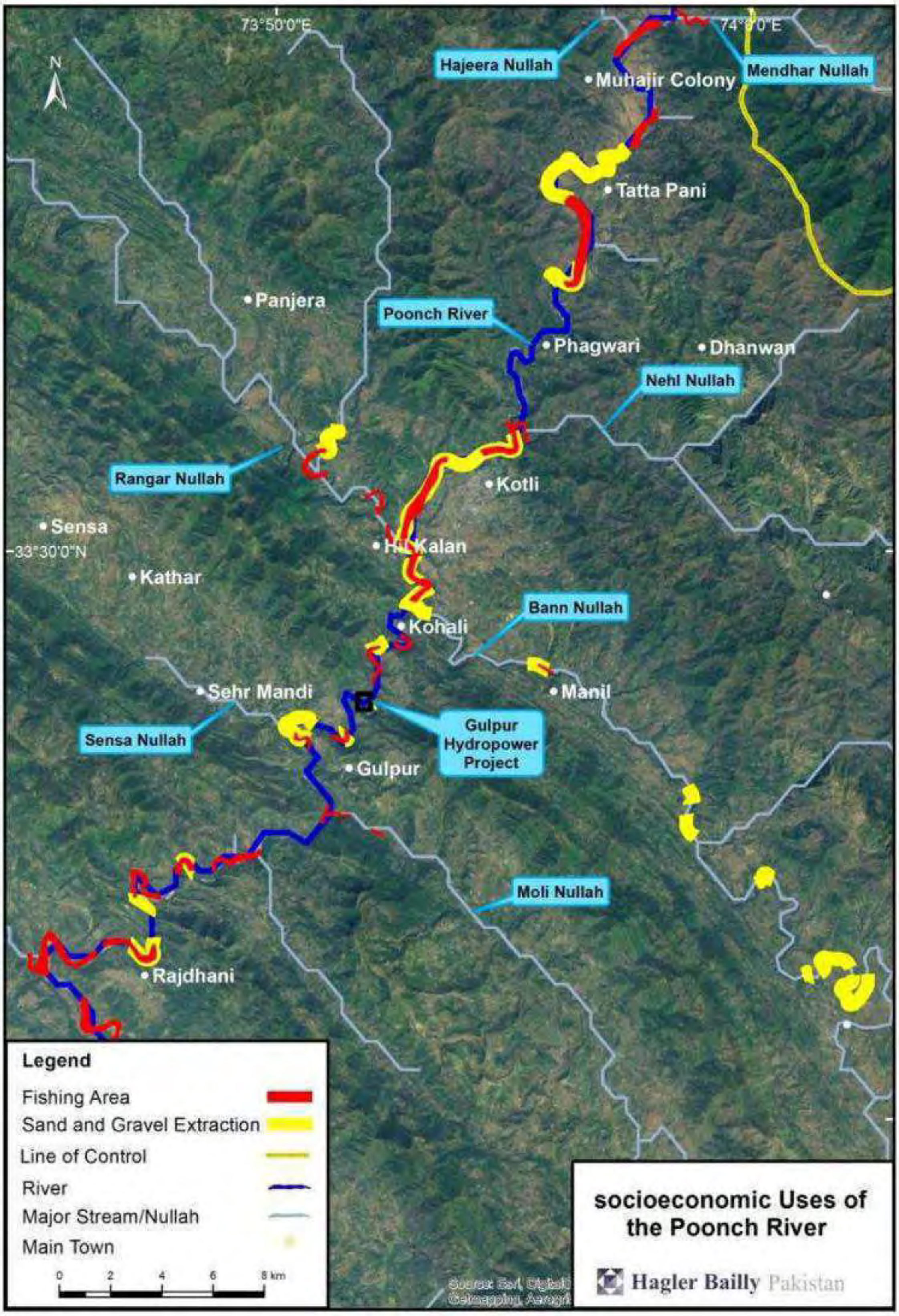
607. (and policing) all non–selective fishing, which could result in an 80–90% reduction in these activities. Fishing pressure could also be reduced by redirecting some of the selective fishing to the Gulpur reservoir, and possibly introducing feed into the reservoir to boost the fish populations.

608. For nutrients, these levels of protection could be achieved through the construction and operation of sewage effluent treatment plants, and other means of reducing the inflow of raw sewage into the rivers.

609. For bushes and trees on the banks, these levels of protection could be achieved through improved community awareness, and command and control measures to reduce harvesting in riparian areas. This is possible because, although the communities have a high level of dependence on bushes and trees for subsistence uses, the hilly terrain through which the Poonch River flows result in the river banks constituting just a small fraction of the area that the communities harvest.

610. For fishing, the named levels of protection could be achieved through banning Consideration of Barrier Effects as a Result of Gulpur Dam

Figure 6–5: Socioeconomic uses of the River



611. At 35 m, the Gulpur HPP dam will present a considerable barrier to in–channel movement of abiotic and biotic components of the river ecosystem. The abiotic components, as well as water, include sediments of different sizes (boulders, cobbles, gravel, sand, mud and silt). The biotic components include migrating fish, drifting macroinvertebrates and floating plant seeds. Of these, the following barrier effects were incorporated into the EFlow scenarios:

- Trapping of bedload and suspended sediments moving down the river.
- Barriers to fish movement between over–wintering areas in Mangla reservoir and breeding areas in the tributaries upstream of the dam (e.g., Pakistani Labeo, Mahaseer, Garua Bachwaa.
- Barriers to fish movement between over–wintering areas in the lower parts of the Poonch River and breeding areas in the upper parts of the river.
- Fragmentation of the habitat of fish resident in the Poonch River (Kashmir Catfish and twin–banded loach.

6.6.1 Sediment Trapping and Flushing

612. Estimates of the reduced bedload were developed based on the design and operation of, and catchment area affected by, Gulpur HPP, together with consideration of sediment inflows from tributaries and the availability of sediment which could be reworked and entrained from the bed and banks. The basic assumptions were:

- Sand and larger calibre sediments will settle out in the reservoir
- Clays and silts will stay in suspension.
- Peak sediment load downstream of the dam will increase in the wet season due to bottom-release flushing for sediments.

613. The estimated percentage reduction relative to 2013 conditions (**Section 7.2.9**, Assessments of Impacts on Sediment Availability) of bedload load at each of the EF Sites is provided in **Table 6–5**.

Table 6–5: The Estimated Percentage Reduction (Relative to 2013 Conditions) of Bed Load Inflows at each of the EF Sites Following Closure of Flushing

Location	*Proportion of catchment affected by dam*	*Estimated % reduction in bedload*
EF Site1	0	0
EF Site	100	90
EF Site3	98	85

614. A time-series of the suspended load was developed using observed suspended sediment measurements and the daily discharge record. Annual suspended sediment-discharge rating curves were calculated for each year of the record (**Table 6–6**), and these were used to generate a daily suspended sediment load curve. One sediment flushing scenario was considered (i.e., the sediment flushing regime is the same in all the ‘dam’ scenarios) limited to the wet season only. Due to this annual bottom–release flushing, large increases in peak wet season suspended sediment load values can be expected at EF Site. These impacts however reduce downstream due to dilution and mixing.

Table 6–6: The modelled median suspended sediment loads (PPM) at the EF sites in 2013 and, following dam closure, under scenarios releasing 4, 8 and 16 m3s-1 EF releases. Suspended sediment load peaks are italicised.

Location	***2013***	***4-m3s-1release***	***8-m3s-1release***	***16-m3s-1release***
EF Site 1	49	n/a	n/a	n/a
Max peak:	***40 000***	***n/a***	***n/a***	***n/a***
EF Site 2	76	3	5	12
Max peak:	***40 000***	***60 000***	***60 000***	***60 000***
EF Site 3	77	54	54	54
Max peak:	***40 000***	***56 000***	***56 000***	***56 000***
EF Site 4	84	72	72	72
Max peak:	***40 000***	***52 000***	***52 000***	***52 000***

6.6.2 Barrier to Fish Movement

615. The influence of the Gulpur dam and reservoir on fish populations at EF Sites 1, 2, and 3 is driven by two factors:

- The barrier presented by the dam to fish migrating upstream and downstream. It is expected that upstream migration will be halted by the dam, but that there will be some downstream movement through the spills and EFlow releases. The bulk of the tributaries of the Poonch River that are used for breeding by Pakistani Labeo, Mahaseer are located upstream of Gulpur HPP (**Appendix B,** Baseline Biodiversity Assessment Report[15]). However, fish restricted to the lower part of the Poonch River by Gulpur HPP will breed in the main river to some extent and will also migrate to breeding grounds in the tributaries downstream of Gulpur HPP (**Table 6–7)**.
- Pakistani Labeo, Snow Trout and Mahaseer will most likely colonize the reservoir, which may lead to a slight increase in their populations at EF Site1.
- Unlike Pakistani Labeo, Mahaseer, the bulk of the favored breeding sites for Garua Bachwaa are located downstream of the Gulpur dam. Garua Bachwaa is also unlikely to colonize the reservoir. Thus, it is expected that the population upstream of the dam will be compromised by the dam.

616. The Twin Banded Loach and Kashmir Catfish are non–migratory, and will not inhabit the reservoir, so any influence of the reservoir is expected to be very small, and was excluded from consideration.

617. To estimate the influence of the barrier created by Gulpur dam on the fish, the extent to which they breed at different locations was assessed. For each fish indicator, it was estimated what percentage breeds in the Jhelum River, what percentage downstream of the planned dam barrier on the Pooch River and what percentage upstream of the planned dam barrier (**Table 6–7)**. These values were used to predict the remaining population of fish at the EF Sites.

[15] HBP, November 2013, Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

Table 6–7: Estimated Percentage of Fish Populations Breeding in Different Areas

Fish	***Jhelum River***	***Poonch River, downstream of Gulpur dam***	***Poonch River, upstream of Gulpur dam***
Pakistani Labeo	40	30	30
Mahasheer	–	10	90
Garua Bachwaa	–	80	20
Snow trout	–	–	100

6.7 Incorporation of Hydraulic Data

618. Survey data of cross-sections at the Gulpur EF Sites were used to model the hydraulics of the sites and the fish hydraulic habitat available over a range of flows. The hydraulic modeling enabled hydraulic indicators (**Table 6–4**) to be inserted into the DRIFT DSS and used to estimate flow and sediment-driven changes in habitat. The data used to calculate the hydraulic indicators are presented in the Eco-Hydraulics Report included in **Appendix G**.

6.8 Biophysical Results for the Scenarios

619. For each scenario, the predicted changes were evaluated per site as:

- estimated mean percentage change from baseline[16] in the abundance, area or concentration of key indicators; and
- time–series of abundance, area or concentration of key indicators under the flow regime resulting from each scenario.

6.8.1 EF Site1 - Kallar Bridge

620. There are no flow changes at EF Site1 associated with Gulpur HPP as the site is upstream of the reservoir. However, EF Site1 will be affected by the barrier that the dam poses to, in particular, fish. For that reason two scenarios are included below: GXBAU, and GXPro 2. Under the GX scenarios EF Site1 is not affected by the releases but is affected by the presence of the dam; X = can be a 4, 8 or 16 m^3s^{-1} release.

Characteristics of the Flow Regime of Each Scenario at EF Site1

621. The main characteristics of the flow regimes EF Site1 associated with each of the scenarios are summarized in **Table 6–8**.

[16] Baseline ecological conditions are those measured in 2013.

Table 6–8: Characteristics of the Flow Regime for each Scenario at EF Site1 - Kallar Bridge

Median values are given for the flow indicators

Scenario/ EFlow indicator	Mean annual runoff	Median annual 9runoff	Dry season: Onset	Dry: Minimum 5–day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5–day discharge	Wet season: Duration
Units	***cumec***	***cumec***	***weeks***[17]	***cumec***	***days***	***weeks***	***cumec***	***days***
NDPro1	85.83		40	13.68	113.5	7	483.67	225
NDBAU	85.83		40	13.68	113.5	7	483.67	225
NDPro2	85.83		40	13.68	113.5	7	483.67	225
G4BAU	As for No Dam option.							
G4Pro2								
G8BAU								
G8PeakBAU								
G8Pro2								
G16BAU								
G16Pro2								

Mean Percentage Changes

622. The mean percentage changes (relative to baseline) for the ecosystem indicators for the scenarios at Gulpur EF Site 1 - Kallar Bridge are given in **Table 6–9**. Blue and green are major changes that represent a move towards natural: green = 40–70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40–70%; red = >70%. Baseline, by definition, equals 100%. GX = 4, 8 or 16 cumec releases (EF Site 1 is upstream of the dam, and is not affected by releases but is affected by the presence of the dam).

Table 6–9: EF Site1: Mean Percentage Changes Relative to 2013 for the Indicators

Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.

Indicators		NDPro1	NDBAU	NDPro2	GXBAU	GXBPro2
Geomorphology	Active channel width	–0.83	–0.83	–0.83	–0.83	–0.83
	Area of silt/mixed deposits	–2.81	–3.74	4.57	–3.74	4.57
	Area of cobble bars	2.26	–15.67	1.98	–15.67	1.98

[17] Weeks = calendar weeks

Indicators		NDPro1	NDBAU	NDPro2	GXBAU	GXBPro2
	Bed sediment type (armouring)	–0.75	–28.19	–2.44	–28.19	–2.44
	Depth of pools	–0.03	–17.44	–3.07	–17.44	–3.07
	Area of secondary channels and backwaters	–9.60	–10.46	–0.10	–10.46	–0.10
Water Quality	Nutrients	26.77	105.70	10.67	105.70	10.67
	Temperature	0.26	0.26	0.26	0.26	0.26
Algae	Periphyton biomass	0.98	20.72	–2.67	20.72	–2.67
Riparian vegetation	Dry bank trees and shrubs	–19.64	–35.70	27.45	–35.70	27.45
Macro–invertebrates	Simulidae	1.52	–17.19	–3.99	–17.19	–3.99
	EPT biomass	8.14	7.75	–7.81	–2.23	–14.55
Fish	Pakistani Labeo	–63.72	–86.36	61.81	–79.22	68.96
	Mahasheer	–59.81	–95.85	46.67	–80.08	79.86
	Twin–banded loach	4.33	–63.74	34.27	–83.38	23.29
	Kashmir Catfish	–2.95	–62.01	30.59	–79.92	21.46
	Garua bachwaa	–65.51	–99.02	73.14	–100.00	7.97
	Snow trout	–24.11	–40.33	19.01	–25.33	28.81
Wildlife	Fish–eating wildlife	0.00	0.00	0.00	0.00	0.00
	Wildlife water needs	–0.88	1.14	–6.68	–4.78	–11.84
	Riverine insectivores	–24.11	–40.33	19.01	–25.33	28.81

623. The values provided in **Table 6–9** are averages for the last 30 years of the record (1982–2012). This is because the influence of the management options takes ***c***. 5–10 years to take effect, and so the early part of the record can be quite different from the middle and later parts.

Discussion of Impacts

624. **Geomorphology:** There are no geomorphological changes expected at EF Site1 as a result of the presence of dam. The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in mining activities in the main channel and tributaries, which will lead to some infilling of interstitial spaces by fines relative to the 2013 condition as sand, cobbles and boulders are removed from the system. This will be accompanied by small reductions in cobble bars and slight infilling of the pools. Conversely, the protection measures associated with Pro2 should result in a decline in the current mining operations, with a concomitant coarsening of the substrate.

625. **Water Quality:** No water quality changes are predicted at EF Site1 as a result of the presence of dam. The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in the amount of nutrients

entering the river from towns and settlements in the upper catchment. The protection measures associated with Pro2 should result in decreased nutrient inflows into the system.

626. **Algae:** There are no algal changes expected at EF Site1 as a result of the presence of dam. The differences between the scenarios are driven by the two management options. The increased nutrients associated with BAU are expected to result in increased periphyton growth.

627. **Riparian Vegetation:** There are no changes in riparian vegetation expected at EF Site1 as a result of the presence of dam. The differences between the scenarios are driven by the two management options. The BAU Scenario is expected to result in an increase in the harvesting and utilization of trees and shrubs from the riparian area, whereas the Pro2 protection measures will be aimed at halving harvesting in the riparian area, which should result in an increase in the density of riparian vegetation.

628. **Macro–invertebrates**: The changes in macro–invertebrates at EF Site1 are mostly related to the differences between the management options, the most significant of which is the increase in nutrients, leading to an increase in periphyton. This affects both the habitat available for EPT and the food available for Simuliidae. Overall, however, abundances do not change noticeably from 2013 values.

629. **Fish:** The protection measures associated with Pro 2 are expected to increase fish populations at EF Site1 relative to the BAU Scenarios, where fishing pressures are expected to double. In addition, with dam in place, it is expected that, provided the water levels do not fluctuate excessively, the Pakistani Labeo, Mahaseer and Snow Trout will colonize the reservoir. This may result in an increase in these fish at EF Site1 relative to the no dam (ND) scenarios, ***viz***.: ***Mo***re fish under GXBAU than under NDBAU, and more fish under GXPro2 than under NDPro2. Garua Bachwaa is not expected to colonize the reservoir, and will also lose access to many of its favored breeding areas, which are downstream of the dam, however, there are some remaining breeding sites upstream of the reservoir, and Garua Bachwaa will benefit from the expected increase in the other fish, which it eats. The net result for Garua Bachwaa is difficult to predict, but is expected to maintain abundances similar to those in 2013 under GXPro2.

630. **Wildlife:** There are no major changes in wildlife dependent on the river for drink or those dependent on aquatic insects for food as a result of the presence of dam. The fish–eating wildlife is expected to follow similar trends to the fish, albeit at a lower magnitude of reaction.

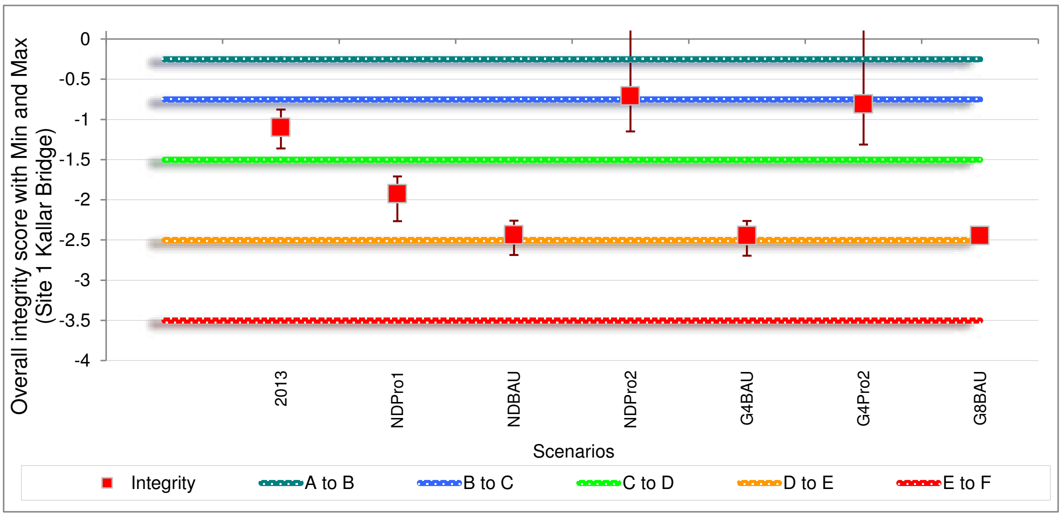
Overall Ecological Integrity

631. The Overall Ecological Integrity[18] for each scenario at EF Site1 is illustrated in **Figure 6–6**.

[18] See Section A.2.2 **Appendix H** 'Environmental Flow Assessment' for definition of Ecological Integrity.

Figure 6–6: Overall Ecosystem Integrity Scores for the Scenarios at EF Site1 - Kallar Bridge

Baseline (2013) integrity is labelled as 2013



6.8.2 EF Site – Borali Bridge

632. EF Site is located between the dam and the tailrace. As such it represents the potentially 'dewatered' or low flow zone and is directly affected by EFlow releases made at the dam. It is also affected by the barrier that Gulpur dam poses to sediments and fish, and by any immunological changes that may take place in the Gulpur reservoir, such as an increase in zooplankton, a decrease in oxygen or a change in water temperature.

Characteristics of Flow Regime

633. The main characteristics of the flow regimes at EF Site associated with each of the additional scenarios are summarized in **Table 6–10.**

Table 6–10: Characteristics of the Flow Regime of the Additional Scenarios at EF Site - Borali Bridge

Median values are given for the flow indicators

Scenario/EFlow indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	**cumec**	**weeks**[19]	**cumec**	**days**	**weeks**	**cumec**	**days**
NDPro 1	126.38	40	20.14	114	7.0	712.20	225.0
NDBAU	126.38	40	20.14	114	7.0	712.20	225.0
NDPro 2	126.38	40	20.14	114	7.0	712.20	225.0
G4ORBAU	32.62	34	4.02	201	12.5	594.52	142.5
G4ORPro 2	32.62	34	4.02	201	12.5	594.52	142.5

[19] Weeks = calendar weeks

Scenario/EFlow indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
G6ORBAU	34.50	34	6.03	201	12.5	594.72	142.5
G6ORPro 2	34.50	34	6.03	201	12.5	594.72	142.5
G8ORBAU	36.51	34	8.03	201	12.5	594.92	142.5
G8ORPro 2	36.51	34	8.03	201	12.5	594.92	142.5
G12ORBAU	40.10	34	12.03	201	12.5	595.32	142.5
G12ORPro 2	40.10	34	12.03	201	12.5	595.32	142.5
G16ORBAU	42.90	34	16.04	199	12.5	595.32	142.5
G16ORPro 2	42.90	34	16.04	199	12.5	595.32	142.5

Mean Percentage Changes

634. The mean percentage changes (relative to Baseline) for the indicators for the additional scenarios at EF Site 2 are given in **Table 6–11**. The values provided in **Table 6–11** are averages for the last 30 years of the record (1982-2012).

Discussion of Impacts

635. Geomorphology:

- The changes in geomorphology at EF Site 2 (**Section 5.1.15**) are driven by:
  - reduced bedload supply;
  - reduced suspended sediment supply for much of the year as a result of trapping of sediments in the reservoir;
  - higher peaks in suspended sediment during summer flushing, and
  - reduced flows in the dry, transitional and wet seasons, which would reduce sediment movement in the reach represented by EF Site 2.
- The overall predictions, relative to the no dam (ND) scenarios, are that channel width would decrease, with a gradual armoring of the river bed and a reduction in secondary channels and backwaters.
- The effects of the two management options (BAU and Pro 2) are overlaid on the effects of the dam, in that BAU is expected to result in a decrease in sediment size and pool depth.

Table 6–11: EF Site 2 The mean percentage changes in abundance for the Indicators under the Additional Scenarios

Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.

	Indicators	NDPro 1	NDBAU	NDPro 2	G4OR BAU	G4OR Pro 2	G6OR BAU	G6OR Pro 2	G8OR BAU	G8OR Pro 2	G12O RBAU	G12O RPro 2	G16O RBAU	G16O RPro 2
Geomorphology	Active channel width	-0.7	-0.7	-0.7	-49.7	-49.7	-48.7	-48.7	-46.1	-46.1	-28.6	-28.6	-20.3	-20.3
	Area of silt/mixed deposits	-3.2	-8.7	0.7	-14.8	-9.7	-16.6	-10.8	-17.1	-11.0	-18.2	-11.5	-20.3	-12.6
	Area of cobble bars	2.3	-15.7	1.0	-45.9	-21.7	-45.9	-21.7	-45.9	-21.7	-45.9	-21.7	-45.9	-21.7
	Bed sediment type (armouring)	-13.4	-21.1	-6.5	20.6	35.2	21.6	36.2	22.2	36.8	22.6	37.2	23.9	38.5
	Depth of pools	4.1	-7.6	3.1	-49.7	-32.2	-36.5	-19.0	-31.7	-14.3	-22.2	-4.8	-19.9	-2.5
	Area of 2o channels and backwaters	-9.6	-10.5	-0.1	-41.8	-33.8	-41.8	-33.8	-41.8	-33.8	-41.8	-33.8	-41.7	-33.7
Water Quality	Nutrients	26.8	105.7	10.7	130.2	27.3	127.5	24.6	122.5	20.2	114.5	14.7	106.7	10.1
	Temperature	0.3	0.3	0.3	-0.7	-0.7	1.0	1.0	2.8	2.8	5.1	5.1	7.1	7.1
Algae	Periphyton biomass	-1.1	9.8	-2.1	5.7	1.4	5.1	1.2	4.3	0.8	3.2	0.2	2.5	0.0
Riparian vegetation	Dry bank trees and shrubs	-19.6	-35.7	27.4	-40.3	22.8	-40.3	22.8	-40.3	22.8	-40.3	22.8	-40.3	22.8
Macro-invertebrates	Simulidae	-6.2	-10.7	-1.9	7.5	19.3	9.5	21.4	12.3	24.4	24.7	37.0	30.9	43.3
	EPT biomass	5.0	8.2	-5.7	-16.4	8.7	-15.1	6.4	-12.8	3.6	-3.5	1.5	1.2	2.4
Fish	Pakistani Labeo	-58.8	-77.0	58.1	-99.7	-26.0	-98.9	-4.5	-98.9	-1.5	-98.6	4.7	-98.0	10.5
	Mahaseer	-55.1	-92.3	51.2	-100.0	-92.9	-100.0	-90.8	-100.0	-87.1	-100.0	-60.5	-99.9	-41.5
	Twin-banded loach	-1.4	-54.4	46.5	-100.0	-90.2	-100.0	-82.8	-100.0	-78.4	-99.4	-50.1	-91.1	-13.5
	Kashmir Catfish	-8.0	-61.7	15.3	-100.0	-91.0	-100.0	-88.7	-100.0	-85.9	-99.9	-70.7	-98.4	-45.2
	Garua bachwaa	-59.5	-94.0	85.6	-95.0	-88.8	-95.0	-88.8	-95.0	-88.2	-95.0	-53.4	-95.0	-9.5
Wildlife	Fish-eating wildlife	-53.0	-84.2	37.8	-100.0	-40.1	-100.0	-12.5	-100.0	-10.9	-100.0	-7.6	-100.0	-4.6
	Wildlife water needs	0.0	0.0	0.0	-100.0	-100.0	-83.6	-83.6	-59.9	-59.9	-13.5	-13.5	0.0	0.0
	Riverine insectivores	-1.8	2.7	-5.2	-42.1	-3.1	-39.1	-5.3	-33.5	-7.1	-13.2	-7.2	-4.6	-5.4

636. **Water Quality:** There are no water quality changes expected at EF Site 2 as a result of the presence of Gulpur dam. There may be some small temperature effects associated with the releases but, provided there is no stratification in the reservoir[20], these are expected to be minor. The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in the amount of nutrients entering the river from towns and settlements in the upper catchment. The protection measures associated with Pro 2 should result in decreased nutrient inflows into the system.

637. **Algae:** The periphyton changes predicted for EF Site 2 are likely to take the form of sporadic changes in periphyton densities in response to climatic and catchment conditions (such as inflows of nutrients. It is extremely difficult to predict where, when and over what area these will occur. However, the lower flows and clearer water at EF Site 2 will increase the chance of periphyton growth.

638. **Riparian Vegetation:** The reduced flows downstream of Gulpur dam, combined with the barrier to the downstream movement of seeds, are expected to result in a small decline in riparian vegetation at EF Site 2. The main differences between the scenarios, however, are driven by the two management options. BAU is expected to result in an increase in the harvesting of shrubs and trees from the riparian area, whereas the protection measures associated with Pro 2 should result in decreased harvesting and increased density of the riparian vegetation.

639. **Macroinvertebrates:** The lower constant flows at EF Site 2 under G4, G8 and G16 are likely to favor Simuliidae, many species of which favor stable low flows. Their food source is also likely to increase slightly, through conditions that favor plankton. Simuliids could also increase in abundance with the expected decline in fine sediments and armoring of the river bed.

640. A drop in turbidity of the water column can increase primary and secondary production, which will provide more food for invertebrates (Huggins et al. 2007). The expected decline in suspended sediments will also reduce abrasion, and will favor higher populations of invertebrates. However, a slight decline in EPT is predicted related to reduction in available habitat, probably exacerbated by competition from other aquatic life such as Simuliidae.

641. **Fish**:

- The effect of Gulpur dam is related to:
  - reduced flows in the dry, transitional and wet seasons, which are expected to reduce available habitat;
  - reduction in macro-invertebrates, which are a food source for some of the fish;
  - increased periphyton, which is a food source for some of the fish; and
  - the barrier to longitudinal movement of Pakistani Labeo, Mahaseer and garua backwaa, but particularly Mahaseer, because about 90% of its breeding habitat is located upstream of the dam, and it does not breed in the Jhelum River.

[20] Given the size of the reservoir relative to inflow, and the release schedules envisaged, stratification is unlikely (NESPAK pers. comm.).

- BAU scenarios are predicted to result in extremely low number of fish at EF Site 2, regardless of whether or not Gulpur dam is present. G4-, G6-, G8-, G12- and G16ORPro 2 all result in better situations for the Pakistani Labeo than the no dam situation with no increase in current pressures (NDPro 1).
- For the remaining species, the release of 4 cumec is predicted to result in the elimination of these species from this reach or at least reduction to extremely low numbers. Releases of 6 and 8 cumec are predicted to result in very low numbers of fish in this reach, but probably no extinctions. Releases of 12 and 16 cumec, together with Protection Level 2 measures, are expected to maintain most of the fish community, albeit in reduced numbers for some. Both G12ORPro 2 and G16ORPro 2 would result in better situations for the Garua Bachwaa than the no dam situation with no increase in current pressures (NDPro 1), although the populations appear to be more susceptible to droughts and floods, i.e., lower resilience, with the reduced flows. For instance, the Pakistani Labeo population drops between 1999 and 2005 relative to the NDPro 1 and NDPro 2 options. The reason for this is that, with Gulpur in place, the wet season basically fails for this period, which means less feeding time and little or no breeding for the Labeo. A similar situation arises for Mahaseer, the loach and the Kashmir Catfish.

642. **Wildlife**:

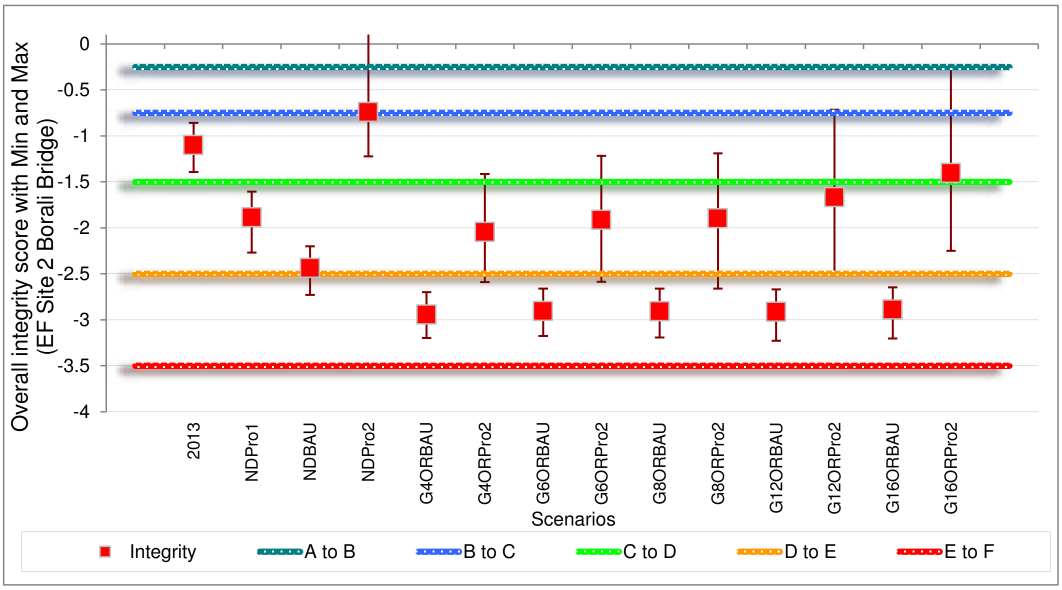
- It is expected that fish-eating wildlife, such as otter, would show very similar changes in abundance to their main food source, the fish. They would thrive under a scenario of no dam and level 2 protection measures but would likely disappear from the mainstream river in this area under the three BAU Scenarios.
- Wildlife that is dependent on the river for drinking water is likely to be deterred if flows are too low and they have to walk some distance across the exposed rocky channel. For this reason, it is predicted that G16OR and G12OR will have little or no impact on these wildlife, but G8OR and G6OR could result in a decline in their numbers, and G4OR could result in the animals seeking other water sources. The protection levels proposed do not affect these animals.
- The small insect-eating birds that rely on the river for food would decline in numbers as their food source (EPT invertebrates: mayflies, stoneflies, caddisflies) also declines. Among the scenarios that include the dam, those incorporating level 2 protection would enhance their numbers most and those that follow BAU would cause the greatest decline.

Overall Ecological Integrity

643. The Overall Integrity for each the scenarios at Gulpur EF Site 2 are illustrated in **Figure 6–7**.

Figure 6–7: Overall Ecosystem Integrity scores for the Additional Scenarios at Gulpur EF Site 2 - Borali Bridge

Baseline (2013) integrity is shown on the Extreme Left



644. In general, the additional scenarios result in slightly less impact on the downstream river ecosystem that the equivalent EFlow releases for the original scenarios. This is because, under the additional scenarios, the turbines are shutoff when flow drops below 20 cumec plus the EFlow release, so the river as represented by EF Site 2 receives more water during the direst times in the record than was the case for the original scenarios. This is particularly the case for the scenarios with higher EFlow releases, such as G12ORPro 2 and G16ORPro 2, as these releases result in higher inflows (32 and 36 cumec, respectively) at which the turbines must be switched off, and thus more frequent periods of no power generation when EF Site 2 receives the full river flow.

645. Except for G4ORPro 2, the other scenarios with Protection Level 2 or Enhanced Protection are predicted to enhance the integrity of the river ecosystem at EF Site 2 relative to 2013 condition or at least result in little change. In terms of overall health, there is little to choose from between G6ORPro and G8ORPro, both of which should maintain overall health at about 2013 levels. River health would decline under the BAU scenarios. With Gulpur dam in place, it is predicted that the condition would drop two condition classes from baseline to a highly impacted E Category.

6.8.3 EF Site3 – Gulpur Brdige

646. EF Site 3 is downstream of the Gulpur tailrace and receives the flow returning to the river after diversion downstream of EF Site 1 and passage through the power house. As modelled, the flow at EF Site 3 is essentially the same as at EF Site1. This is because the reservoir at the dam is small and cannot store much water, and also because the approved design for the dam excludes peaking hydropower releases.

647. As with the other sites, EF Site 3 is affected by the barrier that the Gulpur dam poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir or tunnel, such as an increase in zooplankton or a decrease in oxygen.

Characteristics of the Flow Regime of Each Scenario at Gulpur EF Site 3

648. The main characteristics of the flow regimes at Gulpur EF Site 3 associated with each of the scenarios are summarised in **Table 6–12.**

Table 6–12: Characteristics of the Flow Regime of the Additional Scenarios at Gulpur EF Site 3

Median values are given for the flow indicators.

Scenario/EFlow indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	**cumec**	**weeks[21]**	**cumec**	**days**	**weeks**	**cumec**	**days**
NDPro 1	128.91	40	20.55	114	7	726.46	225
NDBAU	128.91	40	20.55	114	7	726.46	225
NDPro 2	128.91	40	20.55	114	7	726.46	225
G4ORBAU	128.91	40	20.55	114	7	726.46	225
G4ORPro 2	128.91	40	20.55	114	7	726.46	225
G6ORBAU	128.91	40	20.55	114	7	726.46	225
G6ORPro 2	128.91	40	20.55	114	7	726.46	225
G8ORBAU	128.91	40	20.55	114	7	726.46	225
G8ORPro 2	128.91	40	20.55	114	7	726.46	225
G12ORBAU	128.91	40	20.55	114	7	726.46	225
G12ORPro 2	128.91	40	20.55	114	7	726.46	225
G16ORBAU	128.91	40	20.55	114	7	726.46	225

Mean percentage changes

649. The mean percentage changes (relative to Baseline) for the indicators for the scenarios at Gulpur EF Site 3 (Gulpur Bridge) are given in **Table 6–5**. The values provided in **Table 6–13** are averages for the last 30 years of the record (1982-2012). This is because the modeled influence of the management options takes c. 5-10 years to take effect, and so early part of the record can be quite different from the middle and later part.

Discussion of Impacts

650. Geomorphology:

- The changes in geomorphology at EF Site 3 are driven by:
  - Reduced bedload supply; and

[21] Weeks = calendar weeks

    - Reduced suspended sediment supply for much of the year as a result of trapping of sediments in the reservoir.

- The overall predictions, relative to the No Dam (ND) scenarios, are that channel width would remain about the same, with a gradual armoring of the river bed and a concomitant (but small) loss of cobble bars.

651. **Water Quality:** The scenarios plot according to the protection measures indicating that no major water quality changes are predicted for EF Site 3 as a result of the presence of Gulpur dam. Some changes are predicted, however, due to the two management options. The BAU Scenarios are expected to result in an increase in the amount of nutrients entering the river from towns and settlements in the upper catchment and thus higher levels in the river. The protection measures associated with Pro 2 should result in decreased nutrient inflows into the system.

652. **Algae:** The periphyton changes predicted at EF Site 3 are likely to take the form of sporadic changes in periphyton densities in response to climatic and catchment conditions (such as inflows of nutrients. Because of their ephemeral nature, it is not possible to predict where, when and over what area these will occur. However, the clearer water at EF Site 3 is expected to favor periphyton growth.

653. **Riparian Vegetation:** There are no major changes in riparian vegetation expected at EF Site 3 as a result of the presence of Gulpur dam, but differences between the scenarios are expected because of the management options. The BAU Scenario is expected to result in an increase in the harvesting and utilization of trees and shrubs from the riparian area, whereas the Pro 2 protection measures will be aimed at halving harvesting in the riparian area, which should result in an increase in the density of riparian vegetation.

654. **Macro-invertebrates:** Aquatic invertebrates would remain at approximately baseline abundances under all scenarios.

655. **Fish:** The fish species are predicted to increase in abundance, or at least maintain approximately baseline levels, under Pro2, even with Gulpur dam in place. In fact, the expected increase in some macroinvertebrates with the dam in place as a result of fewer sediments may benefit some of the fish, such as Kashmir Catfish. Under the BAU Scenarios they would decline in abundance as a result of overfishing.

656. **Wildlife:** Fish-eating wildlife at EF Site 3 are predicted to follow much the same patterns of abundance as the fish they eat., while no impacts are expected on the wildlife that depend on the rivers for water or invertebrate food.

Overall Integrity

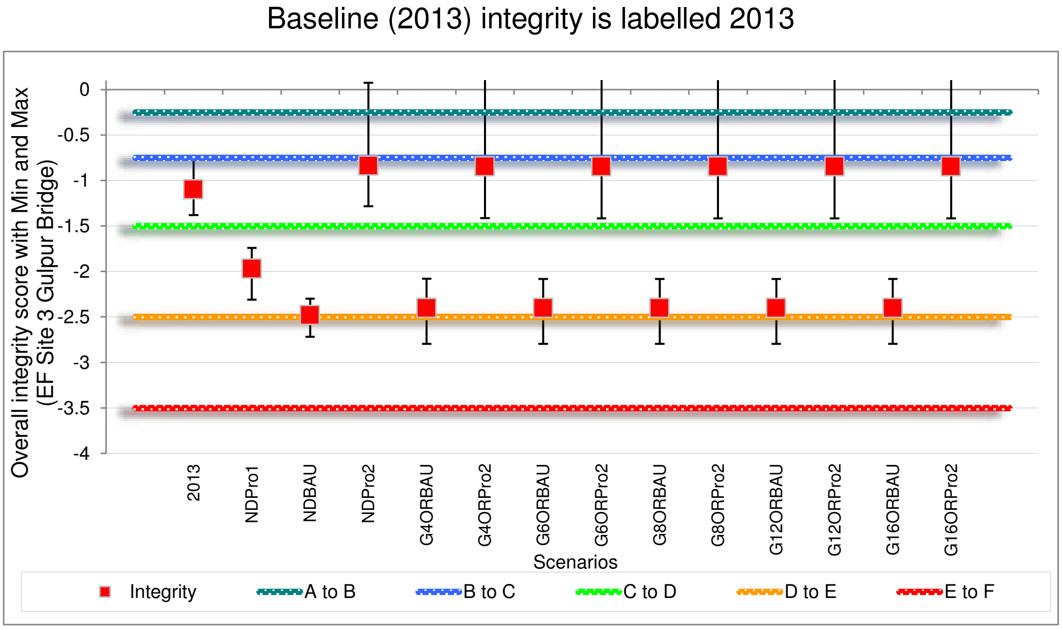
657. The Overall Integrity for each the scenarios at EF Site 3 is illustrated in **Figure 6–8**. All of the scenarios with Protection Level 2 would enhance the integrity of the river ecosystem at EF Site 3. River health would decline under Protection Level 1 or Moderate Protection and the BAU Scenarios, dropping to a Low D Category for BAU.

Table 6–13: Gulpur EF Site 3: The mean percentage changes (relative to 2013) for the Indicators under the Additional Scenarios

Blue and green are major changes that represent a move towards natural: green = 40-70% change from baseline; blue = >70%. Orange and red are major changes that represent a move away from natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.

Indicators		NDPro 1	NDBAU	NDPro 2	G4ORBAU	G4ORPro 2	G6ORBAU	G6ORPro 2	G8ORBAU	G8ORPro 2	G12ORBAU	G12ORPro 2	G16ORBAU	G16ORPro 2
Geomorphology	Active channel width	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
	Area of silt/mixed deposits	-3.3	-8.8	0.7	-10.5	-0.5	-10.5	-0.5	-10.5	-0.5	-10.5	-0.5	-10.5	-0.5
	Area of cobble bars	2.3	-15.7	2.0	-44.3	-18.5	-44.3	-18.5	-44.3	-18.5	-44.3	-18.5	-44.3	-18.5
	Bed sediment type (armouring)	-12.3	-20.0	-5.4	14.1	28.6	14.0	28.6	14.0	28.6	14.0	28.6	14.0	28.6
	Depth of pools	0.8	-10.9	1.2	-21.4	-4.0	-21.4	-4.0	-21.4	-4.0	-21.4	-4.0	-21.4	-4.0
	Area of 2o channels and backwaters	-9.2	-10.1	0.3	-15.0	-4.6	-15.0	-4.6	-15.0	-4.6	-15.0	-4.6	-15.0	-4.6
Water Quality	Nutrients	31.6	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1
	Temperature	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Algae	Periphyton biomass	-1.1	10.0	-2.1	9.8	-2.2	9.8	-2.2	9.8	-2.2	9.8	-2.2	9.8	-2.2
Riparian vegetation	Dry bank trees and shrubs	-16.6	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3
Macro-invertebrates	Simulidae	-5.6	-10.1	-1.3	6.5	17.7	6.4	17.6	6.4	17.6	6.4	17.6	6.4	17.6
	EPT biomass	5.0	7.9	-5.4	12.9	7.1	12.9	7.1	12.9	7.1	12.9	7.1	12.9	7.1
Fish	Pakistani Labeo	-59.1	-87.4	58.9	-88.5	60.8	-88.5	60.8	-88.5	60.8	-88.5	60.8	-88.5	60.8
	Mahaseer	-58.4	-94.4	51.3	-100.0	-7.7	-100.0	-7.8	-100.0	-7.8	-100.0	-7.8	-100.0	-7.8
	Twin-banded loach	-1.2	-53.3	48.2	-6.7	89.3	-6.9	89.3	-6.9	89.3	-6.9	89.3	-6.9	89.3
	Kashmir Catfish	-7.9	-62.2	19.6	-46.0	57.4	-46.1	57.3	-46.1	57.3	-46.1	57.3	-46.1	57.3
	Garua bachwaa	-60.3	-95.7	80.2	-99.0	64.4	-99.0	64.2	-99.0	64.2	-99.0	64.2	-99.0	64.2
Wildlife	Fish-eating wildlife	-53.0	-99.2	39.3	-99.4	42.0	-99.4	42.0	-99.4	42.0	-99.4	42.0	-99.4	42.0
	Wildlife water needs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riverine insectivores	-1.7	2.7	-4.5	1.2	-0.9	1.2	-0.9	1.2	-0.9	1.2	-0.9	1.2	-0.9

Figure 6–8: Overall Ecosystem Integrity Scores for the Scenarios at Gulpur EF Site 3 (Gulpur Bridge).



6.9 Conclusions of EFlow Assessment

658. This section summarizes the impact on the ecosystem integrity and survival of key fish species at three EF Sites under different EFlow scenarios. This section also summarizes the justification for the EFlow recommended for the Project to achieve a balance between environmental degradation and financial benefits. The conclusions are drawn from the analysis conducted for Additional Scenarios described in (**Section 6.4.2)** and for reasons outlined above.

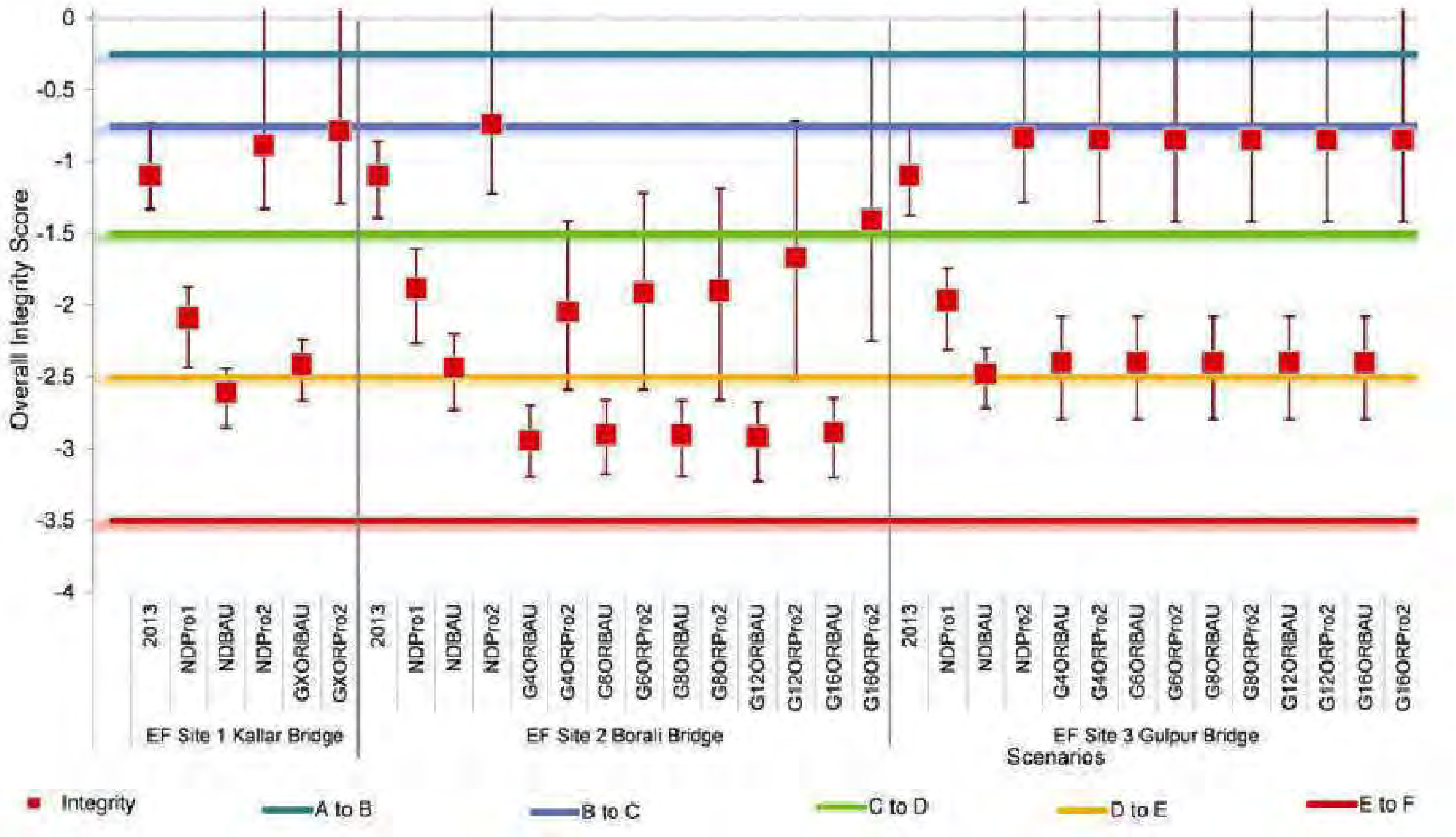
6.9.1 Ecological Integrity

659. **Figure 6–9** summarizes ecological integrity under the scenarios studied.

660. **Without Dam in Place:** With Poor Protection or Business as Usual (BAU) case, the ecosystem integrity of the river which is presently Mid Category C will deteriorate to a Low Category D over the next 52 years at all EF Sites (see **Figure 6–6, Figure 6–7,** and **Figure 6–8**), With protection at current levels (Pro1), the river will still deteriorate to a Mid Category D. An enhanced level of protection (Pro2 Management Scenario) will lead to an improvement of about 0.5 in ecological integrity score resulting in Low Category B river. The conditions are expected to change uniformly at all the sites evaluated upstream and downstream the dam.

Figure 6–9: Overall Integrity Scores for all Sites and all Scenarios

Baseline (2013) integrity is labelled 2013



With Gulpur HPP

661. **At EF Site 1 upstream of the dam inundated area:** The ecological integrity will deteriorate only slightly with dam in place compared to that under the corresponding No-Dam or No Project Scenario (see **Figure 6–6**). In other words, the effect of the dam on ecosystem integrity as felt upstream of the dam will be minimal under both the Business as Usual (BAU) and Enhanced Protection (Pro2) scenarios. The main reasons for this result is that at EF Site1 the decrease in population of fish such as Garua Bachwaa that prefer warmer waters and migrate to upstream segments in summer is compensated by increase in population of fish such as (see **Table 6–14**):

- Mahaseer that has breeding areas located mainly upstream of the dam, and
- Snow Trout which prefers cooler water and breeds in upstream reaches of the river.

662. At EF Site, just downstream of the dam:

- The flows will be reduced in the segment of the river downstream of the dam and above the powerhouse due to diversion of the river water into tunnels. The river will deteriorate to a Mid Category E under all BAU Scenarios (see **Figure 6**–7). In other words, the impact of Poor Protection will be far higher than that of the reduced flows, and increasing minimum flow release from 4 cumec to 16 cumec with Poor Protection will not result in any noticeable improvement in the ecological condition of the river.
- Under Pro2 or Enhanced Protection scenario (see **Figure 6–7**), the conditions will improve from Mid Category D with an EFlow in the range of 4-8 cumec to Low Category C with an EFlow of 16 cumec. The improvement is discernable the above 8 cumec.

663. At EF Site3, downstream of the power station:

- A peaking operation will result in deterioration to a Mid–Category E river similar to that at EF Site 2 where the flows are reduced (see **Figure 6–8**). In other words, the impact of peaking will be quite similar to that of reduced flows at EF Site 2. The river will experience only minimum flows released from the dam for a greater part of the day when the water is being stored in the dam and no flow is released from the power house.
- Under BAU or Poor Protection, the river will deteriorate to a low Category D under all minimum release scenarios, for reason similar to those indicated for EF Site.
- Under Pro2 or Enhanced Protection, the conditions will improve to border line between Category B and C, similar to those at EF Site1 upstream of the dam. In other words, the contribution of Enhanced Protection measures will more than compensate for harm done by the dam.

6.9.2 Impacts on Indicator Fish Species

664. **Table 6–14** summarizes the impacts on the indicator fish species under the scenarios evaluated. The following is an overview of the impacts of the project on the fish species selected as indicators:

Table 6–14: Impact on Indicator Fish Species under Scenarios Studied

Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.

	NDPro 1	NDBAU	NDPro 2	G8PeakBAU	G4ORBAU	G4ORPro 2	G6ORBAU	G6ORPro 2	G8ORBAU	G8ORPro 2	G12ORBAU	G12ORPro 2	G16ORBAU	G16ORPro 2
Mahaseer														
EF Site1	–60	–96	47		–80	80			–80	80			–80	80
EF Site	-55	-92	51		-100	-93	-100	-91	-100	-87	-100	-61	-100	-42
EF Site 3	-59	-94	51	-100	-100	-8	-100	-8	-100	-8	-100	-8	-100	-8
Pakistan Labeo														
EF Site 1	–64	–86	62		–79	69			–79	69			–79	69
EF Site 2	-59	-77	58		-100	-26	-99	-5	-99	-2	-99	5	-98	11
EF Site 3	-59	-87	60	-100	-89	61	-89	61	-89	61	-89	61	-89	61
Kashmir Catfish														
EF Site 1	–3	–62	31		–80	21			–80	21			–80	21
EF Site 2	-8	-62	15		-100	-91	-100	-89	-100	-86	-100	-71	-98	-45
EF Site 3	-8	-62	20	-100	-46	57	-46	57	-46	57	-46	57	-46	57
Twin–Banded Loach														
EF Site 1	4	–64	34	23	–83	23				–83			–83	23
EF Site 2	-1	-54	47		-100	-90	-100	-83	-100	-78	-99	-50	-91	-14
EF Site 3	-1	-53	48	-100	-7	89	-7	89	-7	89	-7	89	-6.9	89
Garua Bachwaa														
EF Site 1	-66	–99	73	8	–100	8				–100			–100	8
EF Site 2	-60	-94	86		-95	-89	-95	-89	-95	-88	-95	-53	-95	-9
EF Site 3	-60	-96	80	-100	-99	64	-99	64	-99	64	-99	64	-99	64
Snow Trout														
EF Site 1	–24	–40	19	29	–25	29				–25			–25	29

Mahaseer

665. **With no dam in place**, at all EFflow Sites upstream and downstream of the dam the population of Mahaseer is predicted to decline by about 95% in the next 52 years if the protection is poor under BAU Scenario. It is predicted to decline by about 58% under Pro1 Moderate Protection scenario, and improve by about 50% under Pro2 Enhanced Protection scenario. The results show that a meaningful and effective protection system is essential for recovery of this specie in the river and limited or half way efforts will not be useful in the long term.

666. **At EF Site 1 with dam in place**, the population of Mahaseer is predicted to decline by about 80% with Poor Protection under BAU Scenario. With Enhanced Protection under Pro2 Scenario, the population is predicted to improve by about 80%. The dam will benefit the population of Mahaseer at Site 1 upstream of the dam, mainly because the two important breeding areas for this fish namely Ranghar and Bann Nullahs are located upstream of the dam. The dam will act as a barrier to movement of fish downstream, and will retain the fish that breed in the nullahs. The impact of the barrier effect of the dam upstream of the dam, however, will be small in comparison to the impact of protection measures or lack thereof.

667. **At EF Site 2 with dam in place**, Mahaseer will practically be eliminated under the Poor Protection or BAU Scenario. Assuming Enhanced Protection as in Project design, a minimum release of 4 cumec from the dam is predicted to improve the conditions only marginally, with 7% of the fish surviving (decline of 93%), while a release of 8 cumec will improve the survival to 9% (91% decline). However, an increase of minimum release to 16 cumec from the dam could improve the survival of fish to 59% (decline of 41%). **It is important to note that these survival rates at EF Site 2 apply to stretch of 700m under Project design where the dam and power house are located in close proximity of each other with a short length of power tunnel**.

668. **At EF Site 3 with dam in place:** Mahaseer will again practically be eliminated under the Poor Protection or BAU Scenario. The principle reason for this is that in addition to impact of Poor Protection which is a dominant factor (decline of over 90% with Poor Protection or BAU under No-Dam scenario), the main breeding areas of Mahaseer including Bann and Ranghar Nullahs are located upstream of the dam. The barrier effect of the dam combined with Poor Protection will result in elimination of Mahaseer fish from this stretch of the river.

- With a Enhanced Protection under Pro2 Scenario, the decline of Mahaseer will be restricted to 8% of present day. Additional mitigation measures such as stocking of Mahaseer from the nursery located in Mirpur adjacent to Mangla reservoir (not included in DRIFT modeling) are proposed as a mitigation (**Section 12**, Environmental Management and Monitoring Plan) to maintain the population of Mahaseer to at least present day levels.

Pakistan Labeo

669. **With no dam in place,** Pakistan Labeo is expected to decline severely over the next 52 years, by around 80% under the BAU Scenario. With Enhanced Protection (Pro2 Scenario), its population could increase by approximately 60%.

670. **At EF Site 1 with dam in place**, the population of Pakistan Labeo is predicted to decline by about 79% with Poor Protection or BAU Scenario. With Enhanced Protection

under Pro2 Scenario, the population is predicted to improve by about 69%. The dam will benefit the population of Pakistan Labeo at Site 1 upstream of the dam, because it will act as a barrier to movement of fish downstream, and will retain the fish upstream of the dam. As in the case of Mahaseer, the impact of the barrier effect of the dam upstream of the dam, however, will be small in comparison to the impact of protection measures or lack thereof.

671. **At EF Site 2 with dam in place**, Pakistan Labeo will practically be eliminated under the Poor Protection or BAU Scenario. Under Pro2 Scenario, a minimum release of 4 cumecs from the dam is predicted to improve the conditions, with 74% of the fish surviving (decline of 26%), while a release of 8 cumecs is expected to maintain the population at present day levels. However, an increase of minimum release to 16 cumecs from the dam could improve the population of the fish to an increase of 11%. This is because the fish can breed in the main river channel and in the side streams. Moreover, increased flow during the winter season may help in successful wintering of the fish. This benefit is mainly due to availability of food (periphyton) which is the result of high nutrient concentration in water due to sewerage disposal from Kotli.

672. **At EF Site 3 with dam in place,** the population of Pakistan Labeo will reduce by about 87% under Poor Protection or BAU Scenario. With Enhanced Protection under Pro2 Scenario, it is estimated that the population of this fish will increase by about 61%. This fish is adversely affected by unregulated fishing, which is the reason it benefits from Enhanced Protection under all minimum release scenarios.

Kashmir Catfish

673. **With no dam in place,** Kashmir Catfish population is expected to decrease by around 60% under Poor Protection or BAU Scenario. However, the population is predicted to increase by about 20% under Pro2 Scenario. The highest increase in population is expected at Site 1, followed by Site 3 and 2, the differences being attributable to habitat conditions prevailing at the sites. Its population will remain relatively unaffected under present level of protection or Pro1 scenario.

674. **At EF Site 1 with dam in place,** the population is expected to decrease significantly by around 80% under the BAU Scenario. However, under Pro2 Scenario, the fish population is predicted to increase by about 21%. The Kashmir Catfish does not benefit from Enhanced Protection as much as the Mahaseer and Pakistan Labeo as it is not a target of subsistence or recreational fishing, and can take refuge in the crevices in the boulders where it is less likely to be captured by netting.

675. **At EF Site 2 with dam in place**, Kashmir Catfish fish will practically be eliminated under the Poor Protection or BAU Scenario. Under the Pro2 Scenario, a minimum release of 4 cumec from the dam is predicted to improve the conditions only marginally, with 9% of the fish surviving (91% decline), while a release of 8 cumec will improve the survival to 14% (86% decline). However, an increase of minimum release to 16 cumec from the dam could improve the survival of fish to 55% (decline of 45%). Being smaller in size, this fish benefits more from low flows due to increase in habitat availability. It also benefits from absence of bigger predators such as Mahaseer which do not benefit as much from increasing flows.

676. **At EF Site 3 with dam in place,** the decline in fish population is expected to be 46% with Poor Protection under the BAU Scenario. This affect is relatively lower in comparison to that on the Mahaseer because at EF Site 3 the fish benefits from the lower predation associated with decline in population of Mahaseer. Under Pro2

Scenario, the fish population is expected to rise by 57% which is a significant increase. The fish will be eliminated under the Peaking Scenario due to instability in the flows and daily reduction in habitat.

Twin-Banded Loach

677. **With no dam in place,** the population of twin–banded loach is expected to decrease by about 60% depending on the location in the river under BAU Scenario. With Enhanced Protection (Pro2 Scenario), the fish population is predicted to improve by about 40% in the next 52 years. Its population will remain relatively unchanged under the current or Moderate Protection or Pro1 Scenario.

678. **At EF Site 1 with dam in place,** the population is predicted to decrease significantly by around 83% under BAU Scenario. With Enhanced Protection (Pro2 Scenario) the population is estimated to increase by around 23%. The dam will adversely impact the population of this fish at this upstream location. The main reason for this is the increase in population of Mahaseer which predates on this fish.

679. **At EF Site 2 with dam in place**, with low flows this fish will practically be eliminated with Poor Protection under the BAU Scenario. Under the Pro2 Scenario, a minimum release of 4 cumec from the dam is predicted to improve the conditions only marginally, with 11% of the fish surviving (decline of 89%), while a release of 8 cumec will improve the survival to 20%. However, an increase of minimum release to 16 cumec from the dam could improve the survival of fish to 93% (decline of 7%). As in case of Kashmir Catfish, being smaller in size this fish benefits more from higher flows at this site due to increase in habitat. It also benefits from absence of bigger predators such as Mahaseer which do not benefit as much from increasing flows.

680. **At EF Site 3 with dam in place,** the population of twin banded loach is expected to benefit from the dam like the Kashmir Catfish. Under BAU Scenario the population of twin–banded loach is expected to decline by 7%, while under enhanced protection or Pro2 Scenario it is expected to increase by about 90%.

Garua Bachwaa

681. **With no dam in place,** the population of Garua Bachwaa is expected to drop by over 90% at all sites under BAU Scenario and is predicted to increase by around 80% under Enhanced Protection or Pro2 Scenario. This indicates that this fish is threatened by extensive fishing and protection measures are very important for its population to grow.

682. **At EF Site 1 with dam in place,** this fish will be eliminated if with Poor Protection under BAU Scenario. With Enhanced Protection under the Pro2 Scenario, an increase of 8% in fish population is expected, compared to about 80% in the no dam scenario. This fish mainly inhabits the Mangla reservoir and lower reaches of the Poonch River where water is comparatively warmer. It migrates for upstream in the summer for a short distance and the obstruction created by the dam is therefore expected to adversely affect the population of this fish at Site 1. It is likely that fish populations upstream of the dam will face genetic isolation. The mitigation measures proposed in BAP such as controlled sand mining and prevention of illegal fishing will help to protect this species (**Section 11.6, EMMP**). The option of capturing and transporting the fish upstream can also be studies as an alternative during the course of implementation of the BAP.

683. **At EF Site 2 with dam in place**, the fish population is expected to decline by about 90% with dam in place. However, when 16 cumec EFlow and Enhanced Protection under Pro2 Scenario are considered, the decline in population is estimated to be only around 10%.

684. **At EF Site 3 with dam in place,** the fish will practically be eliminated with Poor Protection under BAU Scenario. With Pro2 Enhanced Protection, an increase of 64% in fish population is predicted.

Snow Trout

685. **With no dam in place,** the population of Snow Trout is expected to decrease by around 40% under BAU Scenario and increase by about 20% under Pro2 Scenario. The negative affect under BAU Scenario is due to extensive fishing pressure on this fish in the dry winter season when it migrates downstream due to lower temperatures of upstream waters. The increase under the Pro2 Scenario is limited as the population of other predatory fish increases due to enhanced protection under this scenario. Moreover, Snow Trout has limited breeding grounds in the upstream areas in the Indian Administered Kashmir. In addition, it is the only major fish of economic importance in the upper reaches and is likely to be affected by fishing pressure.

686. **At EF Site 1 with dam in place,** the fish is expected to benefit from the reservoir where it will take refuge. An increase of about 29% under Pro2 Scenario is predicted when dam is built.

687. Impact on Snow Trout was not considered for EF Sites 2 and 3 as this fish does not migrate downstream of Site 1 to avoid warm waters. It is confined mainly to the stretch of the river upstream of Site 1 where the water temperatures are favorable for its existence.

6.9.3 EFlow Recommended for the Project

688. As outlined in (**Section 8.6),** Balance between Environmental Degradation and Economic Benefit, impacts of various levels of EFlow were discussed by MPL with the key stakeholders to select an EFlow regime that achieves a balance between the benefits to the ecosystem and the financial loss to the owner and economy. Given:

- The relatively small segment (700 m) of the river impacted Project Design,
- Adoption of a non–peaking mode of operation for the powerhouse to maintain flow in the downstream section of the river to Mangal reservoir, and
- A gain in ecosystem integrity and populations of key fish species through establishment of protection under scenario Pro 2.

689. An EFlow of 4 cumec has been proposed in view of basin wide ecological improvements expected through the implementation of the BAP and economic impacts associated with varying level of EFlows.

7. Assessment of Impacts on Environment

690. This section summarizes the impacts of Project design, construction and operation on the physical environment, terrestrial ecological resources, biodiversity of Poonch River and the socio-economic environment. Environmental flow assessment and impacts on aquatic ecology in the Poonch River which are of critical significance for this Project have been covered in detail (**Section 6)**, Environmental Flow Assessment. Poonch River. Cumulative impacts are addressed in (**Section 7.6)**. (**Section 7.7)** Dam Break Analysis summarizes results for modeling of impact of dam break on downstream areas carried out by MPL.

7.1 Methodology

691. The methodology used for the assessment of Project related impacts is outlined below.

7.1.1 Impact Description

692. There are several guidelines and textbooks on identification and description of environmental and social impacts. These documents use various types of tools in an attempt to define a comprehensive and consistent method to capture all potential impacts of a proposed project. However, it is now widely recognized by ESIA practitioners that impact evaluation is not a purely objective and quantitative exercise. It has a subjective element; often based on judgment and values as much as scientific criteria. Recognizing this, a uniform system of impact description is used to enable the reviewers to understand how impacts have been interpreted. The description of each impact will have the following features:

- a definition of the impact using an impact statement.
- the impact statement clearly identifying the project activity or activities that causes the impact, the pathway or the environmental parameter that is changed by the activity, and the potential receptors of the impact.
- establishing the sensitivity of the receiving environment or receptors.
- based on the stakeholder consultations undertaken, outlining of the level of public concern regarding the specific impact.
- eating of the significance of the impact.
- description of the mitigation and management measures and the effectiveness of proposed measures.
- characterization of the level of uncertainty in the impact assessment.

693. The significance of an impact is determined based on the product of the consequence of the impact and the probability of its occurrence. The consequence of an impact, in turn, is a function primarily of three impact characteristics: magnitude; spatial scale; and duration.

694. Magnitude is determined from quantitative or qualitative evaluation of a number of criteria discussed further below. Where relevant, this includes comparison with standards or thresholds. Examples of thresholds include:

- legal thresholds—established by law or regulation.
- functional thresholds—if exceeded, the impacts will disrupt the functioning of an ecosystem sufficiently to destroy resources important to the nation or biosphere irreversibly and/or irretrievably.
- normative thresholds—established by social norms, usually at the local or regional level and often tied to social or economic concerns.
- preference thresholds—preferences for individuals, groups or organizations only, as distinct from society at large.
- reputational thresholds—the level of risk a company is willing to take when approaching or exceeding the above thresholds.

695. Once the impact consequence is described on the basis of the above impact characteristics, the probability of impact occurrence is factored in to derive the overall impact significance. The probability relates to the likelihood of the impact occurring, not the probability that the source of the impact occurs. For example, a continuous Project activity may an unlikely probability of impact, if there are no receptors within the area influenced by that activity.

696. The resulting significance rating may be further qualified by explaining the effectiveness of proposed management measures designed to mitigate or enhance the impact, and by characterizing the level of confidence or uncertainty in the assessment.

7.1.2 Impact Significance Rating

697. The impact significance rating process serves two purposes: firstly, it helps to highlight the critical impacts requiring consideration in the approval process; secondly, it serves to show the primary impact characteristics, as defined above, used to evaluate impact significance. The impact significance rating system is presented in **Table 7–1**.

Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale and duration.

Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A; and

Part C: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence.

698. Using the matrix, the significance of each described impact is rated.

7.1.3 Mitigation and Good Practice Measures

699. Wherever, the Project is likely to result in unacceptable impact on the environment, mitigation measures are proposed.

700. In addition, in certain cases good practice measures are proposed.

Table 7–1: Method for Rating the Significance of Impacts

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE			
Impact characteristics	**Definition**	**Criteria**	
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded	
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded	
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded	
	Minor+	Minor improvement; change not measurable; or threshold never exceeded	
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction	
	Major+	Substantial improvement; within or better than the threshold; or favorable publicity	
DURATION/ FREQUENCY		**Continuous aspects**	**Intermittent aspects**
	Short term/ low frequency	Less than 4 years	Occurs less than once a year
	Medium	More than 4 years up to end of life of project (approximately 56 years)	Occurs less than 10 times a year but more than once a year
	Long term/ high frequency	Beyond the life of the project (greater than 30 years)	Occurs more than 10 times a year
SPATIAL SCALE		**Biophysical**	**Socio-economic**
	Small	Within 200 meters (m) of the Project footprint	Within the Study Area
	Intermediate	Within 3 kilometer (km) of the Project footprint	10 km from the Project facilities
	Extensive	Beyond 3 km of the Project footprint	Beyond 10 km from the Project facilities

PART B: DETERMINING CONSEQUENCE RATING *Rate consequence based on definition of magnitude, spatial extent and duration*					
			SPATIAL SCALE		
			Small	**Inter-mediate**	**Extensiv e**
MAGNITUD E					
Minor	**DURATION/ FREQUENCY**	**Long / high**	Medium	Medium	Medium
		Medium	Low	Low	Medium
		Short / low	Low	Low	Medium
Moderate	**DURATION/ FREQUENCY**	**Long / high**	Medium	High	High
		Medium	Medium	Medium	High
		Short / low	Low	Medium	Medium
Major	**DURATION/ FREQUENCY**	**Long / high**	High	High	High
		Medium	Medium	Medium	High
		Short / low	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*				
		CONSEQUENCE		
		Low	**Medium**	**High**
PROBABILITY (of exposure to impacts)	**Definite**	Low	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

+ denotes a positive impact.

7.2 Assessment of Impacts on Physical Environment

701. The physical environmental aspects that may be affected by the project activities include the following:

- Soil contamination and erosion from construction.
- Noise and dust associated with construction.
- Use of water for Project activities during construction.
- Generation of waste by the Project activities during construction and operation.
- Vehicular traffic during construction.

702. Given the technology of the Project and limited number of staff (estimated at 100) that will be accommodated at the camp at the Project site during operation, impacts related to soil quality, soil erosion, noise, dust, emissions to air, use of water in the offices and the camps, and traffic during the operation phase are considered to be insignificant. Use of pesticides and weedicides is not anticipated in either construction or operation phase of the project.

703. The closest residential areas are about 0.5 km east and about 1 km south west of the proposed dam and power house (see **Figure 4-1** and **Figure 5-5** for locations and views). The dam structure elevation will be, approximately, 40 m below the residential areas. The dam structures are, therefore, not expected to have a visual impact on the local community. The camp and the offices will consist of low profile structures with heights not exceeding 8 meters. During consultation, the local community did not express any concerns related to visual impacts of the Project.

704. As stated in Section 4.3, the transmission line of the National Transmission and Dispatch Company Ltd. (NTDCL) to which the project will be connected to for evacuation of power generated passes through the Project site about a kilometer southeast of the power house. The transmission interconnection will be constructed by NTDCL adjacent to the project site, starting about two years prior to Project operation. NTDCL will conduct an environmental assessment of the interconnection facilities if required.

705. The impact of operation of the dam on quality of the river water was not considered to be significant. The change in temperature of the water across the dam will not be significant as this is a run of the river project with a limited storage capacity. During the summers, when the water is warmed up by solar radiation and the change in the temperature of the water over the length of the river is higher, the increase in temperature of the water is of the order of 3-4 ^{o}C over the 95 km of the length of the river downstream of LoC in AJK. The reservoir will increase the area of the water exposed to solar radiation by about 20%. The corresponding maximum increase in temperature of water due to the dam will be of the order of 0.8^{o}C. The seasonal variation in temperature of the water is of the order of 20^{o}C. The impact on ecological triggers will therefore be minor. The change in chemistry of the water (BOD, COD, TDS) due to the Project operation will also not be significant as the nutrient levels in river water are low, the water is well oxygenated (**Section 5.1.13** Water Quality), and the storage capacity of the reservoir is limited providing residence time of the order of three days only. The quantity of biomass that will be initially inundated and decompose is also limited as area submerged consists mainly of degraded grass and scrub land. The change in suspended sediment loads is discussed in (**Section 7.2.9** Impacts on Sediment Availability), while the consequential impact on the river ecology is discussed in (**Section 6** Environmental Flow Assessment).

706. Storage of water within the reservoir will cause an increase in groundwater head. Due to this seepage will occur into the subsurface. Since the underlying geology is largely rock, and the layers of soil are relatively thin, groundwater is expected to percolate through fractured rock as opposed to the soils. A continuous water table may not develop due the heterogeneity within the geology underlying the reservoir. Additionally, sedimentation at the bottom of the reservoir over time will limit the amount of seepage into the underlying rock and soils. Slip failures along fractures within the subsurface rock in downstream areas due to seepage from the reservoir are a possible risk; however these are expected to be extremely localized. In comparison, slip-failures due to increased water within the subsurface soil is unlikely, as the soil layer is extremely thin in steeper sections. Slip failures are considered in the geotechnical aspects of dam design, and appropriate mitigation measures if at all required will be designed and the detailed design stage. In larger open valleys downstream of the dam, the soils lay relatively flat. In these areas, the water table may develop or rise but a landslide is not possible.

707. The potential physical impacts are provided in Table 7–2.

Table 7–2: Potential Physical Impacts of the Project

Identified Potential Physical Impacts
Impact PE1: Accidental release of solvents, oils and lubricants can potentially result in the contamination of soil and consequent deterioration of groundwater and surface water quality. Soil contamination may also reduce the fertility of soil reducing suitability for agricultural purposes.
Impact PE2: Land clearing, excavation, tunnel boring and other construction activities may loosen the top soil in the Project area resulting in loss of soil and possible acceleration of soil erosion and land sliding, especially in the wet season.
Impact PE3: Water and soil contamination due to releases from the camp during construction and operation such as solid waste and wastewater, and other solid and liquid waste.
Impact PE4: Use of local water resources for construction activities may reduce the water availability for the local communities.
Impact PE5: Excavation, material storage, material transportation, batching, and vehicular movement will create fugitive dust emissions specially while off road driving.
Impact PE6: Exhaust emissions from construction machinery, project traffic and concrete batching plant may lead to deterioration in the local ambient air quality.
Impact PE7: Noise from drilling, blasting, excavation, generators and batching plant may cause nuisance in the vicinity of the Project facilities.
Impact PE8: Traffic congestion, reduced road safety, and higher levels of noise, dust and other pollutants.

7.2.1 Soil Quality

708. Samples for assessment of soil quality were collected (**Section 5.1.4** Soils) at five locations to establish baseline parameters for the Project area. No major contamination was identified at the sampled locations. In case of oil spills during construction process, poor soil quality will result in contamination of soil and as well as ground water. Currently, the community is using the flat land around settlements for agricultural purposes. Soil contamination will make this land unsuitable for agriculture and vegetation. Such spills can occur during construction process when tankers will access the area for refueling of excavation and other construction machinery. As the construction site is a protected area part of Poonch River Mahaseer National Park, such incidents will be avoided and adequate cautionary measures will be taken.

709. Improper handling of oils, lubricants and other such solvents may result during machinery refueling. Storage in areas with no lining and low quality storage containers poses another threat of soil contamination. The impact will be minimized by adopting mitigation measures and extra caution during refueling and machinery maintenance at on site workshops.

Impact PE1: Accidental release of solvents, oils and lubricants can potentially result in the contamination of soil and consequent deterioration of groundwater and surface water quality. Soil contamination may also reduce the fertility of soil reducing suitability for agricultural purposes.
Applicable Project Phase
Construction

Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Medium	Intermediate	Medium	Possible	Medium	-	High
Mitigation Measures: • Fuel tanks will be appropriately marked by content and will be stored in dyked areas with an extra 10% of the storage capacity of the fuel tank. The area will be lined with an impervious base. • Grease traps will be installed on the site, wherever needed, to prevent flow of oily water. • Spill cleaning kit (shovels, plastic bags and absorbent materials) will be available near fuel and oil storage areas. • Emergency plan for spill management will be prepared and inducted to the staff for any incident of spill.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Medium	Intermediate	Low	Unlikely	Low	-	High
Good Practice Measures: The bottom of any soak pit or septic tank shall be at least 10 m above the groundwater table. The distance can be reduced, based on the soil properties, if it is established that distance will not result in contamination of groundwater.								

7.2.2 Soil Erosion

710. In (**Section 4.1.2)** it was identified that the area around Project facilities is mainly Siwalik sandstone which are a type of sedimentary rocks. The top cover of soil on the slopes around the Project facilities is mainly sand and fine clay. Any excavation work during the construction activities, whether permanent or temporary, would lead to loss of soil. Excavated material collected during boring of the diversion tunnels will be used for the construction of cofferdam to divert water. Furthermore, construction will require excavation for the powerhouse, tunnels and other project facilities. These activities will result in loss of soil. Erosion of soil can also occur from removal of vegetation cover, runoff from unprotected excavated areas, muck disposal sites and quarry sites. Excavations on slopes would also decrease its stability. Given the topography of the area, unprotected excavations on sloping grounds may lead to landslides, especially during the rainy season. Major landslides will disturb the slopes of the area and may also alter the bed of Poonch River.

711. It is expected that moderate level of risk is associated with the type of construction activities that are likely to take place. The current land formation is fairly stable sandstone therefore no major risk is associated with regards to slope stability. The duration of the risk is expected to be short and the spatial scale of risk is small because the excavation effects are not likely to affect areas further than 200 meters from the Project facilities. The probability of this risk is estimated to be definite due to extensive excavation activities expected for the dam, powerhouse and most importantly the tunnels.

Impact PE2: Land clearing, excavation, tunnel boring and other construction activities may loosen the top soil in the Project area resulting in loss of soil and possible acceleration of soil erosion and land sliding, especially in the wet season.
Applicable Project Phase
Construction

Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Definite	Low	-	High

Mitigation Measures:

- Vegetation loss will be limited to demarcated construction area.
- Areas such as muck disposal area, batching plant, labor camp and quarry sites after the closure shall be covered with grass and shrubs.
- Slope stabilization measures will be adopted such as adequate vertical and horizontal drains, drainage along roadsides, cross drainage and retaining walls.
- Slope movements will be monitored around excavation work areas.

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Small	Low	Possible	Low	-	High

Good Practice Measures:

Local species shall be selected for plantation to restore the biodiversity of the area in consultation with Forest Department after completion of respective activities.

7.2.3 Waste Disposal

712. River water was tested upstream and downstream of Kotli town (**Section 5.1.7**) to estimate the contribution of waste from Kotli into the river and to establish baseline levels for future comparisons. The current level of nutrients and metals in water were tested to be below the WHO threshold limits for drinking water. There is a risk that when untreated wastewater and solid waste is dumped into the river from the construction camp, the concentration of contaminants may increase above the WHO and NEQS guideline limits. The construction of the Project will require mobilization of labor in large numbers in the area. This will require development of adequate infrastructure and camp facilities for the construction staff. It is expected that out of total 700 of construction workforce, approximate 400 people will be accommodated on the construction site for the four construction period. Waste such as sewage, wastewater, construction waste, chemical waste and other solid waste pose a risk in the area if not disposed carefully. During the construction of the tunnel, there is a possibility of release of ground water which may be contaminated, high in pH or high in sediment content. If that is the case, this water will be unsuitable for release in Poonch River and may lead to environmental damage. It is important that this possibility is evaluated and mitigation measures such as sedimentation ponds and treatment of water to neutralize the pH are implemented.

713. Due to the planned construction activities and the number of labor expected at camp site during construction and operation, a moderate level of impact risk to water and land resources in the area is estimated. It is expected that the impact will last more than four years but not beyond the life of the Project. It is possible that if the waste generated during construction and operation is disposed of in the Poonch River, the spatial scale of the impact will be extensive.

Impact PE3: Water and soil contamination due to releases from the camp during construction and operation such as solid waste and wastewater, and other solid and liquid waste.
Applicable Project Phase
Construction and Operation

Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Medium	Extensive	High	Possible	High	-	High

Mitigation Measures:

- Wastewater treatment system will be made to ensure that the effluents during construction and operation comply with NEQS standards and the conditions of lenders.
- Release of camp effluents directly to the water channels or land will be prohibited.
- Waste generated will be collected at designated waste dumping area and cleared from site by contractor during construction and by the company during operation.
- Lining of all effluent channels with cement at all working areas will be done to prevent seepage.
- During tunneling if ground water is released, it will be tested for pH and sediment content, and will be treated in sediment ponds to bring pH and sediment content to acceptable levels, before the water is released in Poonch river.

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Small	Low	Possible	Low	-	High

Good Practice Measures:

All waste shall be collected and recycled or sent to an incinerator.

7.2.4 Water Resource Depletion

714. The quantity of water required for the Project is given in (**Section 4.9**). Springs are the main source of drinking water in the area. River water quality was tested (**Section 5.1.7**) and the water was found to be unsuitable for drinking. If the construction contractors over utilize the local ground water resources, a negative impact is expected. During winters, the flow in the springs is low. Heavy construction activity particularly excavation may affect the ground water table in the area.

715. There are no settlements on the ridge across which the power generation tunnel will be constructed. Communities nearest to the proposed site of the dam where excavation for foundations is expected are located more than 500 m from the dam site. There are several springs located within the 10 km radius of the project where surplus water can be acquired for the Project use. Permission from local authorities will be taken for acquisition of spring water for the Project. The Construction Management Plan will take levels of ground water table, location and flow of natural springs into account to ensure the availability of water to the communities and the access of the communities to the water resources being used by them is not adversely affected. River water will be used for sprinkling and for maintenance of vegetation at the Project site during operation.

Impact PE4: Use of local water resources for construction activities may reduce the water availability for the local communities.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Possible	Low	-	High
Mitigation Measures: • Water for different construction activities will be arranged from the river and via a water contractor from a source approved by the local authorities. • Water conservation techniques will be developed and implemented by the EPC contractor. • Access of community to water sources shall be kept clear so that the community's ability to meet its water requirements are not compromised.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Intermediate	Low	Unlikely	Low	-	High
Good Practice Measures: • Records of water usage will be maintained.								

7.2.5 Fugitive Dust Emissions

716. In (**Section 5.1.5, Table 5-2**) show the air quality monitoring results for the sampling carried out at four locations around project facilities. The air samples were tested for carbon monoxide, nitrogen dioxide, sulfur dioxide and particulate matter concentrations present. The highest concentration of particulate matter, 97 ug/m^3 was measured at the proposed power house site. The IFC and NEQS guidelines for particulate matter concentration (PM_{10}) are 150 ug/m^3**.** The current concentration levels of dust in the region are well below the maximum standards set by IFC and NEQS.

717. Most of the top soil cover in the area is fine clay therefore excavation, material movement activities and material storage will result in spread of fine particulate matter in the air. Excessive particulate matter in the air could result in breathing problems for the community in the area. Furthermore, the roads are two lane and therefore the shoulders of the road could be used and cut more often generating more dust emissions. Construction of the dam wall will require concrete batching plant on site. Operation of batching plant will also contribute significantly to dust emissions in the area.

718. It is estimated that a moderate level of risk is associated with construction activities and material movement that will be taking place around the construction site. The duration of the impact is expected to be short because the particulate matter in air is not normally on long-term basis and is dependent upon weather conditions. The weather conditions lead to dispersion and spread of dust particles therefore it is expected that the spatial scale of the impact will be intermediate.

<table>
<tr><td colspan="9">Impact PE5: Excavation, material storage, material transportation, batching, and vehicular movement will create fugitive dust emissions specially while off road driving.</td></tr>
<tr><td colspan="9">Applicable Project Phase</td></tr>
<tr><td colspan="9">Construction</td></tr>
<tr><td colspan="9">Impact Rating</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Initial Impact</td><td>Moderate</td><td>Short</td><td>Intermediate</td><td>Medium</td><td>Definite</td><td>Medium</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Mitigation Measures:
• Water will be sprinkled on unpaved Project roads in dry weather for fugitive dust control.
• Grading operation will be suspended when the wind speed exceeds 20 km/hr.
• All storage piles with fine material shall be adequately wetted or covered with plastic to ensure protection of ambient air from fugitive emission during wind storm.
• Batching plants and associated machinery will be installed with suitable dust control arrangements.
• Speed limits and defensive driving policies will be strictly implemented.
• Road damage caused by Project activities will be promptly attended to with proper repair and maintenance.</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Residual Impact</td><td>Minor</td><td>Short</td><td>Small</td><td>Low</td><td>Unlikely</td><td>Low</td><td>-</td><td>High</td></tr>
</table>

7.2.6 Vehicular and Machinery Exhaust Emissions

719. In (**Section 5.1.5, Table 5-2**) shows the results of air quality monitoring carried out at four locations around the proposed site for Project facilities. The air quality samples were tested for the concentrations of carbon monoxide, nitrogen dioxide and sulfur dioxide. The concentration of carbon monoxide was measured below 1 ug/m^3 and according to NEQS standards the maximum allowed limit is 5 ug/m^3. The concentrations of nitrogen dioxide and sulfur dioxide were below 5 ug/m^3 at all four locations where samples were collected. According to NEQS, the maximum allowed limit for nitrogen dioxide is 80 ug/m^3. For sulfur dioxide, standards for IFC and NEQS are 125 ug/m^3 and 120 ug/m^3 respectively.

720. Emissions from the exhaust of construction vehicles and concrete batching plant pose a potential risk which will affect ambient air quality. Use of low grade fuels and lubricants also increases the emission levels from the construction machinery. The current concentrations of pollutants were tested to be significantly below the maximum allowed limits and two communal settlements are present near Project facilities, therefore a moderate level of risk is estimated. The duration of the risk is expected to be more than four years and the spatial scale of the impact is estimated to be within 3 km radius of the project facilities due to the dispersion of pollutants from wind.

<table>
<tr><td colspan="9">Impact PE6: Exhaust emissions from construction machinery, project traffic and concrete batching plant may lead to deterioration in the local ambient air quality.</td></tr>
<tr><td colspan="9">Applicable Project Phase</td></tr>
<tr><td colspan="9">Construction</td></tr>
<tr><td colspan="9">Impact Rating</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Initial Impact</td><td>Moderate</td><td>Medium</td><td>Intermediate</td><td>Medium</td><td>Definite</td><td>Medium</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Mitigation Measures:
• Equipment and vehicles in good working condition and low emission levels will be used. A visual check will be performed when the equipment is mobilized and periodically later to screen out equipment and vehicles that emit unacceptable levels of smoke.
• Batching plant machinery will be maintained and exhaust emissions will be minimized.
• Batching plant will be set up considering the wind direction so that the nearby communities are not affected by the emissions from batching plant.
• Regular maintenance and service of vehicles and equipment will be conducted.</td></tr>
<tr><td></td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Consequence</td><td>Probability</td><td>Significance</td><td>+/-</td><td>Confidence</td></tr>
<tr><td>Residual Impact</td><td>Minor</td><td>Short</td><td>Small</td><td>Low</td><td>Possible</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><td colspan="9">Good Practice Measures:
• Catalytic exhaust convertors shall be installed wherever available in vehicles and equipment.
• All stacks shall be at least 8ft high to protect the labor and passersby from direct exposure to emissions.</td></tr>
</table>

7.2.7 Noise Nuisance

721. The current ambient noise levels were measured in the vicinity of the Project facilities and were measured to be in the range 45-56 dB(A) discussed in (**Section 5.1.7 Table 5-3**). The NEQS and IFC limit for daytime noise in residential areas is 55 dBA and for nighttime is 45 dBA. It was observed that daytime limit was exceeded once during early morning. The nighttime limit was exceeded during all measurements taken at both the receptor communal settlements. The major contributions in the noise levels were from the river and dogs owned by the local community. The evening noise levels went down to 45 dBA at Rehmani Mohallah but at Naroch Colony the noise level remained at approximately 50 dBA. The extra noise level at Naroch Colony was due to the sound from the rapids in the river.

722. The construction and related activities for the Project, including drilling, blasting, excavation, use of generators and operation of the batching plant, are expected to cause an increase in noise in the area. Noise control measures will be adopted by the construction contractor to make sure that noise levels are maintained close to the baseline noise levels. The impact duration from noise is expected to be short. As the topography is undulating with obstructions, it is expected that the noise impact will not be beyond 200 meters of the activities.

Impact PE7: Noise from drilling, blasting, excavation, generators and batching plant may cause nuisance in the vicinity of the Project facilities.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Small	Low	Definite	Low	-	High
Mitigation Measures: • Construction equipment that could potentially generate high noise levels will have an adequate muffler system. • All stationary noise generating equipment such as air compressors and power generators will be placed at least 200 m away from the residential area. • In case threshold values are exceeded then adjusting the distances for the equipment on the basis of monitoring report. • A preventive maintenance procedure for Project vehicles and equipment will be set and followed which will help prevent noise levels from deteriorating with use. • Provision of Personal Protective Equipment (PPEs), i.e. ear muffs and plugs, will reduce noise impact on personnel. • Restriction on pressure horn. • Sirens will be used to warn the locals prior to blasting and will only be carried out during daytime.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short	Small	Low	Possible	Low	-	High

7.2.8 Traffic

723. As described in (**Section 4**) 'Project Description', equipment will be transported to the Project from the port in Karachi through the GT road turning north at Dina, passing through Mirpur, and then connecting to the Project site. Currently the road(s) can cater for the needs of the traffic but with the anticipated increase due to construction related heavy and light traffic there are likely to be impacts on the existing road infrastructure. This study focuses on the routes that may be used for Project related traffic and the likely impacts that may be caused due to the Project. Traffic count surveys were conducted to assess the baseline traffic load.

724. The baseline Passenger Car Equivalent (PCE) values at Palak and Gulpur junction are as low as 1,724 and 1,776 per day for traffic in the two directions (**Section 5.1.17**, Traffic Baseline Survey). The main road shown in **Figure 5-31** (Mirpur/Islamabad – Kotli road) to which the access road to be constructed for the Project will connect to is considered as Class 1 Highway or a two lane highway. The PCE for combined flow is only 195 per hour according to HCM 2000[1] the recommended capacity of a two lane highway is 3,200 PCE/day. The traffic flow is therefore low and with addition of maximum 200 trucks per day the increase in traffic will not be significant.

725. While the risk of congestion is low in view of the rated capacity of the roads and anticipated Project related traffic, the following are the potential impacts envisaged:

- Traffic congestion at the junction of Project access road and main road connecting Mirpur and Islamabad with Kotli.

[1] The Highway Capacity Manual (HCM) is a publication of the Transportation Research Board of the National Academy of Science in the United States.

- Damage to the road shoulders at the proposed quarrying sites, camp site and near the batching plant(s).
- Noise due to the movement of heavy traffic especially while loading and offloading near community areas.
- Fugitive dust emission due to movement of heavy traffic and especially the dust emissions from the trucks that would be carrying quarried material to and away from the quarrying site while transporting the spoil load for disposal away from site.
- Increased risk of road side accidents as the traffic would have to pass through several small and large settlements where the shops, schools, mosques and other such types of places are located close to the road shoulder.
- Accidental breakdown or accident of a heavy vehicle carrying equipment or construction material could block the road entirely could result in blockage of traffic as options for diversion of traffic to alternative routes in hilly terrain of AJK tend to be limited.
- The main road that connects the Project site to Kotli passes through settlements and cattle that frequently cross the road could be at risk.
- Exhaust emissions from vehicles would impact the ambient air quality as well and in case of traffic blockages or congestion it may be a nuisance for the community.

Impact PE8: Traffic congestion, reduced road safety, and higher levels of noise, dust and other pollutants.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Moderate	Short	Extensive	Medium	Definite	Medium	-	High

Mitigation Measures:

- Contractor's vehicle will follow strict speed limits within city and all applicable local traffic rules and regulations imposed by National Highway Authority (NHA) especially near sensitive receptors (schools, hospital, mosques, etc.).
- In no case horn will be used during the day timings near the sensitive receptors.
- Over speeding will be subject to disciplinary actions.
- Local traffic will be allowed to overtake and drivers will be encouraged to make way for the local commuters, ambulances, army and special persons conveys in all cases.
- Contractor's personnel will only use access routes assigned to them for project activities which will be finalized during meeting with the representatives of MPL and subcontractors.
- Trucks and vehicles will not be overloaded and will follow NHA guidelines for loads and size.
- Large vehicles that can slow down the local traffic significantly will only travel in the night time or a special permission from the district administration will be obtained.
- Contractor's vehicles and equipment will be parked at identified designated area.
- Vehicles and machinery will be appropriately parked/placed to avoid inconvenience to local commuters and pedestrians.
- Prior communication to residents and safety signs will be installed well before the commencement of any activity at site.
- The vehicles will be encouraged to leave the local area as quickly as possible after the delivery of material to the Project site.
- Vehicle maintenance work will only be carried out in designated workshops.

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Medium	Small	Low	Possible	Low	-	High

Good Practice Measures:

- Diversion plans shall be developed to minimize disturbance to local population during occasional high activity timings / days. These plans shall be communicated to residents well in advance and proper diversion signs will be placed to inform locals.
- Movement of contractor's vehicles for transportation of material and wastes from and to the site shall be restricted to low traffic timings.

7.2.9 Sediment Deposition

726. An analysis carried out to develop the baseline condition of suspended sediment and river bed of the Poonch River is summarized in (**Section 5.1.14**) Sediment Loads in the Poonch River. This analysis was followed by the assessment of impacts on the river bed and sediment due to the dam. The expected impacts of the Gulpur dam were assessed for upstream and downstream of Gulpur dam. Impact rating was not carried out for direct impacts of this aspect. Consequential impacts on livelihoods associated with mining of sand and gravel from river bed resulting from changes in pattern of sediment deposition are discussed in (**Section 7.5.2**) Local Livelihoods and Well Being. Impacts of changes in water quality and geomorphology of the river on aquatic ecology are discussed in (**Section 6**) Environmental Flow Assessment.

Expected Changes Upstream of Gulpur Dam

727. If the proposed Gulphur Project reservoir is constructed, the sediment yield from more than 80% of the Poonch catchment area (estimated at approximately 7 million cubic meters[2]) will be affected by the new dam. **Table 7-3** includes a summary of expected percentage trapping of different particle sizes in the dam. It was estimated that all of the cobble and boulders, almost all of the sand load and approximately 30% of the silt load would be trapped in the proposed Gulphur Project reservoir[3].

Table 7–3: Summary of Expected Percentage Trapping of Different Sediment Particle Sizes in the Gulpur Project for Flows up to 830 cumec [4]

Sediment Type	Particle Size (mm)	Volume of Sediment in inflow (million ton/yr)	% Trapping Assumed	Estimate of Trapped Sediment (million ton/yr)
Clay	<0.0055	1.3	0%	0
Silt	0.0055 – 0.0625	6.5	30%	1.9
Sand	>0.0625	3.0	100%	3.0
Total		**10.8**	**-**	**5.9**

Source: (Mott MacDonald 2011)[5]

[2] Based on the measured sedimentation rate of the Poonch branch of the Mangla Reservoir (Izhar-ul-Haq and Tanveer Abbas 2007)

[3] Mott MacDonald (2011). Gulpur Hydroelectric Power Project: Review of Requirement for Desanding Bay (Final Report), Sambu Construction Co. Ltd, November 2011.

[4] cubic meters per second

Expected Changes Downstream of Gulpur Dam

728. The expected changes in sediment downstream of Gulpur dam can be divided into those in the reach between the dam and the tailrace (low flow section) and those downstream of the tail race. In general, both reaches are expected to experience a reduction in sediment supply, but differences in the volume of water between the two reaches will result in very different outcomes.

729. **Figure 7–1** graphically illustrates suspended sediment loads generated for the present day (no dam), 4 cumec (m^3/s) and 16 cumec base flow release scenarios that could be expected in the low flow zone downstream of the dam. The critical reductions in suspended sediment are linked to the large declines in the base flow, whereas the large peaks in the 4 cumec and 16 cumec scenarios are associated with proposed periodic flushing of the reservoir (HBP 2014)[6]. In the low flow or dewatered segment between the dam and the tailrace there will be very low total sediment loads because for most of the year the discharges will be very low, and the cobbles and boulders in particular will be considerably reduced. However, during flushing or sluicing of the reservoir, very large peak suspended sediments are likely to occur during high flows.

730. Sediment concentration generally increases with volume, although the actual concentrations linked to a particular discharge vary widely. For example, for a mean annual discharge of 125 cumec, the sediment concentration ranges between 10 ppm[7] and 15,000 ppm. Within the context of this natural variability the changes in discharge and the sediment trapping effects of the reservoir can be expected to result in altered sediment delivery to the reaches downstream of the reservoir.

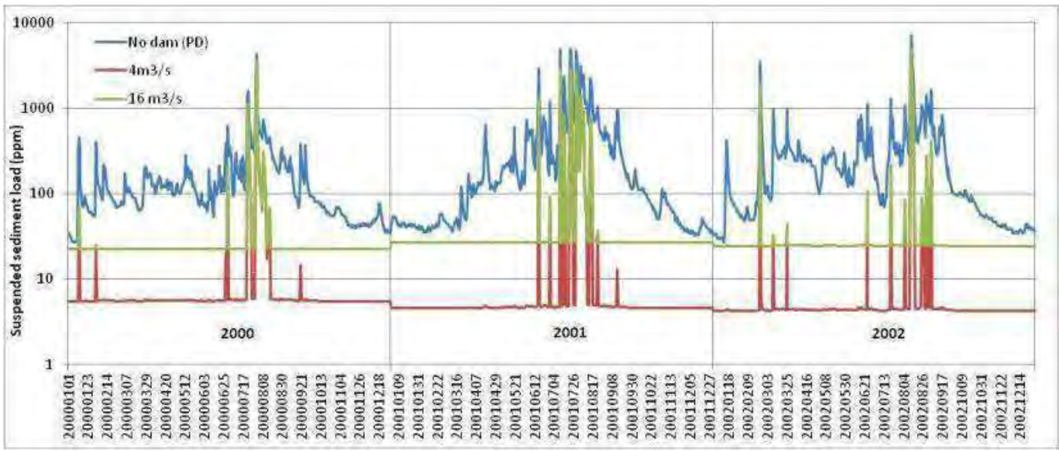
731. Downstream of the tailrace, the suspended loads will be reduced relative to 2013 because of the sediment trapping effect of the reservoir. As in the upstream low flow or dewatered zone, annual flushing of the reservoir may, however, yield peak suspended sediment discharges higher than normal. The deposition of cobbles and boulders is expected to be low immediately downstream of the tailrace but should increase with distance as a result of the replenishment by supply of these sediments from lateral bars, the channel bed and from tributary inputs.

[5] Mott MacDonald (2011). Gulpur Hydroelectric Power Project: Review of Requirement for Desanding Bay (Final Report), Sambu Construction Co. Ltd, November 2011.
PWA (1996). Garcia River Gravel Management Plan. Philip Williams & Associates, Ltd., San

[6] Hagler Bailly Pakistan (2014) Gulpur Hydropower Project: Biodiversity Impact Assessment, **Appendix 1** Environmental Flow Assessment.

[7] parts per million

Figure 7–1: Suspended sediment loads generated for the present day (no dam), 4 cumec and 16 cumec baseflow release scenarios



7.3 Assessment of Impacts on Terrestrial Ecology

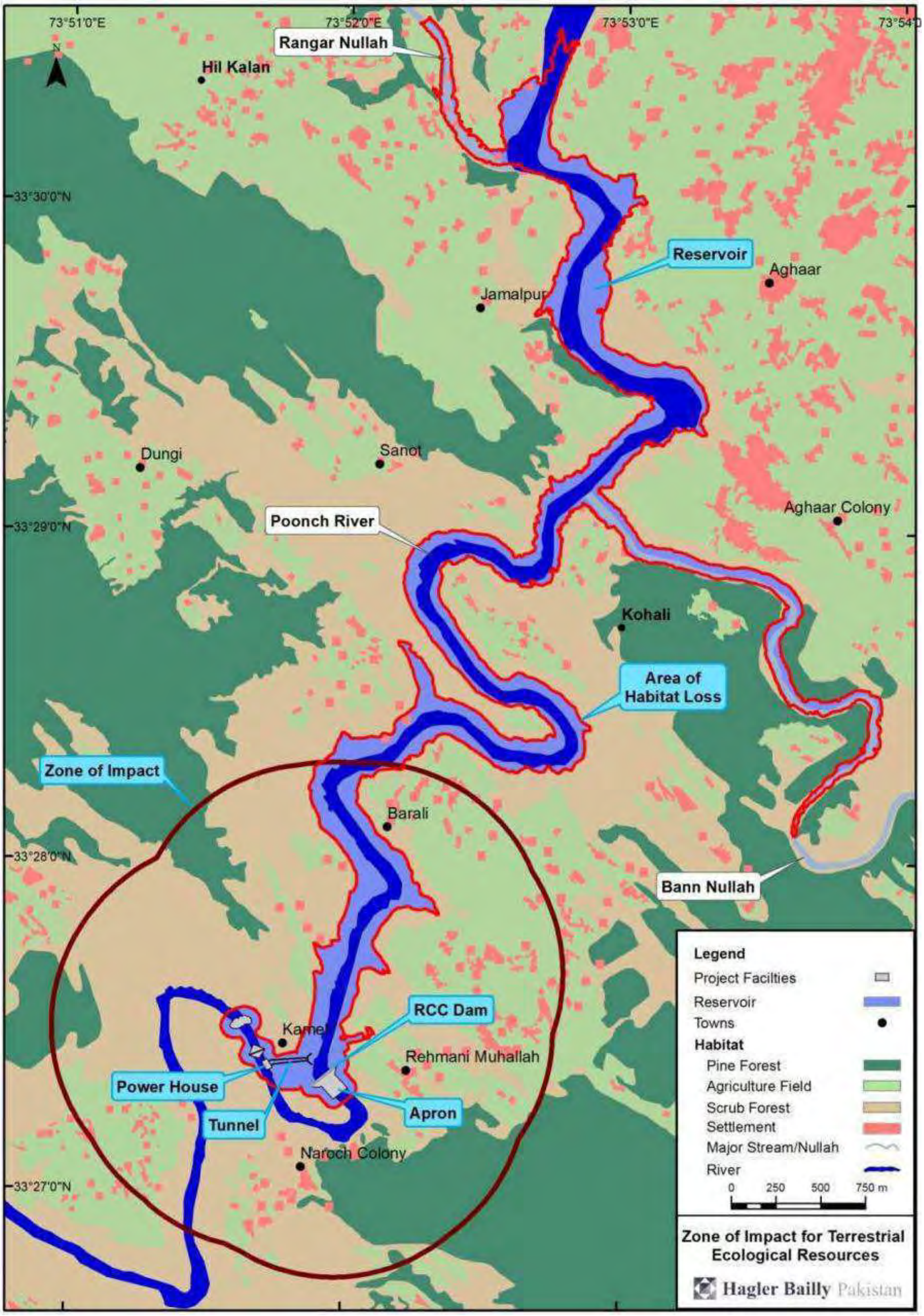
732. The Project is a run-of-the-river (RoR) type and will require construction of a dam on the Poonch River. The Project with design capacity of 100 MW will use the water resources of the Poonch River for power generation.

733. A map showing the location of the proposed Project facilities is provided in **Figure 2-2** in **(Section 2**). The major structures associated with the Project include the dam, intake structure and powerhouse. All the structures will be located near Barali village on the Poonch River at about 11 km downstream of Kotli Town and about 6 km downstream of the confluence of Ban Nullah with the river. The intake structure and intake portal of the power tunnel will be located on west bank of the Poonch River, 150 m upstream of dam structure on the eastern face of a ridge. The power house and outlet will be located on right bank of the Poonch River about 800 m downstream of the Dam structure. A low flow section of a length of about 700 m will be created downstream of the dam to the outlet of the powerhouse.

734. The Area of Habitat Loss is defined as the areas that will be occupied due to construction and operation of Project infrastructure. It has been demarcated taking into consideration the footprint of each Project facility and a 50 m zone around each facility, as well as the area that will be submerged under water due to formation of reservoir (**Figure 7–2**). The Area of Habitat Loss is estimated at 2.7 km^2.

735. The Zone of Impact for Terrestrial Ecological Resources (referred to in this section as the Zone of Impact) consists of the Project facilities and a 1 km potential impact zone around these facilities to account for an area in which the ecological resources may be impacted by Project related disturbances such as sound, light and vibrations during construction and operations (**Figure 7–2**).

Figure 7–2: Zone of Impact for Terrestrial Ecological Resources



736. The terrestrial ecological resources of the Study Area are described in (**Section 5.2**) Ecology Baseline in (**Section 5**) Description of Environment. The aspects affecting ecology and biodiversity in the Terrestrial Study Area (**Section 5.2**) are discussed below:

- Impact TE1: Decline in abundance and diversity of terrestrial flora and fauna caused by construction related activities.
- Impact TE2: Project operation leading to animal disturbance, displacement and decline.

7.3.1 Terrestrial Habitat Loss

737. Site clearance and construction of Project infrastructure such as powerhouse, dam, and the inlet and outlet of power tunnel will result in immediate and direct modification of land and loss of approximately 21 hectares of terrestrial habitat leading to loss of plants and animals in this area. There will be a permanent modification of land within the footprint of specific Project facilities and its ancillaries but the loss will be less severe in the areas that lie adjacent to and immediately outside the Project facilities. In addition, once the Project begins operations, an area of approximately 292 hectares will become submerged in water due to formation of a reservoir upstream of the dam (**Section 2, Figure 2-2**). The submerged terrestrial habitat will be converted into aquatic habitat. The habitat loss and fragmentation resulting from Project infrastructure will lead to displacement of terrestrial species, and may lead to creation of barriers to the movements of animals.

738. The Area of Habitat Loss (total of 313 hectares) consists largely of riparian habitat and scrub forest. The dominant plant species in this habitat are *Dalbergia sissoo, Dodonaea viscosa, Acacia modesta* and *Nerium oleander* that are widespread and common species in the entire Poonch River basin. Some of these plant species have a socio-economic value for the local communities. *Berberis sp., Dodonaea viscosa, Nerium oleander* have medicinal properties. Some species such as *Acacia modesta, Berberis sp., Carissa opaca, Dalbergia sissoo* are used for grazing while *Acacia modesta, Cassia fistula, Dodonaea viscosa* and *Lantana camara* are collected by locals for firewood. However, all these species are common and abundant in the entire Poonch River basin. Habitat loss caused by construction of Project infrastructure will not have any significant impact on the overall population of these vegetation species though individual are likely to suffer harm.

739. Mammal species observed in this Area of Habitat Loss include Asiatic Jackal *Canis aureus*, Indian grey mongoose *Herpestes edwardsii* and Fox *Vulpes vulpes.* No threatened flora or fauna species were found or reported from this Area of Habitat Loss. Signs of the Otter *Lutra lutra* (Near Threatened in IUCN Red List 2013) were not observed. Moreover, no critical habitat, threatened or unique ecosystem was identified in this area. The habitats found in the Area of Habitat Loss are homogenous and widespread. They hold no significance for the survival of endemic or restricted range species.

740. Even though there will be irreversible short term harm to some ecological receptors (individuals), the species will not suffer as the area of habitat occupied by the Project infrastructure will be is small. Therefore, the magnitude of impact is considered minor.

7.3.2 Impacts on Biodiversity due to Construction Activities

741. Construction of Project infrastructure such as the powerhouse, dam and power tunnel will result in disturbance to the floral and faunal species in the Zone of Impact around the Project facilities **(Figure 7–2)** due to blasting, noise, vibrations, illumination, and introduction of alien species. Pollution may increase due to vehicles and machinery, spillage of fuels or chemicals, emissions and noise.

742. Habitat loss, habitat fragmentation and sensory disturbances may result in a decrease in species abundance and possibly change species diversity within the Zone of Impact. In addition, the spatial and temporal distribution of species will also be affected as a result of loss of habitat integrity due to habitat fragmentation and degradation. Habitat alteration and disturbance may increase the likelihood of spread of alien invasive species such as *Lantana camara.* The four habitat types (**Section 5.2**) found in this Zone of Impact will be affected. The Agricultural Fields and Pine Forest were observed to contain the highest diversity of species and therefore represent the greatest relative loss. However, no terrestrial critical habitat was identified in the Zone of Impact and it does not contain any threatened or unique ecosystem (even though the Aquatic Study Area comprising of a section of the Poonch River is a designated national park and a Critical Habitat - **Section 5.2**). Moreover, the habitats found in this Area of Habitat Loss are homogenous and widespread. They hold no significance for the survival of endemic or restricted range species.

743. Land disturbance due to construction related activities will lead to a localized reduction in food, shelter and range for mammals, birds and herpeto-fauna (reptiles and amphibians). Surface stripping will result in the removal of vegetation cover and may cause accidental death of small mammals and reptiles. However such fauna may be mobile and may move away from the area prior to preliminary earthworks. Food supplies in the form of seeds, vegetation and prey species will be negatively affected on a localized basis (only within the Project infrastructure facilities and its ancillaries). Land disturbance will not significantly affect the birds of conservation importance (White-backed Vulture *Gyps bengalensis* and Egyptian Vulture *Neophron percnopterus*). The feeding and resting areas of the vultures are located at least 2 km from the proposed Project facilities and vultures are able to adjust their home ranges and movement patterns to changes in local conditions[8]. In addition, the habitats being disturbed are not considered critical to the breeding, nesting or feeding of these vulture species (**Section 5.2.5**). The birds also react to disturbance and are likely to avoid the area once construction activities begin. However, the Project construction will impact the ecological integrity of the vulture habitat including the habitat structure and foraging opportunities.

744. In addition to direct land disturbance, the site fencing may present a barrier to movement, resulting in habitat fragmentation for small and medium sized mammals as well as the reptiles found in the Study Area. Large migratory mammals have not been observed in the area.

745. Seed sources for re-establishing plants will remain available from adjacent lands (driven by wind). The areas around the Zone of Impact provides similar habitat to the habitat already existing at the site, so repopulation by flora and fauna is likely to occur in the areas not occupied by the Project infrastructure, once disturbance associated with construction is stopped.

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[8] Khatri, P.C. (2013) Home range use of winter migratory vultures in and around Jorbeer, Bikaner (Rajasthan) India. Bioscience Discovery, 4(1): 96-99

746. There are reports of hunting and poaching in the region. Locals are known to hunt Common Leopard *Panthera pardus*, Barking Deer *Muntiacus muntjak* as well as some pheasant and partridge species in the vicinity of the Zone of Impact. Despite the presence of hunting rules and regulations, they are seldom enforced. Improved access to the site as a result of the Project may indirectly increase the incidence of poaching. To prevent further exacerbation of existing impacts and prevent poaching by Project staff and contractors, awareness training will be provided along with information on the penalties for poaching (in terms of the Project's policies and AJK wildlife protection laws). Long term impacts are therefore unlikely. By working with local government agencies particularly AJK Fisheries and Wildlife Department and NGOs such as the Himalayan Wildlife Foundation, MPL can implement measures to enhance conservation in the area. Increase in Project related traffic may increase the incidence of road animal kills.

747. Inadequate management and disposal of waste from the construction site and camping locations can lead to deterioration of soil and habitat quality with consequent negative impacts on the flora and fauna.

748. In addition, the biodiversity may be disturbed due to loss of soil productivity caused by contamination from oil spills and leakages from Project vehicles and machinery, uncontrolled discharge of wastewater, and storm water runoff from project site. Soils disturbed due to vegetation stripping and exposure as a result of Project related construction activities will be more easily eroded by the forces of wind and water. This eroded soil will have lower productivity due to loss of top soil. In addition, the eroded soil may damage the aquatic ecological resources by siltation of the river.

749. The aquatic ecological resources of the Poonch River may be negatively impacted if the river waters are polluted due to discharge of untreated waste water or solid waste from camp sites.

750. At a local scale, a decrease in biodiversity and ecological function caused by construction related disturbances is of minor magnitude near the Project facilities, and because of the homogenous and widespread distribution of species, the area wide impact on biodiversity is also minor.

Impact TE1: Decline in abundance and diversity of terrestrial flora and fauna caused by construction related activities.

Applicable Project Phase

Construction

Impact Rating

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Minor	Short Term	Small	Low	Possible	Low	-	High

Mitigation Measures:

Impact	Mitigation measures
Disturbance to animals due to noise and vibration	• See PE7
Effects on animal health due to air pollution and dust	• See PE5 and PE6
Disturbance to animals due to construction site lighting	• Large flood lights should not be installed outside 50 m of the Project fence. • Lights should be directed towards Project facilities and not towards

	the natural habitats.
Decline in ecological integrity of vulture habitat	• Protection and monitoring of vulture populations is included in BAP.
Induced impact due to human presence including encroachment into pristine areas, involvement of project staff in hunting activities and wildlife trade	• Regulations for Project staff and contractors to avoid illegal poaching to be incorporated in contract documents. • Provide awareness training to staff and contractors on: prevention of injury of animals; identification of likely species found on site; identifications of animal hazards (such as venomous snakes); and what to do if dangerous animals are encountered. • Provide adequate knowledge to the workers on relevant government regulations and punishments for illegal poaching. • Encourage personnel to report sightings of wildlife of conservation importance or incidents of poaching to MPL.
Mortality and injury to animals from vehicle collisions	• See PE8 • Enforce speed limits in ecologically sensitive areas. • Project staff and contractors to report kills of large mammals particularly designated species of conservation concern.
Spread of Alien Invasive Species (AIS)	• Source goods/materials locally where possible. • Minimize disturbance to, or movement of, soil and vegetation. • Prevent soil damage and erosion. • Prevent AIS establishment on exposed stored soil (do not store bare soil near known sources of AIS). • Train and raise awareness regarding AIS among Project staff and contractors. • Retain as much natural vegetation as possible.
Deterioration of soil and habitat quality due to oil spills and leakages from Project vehicles and machinery, storm water runoff from Project site, uncontrolled disposal of Project construction waste,as well as waste water and soild waste from camp sites	• See PE1 • See PE3
Contamination of River water due to discharge of untreated waste water and solid waste from camp facilities	• See PE3 • Solid waste should only be disposed of at designated sites.
Wind and water erosion of exposed surfaces	• See PE2
Decline in ecological integrity of Poonch River basin	• Implementation of Biodiversity Action Plan (**Section 11.6**).

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Short Term	Small	Low	Possible	Low	-	High

7.3.3 Impacts on Biodiversity due to Project Operation

751. The operation of the hydropower plant and associated activities during operation will result in some potential disturbances to species, which may exacerbate the effects of habitat loss and decreased species abundance. In addition, the spatial and temporal distribution of species will also be affected as a result of loss of habitat integrity due to habitat fragmentation and degradation. These disturbances include noise and light. As plant operation will be continuous, the disturbances will also be continuous and affect

both diurnal and nocturnal wildlife. The lighting required for operation and safety at the Project site can influence nocturnal foraging behaviors as well as disrupt sleep patterns of crepuscular and nocturnal species. However, considering the fact that no threatened ecosystem or species is reported from the Zone of Impact, the magnitude of this impact is considered minor.

752. Influx of Project staff and contractors during the operations phase of the Project may increase encroachment into pristine areas, increase the incidence of Project staff and contractors in hunting activities and wildlife trade.

753. Inadequate management and disposal of solid waste from the camping locations can lead to deterioration of soil and habitat quality with consequent negative impacts on the flora and fauna. In addition, the biodiversity may be disturbed due to loss of soil productivity caused by uncontrolled discharge of waste water.

Impact TE2: Project operation leading to animal disturbance, displacement and decline.							
Applicable Project Phase							
Operations							
Impact Rating							
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Minor	Medium Term	Small	Low	Possible	Low	-	High

Mitigation Measures:

Impact	Mitigation measures
Disturbance due to Project site lighting	• Large flood lights should not be installed outside 50 m of the Project fence. • Lights should be directed towards Project facilities and not towards the natural habitats.
Induced impact due to human presence including encroachment into pristine areas, involvement of Project staff in hunting activities and wildlife trade	• Regulations for Project staff to avoid illegal poaching to be incorporated in contract documents. • Provide awareness training to staff and contractors on: prevention of injury of animals, identification of likely species found on site, identifications of animal hazards (such as venomous snakes) and what to do if dangerous animals are encountered. • Provide adequate knowledge to the workers on relevant government regulations and punishments for illegal poaching. • Encourage personnel to report incidents of poaching.
Contamination of River water due to discharge of untreated waste water and solid waste from camp facilities	• See PE3. • Solid waste should only be disposed of at designated sites.
Deterioration of soil and habitat quality due to contamination from waste water discharge, and soild waste from camp sites	• See PE1. • Solid waste should only be disposed of at designated sites.
Decline in ecological integrity of Poonch River basin	• Implementation of Biodiversity Action Plan (**Section 11. 8**)

	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Minor	Medium Term	Small	Low	Possible	Low	-	High

7.4 Assessment of Impacts on Ecology and Biodiversity of Poonch River

754. Impacts on the ecology and biodiversity[9] of Poonch River under various level of environmental flow released from the dam, turbine configurations, operating rules for the turbines, and non-flow related management options were studied using the DRIFT approach. (**Section 6**) Environmental Flow Assessment summarizes the results of the scenarios modeled. The results were used to select a turbine configuration and a non-peaking operating mode for the power house. A recommended environmental flow for the Project was then arrived at by balancing the impacts on the river environment against that on the power generated and consequently on the economy. (**Section 8**) Analysis of Alternatives presents this analysis and rationale for selection of the EFlow for the Project. Consistent with ADB SPS IFC Guidelines, the Project was designed to achieve a net gain in biodiversity in view of the location of the Project in a Critical Habitat (**Section 5.2.10, Critical Habitat Assessment**)

755. The river ecosystem upstream of the LoC in the Indian Administered Kashmir IAK) will also benefit from enhanced protection in the AJK. This benefit, however, will be lost if the Parnai HPP is built as planned in IAK, in which case the ecosystem in the 60 km[10] stretch of the Poonch River between Parnai dam and the confluence of Poonch River with Mendhar Nullah will be adversely impacted. The ecosystem integrity of the Poonch River will drop from Category B or Slightly Modified to a Low Category D or Moderately/Largely Modified, while that of Mendhar Nullah will deteriorate to Category D or Largely Modified (**Section 7.6.7** Summary of Cumulative Impacts on Biodiversity).

756. The Parnai dam will divert water of the Poonch River through a tunnel to a powerhouse located on the Mendhar Nullah. A peaking operation as planned will result in variations in flow in both the Poonch River and Mendhar Nullah which will lead to degradation of the river ecosystem. Mendhar Nullah is also a breeding habitat for the Endangered Mahaseer. Considering the transboundary impact of the Prnai HPP, it is important that the relevant authority in Pakistan take up the issue with India under the provisions of Indus Water treaty and precedence set by the Final Award[11] by the Permanent Court of Arbitration for the Kishenganga Hydroelectric Project.

757. **Table 7–4** summarizes the principal impacts of the Project on the ecology and biodiversity of the Poonch River. The impacts will occur after the construction of the coffer dam and will continue through the operations.

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9 Impacts on biodiversity were studied for a selected set of ecosystem indicators, and the impacts related to individual indicators were integrated to arrive at an impact on the ecosystem integrity.

10 Inclusive of a 15 km stretch of Poonch River downstream of LoC.

11 Kishenganga Hydroelectric Project, Final Award, Permanent Court of Arbitration, December 2013.

Table 7–4: Potential Ecological Impacts of the Project on Biodiversity of Poonch River

Identified Potential Impacts on Ecology and Biodiversity
Impact RE1: Improvement in ecological integrity of the Poonch River following implementation of the Biodiversity Action Plan.
Impact RE2: Loss of riverine ecosystem due to inundation by Gulpur reservoir
Impact RE3: Degradation of the river ecosystem in the low flow segment downstream of the Gulpur dam.
Impact RE4: Decrease in population of Mahaseer downstream of the Gulpur tailrace outlet to Mangla reservoir.

7.4.1 Enhancement of Ecological Integrity of Poonch River through Implementation of the Biodiversity Action Plan

758. Following the implementation of a Biodiversity Action Plan (BAP) (**Section 11.6**), which is an integral part of the Project design, the ecological integrity of the segment of the river upstream of the dam and downstream of the power house would improve from Mid Category C or Moderately Modified to Borderline Category B and C, Slightly Modified/Moderately Modified[12]. This is a positive impact on the ecosystem of the river that will occur on about 87% percent of the length of the river between the Line of Control (LoC) and the Mangla reservoir.

Impact RE1: Improvement in ecological integrity of the Poonch River following implementation of the Biodiversity Action Plan								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Major+	Long-term	Extensive	High	Definite	High	+	High

7.4.2 Loss of Riverine Ecosystem due to Inundation by Gulpur Reservoir

759. A segment of 10 km or 12% of the length of the river between the LoC and Mangla reservoir will be inundated by the Gulpur reservoir, where the river will cease to exist. The fish that can survive in a lake environment such as the Endangered Mahaseer will benefit from extension in habitat and enhanced protection under the BAP, while the fish that require riffle habitat such as the Critically Endangered Kashmir Catfish will not survive in the reservoir. Wetland conditions created in the reservoir may support migratory birds as has happened in case of Mangla reservoir. The magnitude of impact is rated as Moderate for this reason.

760. Mitigation of this impact other than enhanced protection of the ecosystems through implementation of the BAP which has been made a part of the Project design will not be possible. This impact will be offset by the gain in ecosystem integrity as described for impact RE1. It may, however, be noted that in under the Business as Usual scenario with poor protection this segment of the river is predicted to degrade to Mid Category E or severely modified, with population of the fish species dropping to critical levels with extensive loss of ecosystem functions. While the ecosystem will

[12] **Table 6-2** in **Section 6** defines the ecological categories.

change from riverine to lake, a new ecosystem will be created which will support life forms that are adapted to it.

Impact RE2: Loss of riverine ecosystem due to inundation by Gulpur reservoir								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Moderate	Long-term	Extensive	High	Definite	High	-	High

7.4.3 Degradation of the River Ecosystem in the Low Flow Segment

761. The ecosystem integrity in the low flow section of the river between the dam and the power house tailrace outlet which is 700 m in length will experience degradation for Mid Category C or Moderately Modified at present to Mid Category D or Largely Modified. Similar to impact RE3 above, mitigation of this impact other than enhanced protection of the ecosystems through implementation of the BAP which has been made a part of the Project design will not be possible. In addition, as mentioned in case of impact RE3 above, under the Business as Usual scenario with poor protection this segment of the river is predicted to degrade to Mid Category E or Severely Modified, with population of the fish species dropping to critical levels and extensive loss of ecosystem functions. The negative impact on biodiversity in the low flow segment of the river will be offset by gain in river biodiversity at the basin level through implementation of the BAP as discussed for Impact RE1.

Impact RE3: Degradation of the river ecosystem in the low flow Segment downstream of the Gulpur dam								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Moderate	Long-term	Intermediate	High	Definite	High	-	High

7.4.4 Decrease in Population of Mahaseer Downstream of the Gulpur Tailrace

762. The population of the Endangered Mahaseer is expected drop by about 8% compared to present day in the 34 km section of the river downstream of the Gulpur tailrace outlet (**Table 6-4 Section 6.6.1**) assuming enhanced protection under the Protection Level 2 Scenario. The main reason for this is the location of the principal breeding areas of Mahaseer upstream of the Gulpur dam (**Table 6-6 Section 6**). Following the construction of the Project, the fish will continue to breed in the river, but even with enhanced protection under the BAP it will not be possible to maintain the present day population levels of Mahaseer. The AJK Fish and Wildlife Department plans to construct a fish hatchery near the confluence of Moli Nullah and Poonch River located about 15 km downstream of the dam. As included in the Biodiversity Action Plan for the Project, MPL will provide supplemental equipment and technical support for the Department to breed Mahaseer for release in the downstream section of the river as a measure to mitigate this impact. There is evidence of successful captive breeding of this

fish in hatcheries in Pakistan, India and Nepal[13]. Breeding of Mahaseer has successfully been demonstrated in Pakistan at the hatchery of the Punjab Forestry, Fisheries, and Wildlife Department at Garyala in District Attock[14]. Captive breeding and stocking of Mahaseer in Poonch River is expected to compensate for the loss of population of this fish die to the Project, and possibly improve the population above present day levels.

Impact RE4: Decrease in population of Mahaseer downstream of the Gulpur tailrace outlet to Mangla reservoir								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Minor	Long-term	Extensive	Medium	Definite	Medium	-	High
Mitigation measures: • Supplemental equipment and technical support to AJK Fish and Wildlife Department for a hatchery for breeding of Mahaseer and stocking in Poonch River downstream of Gulpur dam.								
Residual Impact	Minor	Long-term	Extensive	Medium	Possible	Medium	+	High

7.5 Assessment of Impacts on Socioeconomic Environment

763. The potential socioeconomic impacts of the Project are identified and assessed in this section. MPL will produce a Land Acquisition and Resettlement Plan (LARP) which will address all issues and impacts associated with land acquisition and resettlement. Therefore, land ownership and resettlement impacts are not covered in this section.

764. The ecosystem services of the Poonch River basin are summarized in (**Section 5.2.12**). These include sand and gravel mining, fishing, opportunities for recreation, vegetation for grazing and fuel wood, medicinal plants, plants that provide fruits/dry fruits, as well as scavenger species particularly the vultures that are important for rapid disposal of dead livestock. The potential impacts on sand and gravel mining and fishing are discussed below. Impacts on the plants and animals of socio-economic importance have been discussed in (**Section 7.3**) Assessment of Impacts on Terrestrial Ecology. Recreational activities such as swimming and bathing will not be impacted by Project operations as there is constant release of environmental flow downstream of the dam, and full flow is restored downstream of the tailrace tunnel with a non-peaking operation. Recreational opportunities may even be enhanced due to creation of a reservoir with a larger water front and opportunism for boating.

765. The communities did not report any vector borne diseases such as malaria the prevalence of which could increase due to the reservoir created by the Project. Furthermore, the population density is low in the areas proximal to the reservoir in view of steeper slopes in the valley (**Figure 4-1** and **Figure 4-2**). After Project development, any residential buildings are likely to be located at least 200 m from the expected banks of the reservoir. The storage volume of the reservoir will also be limited as this is a run of

[13] Breeding of pond reared golden mahseer (Tor putitora) in Pokhara, Nepal. Gurung, T.B., A.K. Rai, P.L. Joshi, A. Nepal, A. Baidya and J. Bista. Cold water fisheries in trans Himalayan countries, FAO Technical Paper 431, 2002.

[14] Evaluation Report on Project 'Establishment of Mahseer Fish Hatchery and Seed Rearing Farm for Stock Replenishment in Semi Cold Natural Water Bodies of the Province', Directorate General of Fisheries, Forestry, Wildlife & Fisheries Department, December 2010.

the river Project, and the likelihood of stagnant pockets of warm water being formed in the high flow summer or flood season that serve as breeding areas for insects is low. Malaria as a long term risk in the context of climate risk assessment is discussed in (**Section 7.8.7**).

766. The potential socioeconomic impacts of the Project are categorized into the following three impact groups:

- **Macroeconomic:** Impacts related to the national economy;
- **Local Livelihoods and Wellbeing**: Economic benefits to the community residing in the vicinity of the Project; and
- **Socio-Cultural:** Social and cultural impacts on the local communities due to the Project.

767. The identified socioeconomic impacts are summarized in **Table 7–5.** In this section, the term 'local' is used in the context of the Study Area, whereas 'domestic' pertains to national level.

Table 7–5: Potential Socioeconomic Impacts of the Project

Impact Group	*Identified Potential Socioeconomic Impacts*
Macroeconomic	**Impact ME1**: Availability of power to meet the growing demand in the economy and reduction in power outages.
	Impact ME2: Government revenues from the Project in the form of taxes and royalties leading to increased developmental spending.
Local Livelihoods and Wellbeing	**Impact LW1**: Direct, indirect and induced employment at the domestic and local levels, resulting in increased prosperity and wellbeing due to higher and stable incomes of people.
	Impact LW2: Increase in the stock of skilled human capital due to transfer of knowledge and skill under the Project resulting in enhanced productivity.
	Impact LW3: Increase in local incomes and wellbeing due to increase in catch of fish following creation of favorable habitats for the fish in the Poonch River.
	Impact LW4: Loss of income from sand and gravel mining due to change in pattern of sediment deposition following construction of the dam..
Sociocultural	**Impact SC1**: Increase in population due to in-migration of job seekers (in-migrants) leading to pressure on existing infrastructure and services.
	Impact SC2: Disputes over distribution of Project benefits within local community and between local community and the in-migrants, resulting in social unrest.
	Impact SC3: Potential social unrest in the Project area due to conflicting socio-cultural norms amongst the local community and in-migrants.
	Impact SC4: Better access to health facilities for the local communities.
	Impact SC5: Increase in opportunities for recreational fishing due to increase in population of fish.

7.5.1 Macroeconomic Impacts

Availability of Power and Reduction in Load Shedding

768. As discussed in (**Section 8**), Analysis of Alternatives, AJK and Pakistan are going through an acute power shortage. The gap between supply and demand has crossed 5,000 MW. The proposed Project will supply the much needed power to reduce the current gap. Improved availability of power will directly and indirectly benefit all sectors of the economy and will enhance economic growth.

Impact ME1: Availability of power to meet the growing demand in the economy and reduction in power outages								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Major+	Long-term	Extensive	High	Definite	High	+	High

Increase in Government Revenues

769. The Project will invest in equipment, construction materials, infrastructure and human resources. This investment and the return generated from the Project will be circulated within the AJK economy through the following mechanisms:

- Payments made to domestic suppliers against the goods and services procured under the Project.
- Expenditures made by Project staff on purchasing local goods and services, using the income earned under the Project.
- Government spending on developmental activities against the taxes and royalties collected under the Project.

770. The circulation of income through increased spending on purchase of domestic goods and services, i.e., goods produced within AJK, will result in economic growth and generation of employment opportunities.

771. Government revenues collected during the operational phase of the project, in the form of taxes and royalties will benefit the national economy and help promote development within AJK District in particular and at the national level in general. Foreign technology and skill set due to the Project will indirectly add to the national and District level economies.

772. The Project's suppliers of goods and services, and formal businesses that would be created or expand because of induced economic impacts, would pay taxes on their profits and payrolls. The positive fiscal impact (both direct and indirect) would form a sustainable source of income for the government.

773. The increased government income from the Project would carry a high rate of social return if invested in infrastructure such as roads, educational institutions, hospitals, and public services. The term "rate of social return" reflects the total value of all benefits associated with an investment that accrue to members of society. The increased government revenue could be used to meet this objective by improving infrastructure and services in areas local to the Project. The realization of this impact relies on government decisions regarding the allocation of its revenues.

Impact ME2: Government revenues from the Project, in the form of taxes and royalties, leading to increased developmental spending in the country								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Moderate+	Long-term	Extensive	High	Definite	High	+	High

7.5.2 Local Livelihoods and Wellbeing

774. During the consultation for the Project the community expressed a need for provision of transparent and merit based employment to the locals and investment in the community infrastructure. Sand and gravel mining were identified by the community as means of livelihood and the community demanded that the project should not deprive them of these resources. Increase in abundance of fish expected from the implementation of the Biodiversity Action Plan (**Section 11**, Environmental Management and Monitoring Plan) will provide income generating and recreational opportunities to the local community.

775. MPL will produce an annual Corporate Social Responsibility (CSR) plan, which will provide detailed information on method, roles and responsibilities of interaction with the local community, mitigation of socio-cultural impacts such as social ills, socio-cultural conflicts and enhancement of positive impacts such as recreational opportunities due to increased fish catch in the area.

Employment

776. In AJK, education levels of the population are generally higher as demonstrated by the literacy level of more than 70% **(Section 5.3**), compared to AJK average of 70.4%[15] and national average of 54%[16]. The skill set of the local community will be developed through vocational institutions and training centers in the Project Area. Presently, 7% of the local community is dependent on sand and gravel mining. Other sources of income include businesses, daily wage labor and overseas employment. During community consultations, women expressed an interest in gaining access to office-based employment opportunities alongside men.

777. The incomes of people employed by the Project are likely to lead to improved nutritional status, better housing, access to education and improvement in overall well-being of their families. Poverty cycles in poor families could be broken if children in the families become better educated and have more livelihood options than their parents had. The Project will provide employment to 700 persons in the construction stage and 100 in the operations stage (**Section 4.4**, Workforce). The Project will directly and through indirect and induced mechanisms contribute to alleviating poverty and vulnerability in AJK, and to prosperity and well-being of the people employed by the Project.

15 Source: http://pndajk.gov.pk/glance.asp Accessed March 2014

16 Pakistan Bureau of Statistics. *Pakistan Social & Living Standards Measurement Survey (PSLM).* Government Report, Islamabad: Pakistan Bureau of Statistics, 2005-06.

Impact LW1: Direct, indirect and induced employment at the local levels, resulting in increased prosperity and wellbeing due to higher and stable incomes of people.								
Applicable Project Phase								
Construction and Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+ /-*	*Confidence*
Initial Impact	Minor+	Long-term	Extensive	Medium	Possible	Medium	+	High
Enhancement Measures: • Ensure preferential recruitment of local candidates provided they have the required skills and qualifications. • Include an assessment of the contractor's demonstrated commitment to domestic and local procurement and local hiring in the tender evaluation process. • Coordinate recruitment efforts related to non-skilled labor, including for non-skilled labor positions required by contractors. **Good practice measures:** • Determine what is considered to be 'fair and transparent' in recruitment and in distribution of jobs between different community groups, in consultation with local communities and their leaders. • Set long-term (10 to 15 year) targets for local representation at the managerial level. Implement training and development to meet these target timeframes.								
Enhanced Impact	Moderate+	Long-term	Extensive	High	Definite	High	+	Medium

Training and Skill Development

778. The Project will result in the training and skill development of local and domestic labor, especially during the construction phase of the Project. Financial and technical investment by foreign companies is generally seen as a positive opportunity for developing countries as their technology is usually more advanced compared to local available technology.

779. The knowledge and skills acquired by the local community will be of value to the labor-force of the country at national and local levels. The creation and injection of highly trained workers, qualified in multiple skills, into the economy will improve the productivity of the workforce and the benefits will extend to other firms and industries. This impact can therefore stretch to Micro and Macro Economic levels.

780. For enhancement of employment benefits at the local and domestic levels, various training programs will be implemented by MPL. The training programs will focus on maximization of participation of local community in the construction and operational phases of the Project.

Impact LW2: Increase in the stock of skilled human capital due to transfer of knowledge and skill under the Project resulting in enhanced productivity of the local labor.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	*+ /-*	*Confidence*
Initial Impact	Minor+	Long-term	Intermediate	Medium	Possible	Medium	+	Low

Enhancement measures:

- Support a 'vocational training program' to assist local people to qualify for semi-skilled positions focusing on issues such as procurement, involvement of vulnerable groups in Project opportunities and continual professional development of staff.

Good practice measures:

- Assist local people having practical skills but lacking qualifications to obtain their certificates and thus increase their employment opportunities.
- Support initiatives promoting a culture of learning in local communities.
- Plan and implement training program for vulnerable groups to encourage their participation in economic opportunities created by the Project.
- Assist employees and local communities to improve basic personal financial life skills through training and awareness campaigns, respectively.
- Consider further training programs to prepare retrenched workers to seek employment in sectors not related to dam construction.

Enhanced Impact	Moderate+	Long-term	Extensive	High	Possible	High	+	Low

Enhancement of Subsistence and Recreational Fishing

781. Estimates for consumption of fish caught from Poonch RIver are provided in (**Section 5.3.10**), Livelihoods and Incomes. Common fish consumed in the area are Pakistan Labeo (70% of total fish consumption) and Mahaseer (30% of total fish consumption). The market rate of fish is presently Rs 300 ($3) per kg. The total annual market value of the fish caught per in the entire stretch of Poonch River downstream of the LoC to the Mangla reservoir is estimated at Rs 7.5 million ($0.75 million).

782. After the implementation of the BAP, total fish catch of both fish Pakistan Labeo and Mahaseer could increase. Based on the mean percentage change in fish population predicted through DRIFT Modeling (**Section 6** Environmental Flow Assessment) and assuming an increase in fish catch in proportion to increase in fish population, the annual catch of Pakistan Labeo could potentially increase to 40,600 kg per year and of Mahaseer to 11,700 kg per year. This makes the total fish catch in the river to be approximately 52,300 kg per year. At the present rate of fish in the market, the total market value of the fish caught per year in the entire stretch of Poonch River downstream of the LoC to the Mangla reservoir could correspondingly increase to Rs 15.7 million (USD1.57 million).

783. According to results of the socio-economic survey conducted in the Study Area (**Section 5.3.9**, Recreational Uses of the River), fishing is mostly done to supplement food and is not actively pursued as an income generating activity. The magnitude of impact of increase in fish catch on local incomes would therefore be minor. Locals and visiting anglers also catch fish in the river for recreation but this activity has declined over time as illegal and unregulated fishing using nets has reduced the number of fish in the river making it difficult for anglers to catch fish.

784. According to the Himalayan Wildlife Foundation, there is considerable potential for promotion of recreational fishing in Poonch River as the Mahaseer is considered a prized angling fish in the Indian subcontinent[17]. The management policies in protected areas and provisions of the legislation in AJK allow for community based sustainable harvesting of fish, which can include subsistence as well as recreational fishing. The AJK Fisheries and Wildlife Department will monitor the fish populations and regulate the

[17] Ecological Baseline Study of Poonch River, AJ&K, With Special Emphasis on Mahseer Fish, Himalayan Wildlife Foundation, January 2012.

extent to which harvesting of fish from the river can be allowed to increase, which will determine the extent of fish that is harvested from the river.

Impact LW3: Increase in local incomes and wellbeing due to increase in catch of fish following creation of favorable habitats for the fish in the Poonch River.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Minor+	Long	Extensive	Medium+	Possible	Medium+	+	High

Sand and Gravel Mining

785. During the socioeconomic survey, it was observed that about 7% people in the Study Area were earning livelihood through sand and gravel mining. Majority of the households use sand and gravel for construction and renovation purposes at their homes (**Section 5.3.8, '**Livelihoods and Incomes').

786. Changes in sediment deposition patterns in the river resulting from the operation of the dam are summarized in (**Section 7.2.9**) Impacts on Sediment Availability. This analysis was followed by the assessment of socioeconomic impacts on the river bed and sediment due to the dam included in the specialist report in **Appendix F**, 'Possible Mitigation Strategies with Respect to Sand and Gravel Mining in Poonch Basin', Sustainable mining of sand and gravel in the Poonch Basin is a part of the Biodiversity Action Plan prepared for the Project. This section summarizes the expected impacts of the Gulpur dam on deposition of sediments upstream and downstream of Gulpur dam, consequential impacts on the access of community to sand and gravel deposited in the river bed, and provision of mining alternatives to the community that have minimum impact on ecology.

787. As discussed in (**Section 7.2.9**), it was estimated that all of the cobble and boulders, almost all of the sand load and approximately 30% of the silt load would be trapped and deposited in the proposed Gulpur Project reservoir. For Gulpur Project, Mott MacDonald[18] estimated that 40% of the total load of the average total sediment inflow would be deposited in the reservoir, which is well in excess of the current levels of sediment extraction from the region.

788. Cobbles would be trapped close to the upstream end of the reservoir or slightly upstream in the wet season backup zone because the lowered flow velocities in this backup area would be too slow to transport very large bed elements. Progressively smaller sediment classes, including sands, which travel as suspended load in high velocities, would be deposited where the river enters the reservoir and flow velocities drop. The normal operating level of the dam for Gulpur Project is 535 m asl[19], which means that the backup will extend to near Kolti town. Given that there is good access to both banks along much of this reach, and that sediment mining operations are already in existence here, it is likely that exploitation of the sediments which become deposited in this reach would be a viable proposition.

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[18] Mott MacDonald (2011). Gulpur Hydroelectric Power Project: Review of Requirement for Desanding Bay (Final Report), Sambu Construction Co. Ltd, November 2011.

[19] Metres above sea level

789. The expected changes in sediment downstream of Gulpur dam can be divided into those in the reach between the dam and the tailrace and those downstream of the tail race. In general, both reaches are expected to experience a reduction in sediment supply, but differences in the volume of water between the two reaches will result in very different outcomes. The critical reductions in suspended sediment will be linked to the large declines in the base flow, whereas the large peaks will be associated with proposed periodic flushing of the reservoir. In the low flow segment between the dam and the tailrace there will be very low total sediment loads because for most of the year the discharges will be very low, and the availability of cobbles and boulders in particular will be considerably reduced. However, during flushing or sluicing of the reservoir, very large peak suspended sediments are likely to occur during high flows.

790. Downstream of the tailrace, the suspended loads will be reduced relative to present levels because of the sediment trapping effect of the reservoir. As in the upstream dewatered zone, annual flushing of the reservoir may, however, yield peak suspended sediment discharges higher than normal. As discussed in (**Section 7.2.9**), the availability of cobbles and boulders is expected to be low immediately downstream of the tailrace, about 10-15% of the present levels, but should improve with distance as a result of the replenishment by supply of these sediments from lateral bars, the channel bed and from tributary inputs.

791. Arguably the best way to achieve the proposed reductions in mining impacts is to focus mining activities in fewer areas where they can be better managed as this will reduce the area of sediment mining, reduce mining in sensitive areas and potential reduce the direct site-specific impacts. The construction of Gulpur dam would present an opportunity for doing just this. Although the feasibility of implementing a large-scale mining operation in the head waters of the Gulpur reservoir is subject to confirmation, initial indications suggest that:

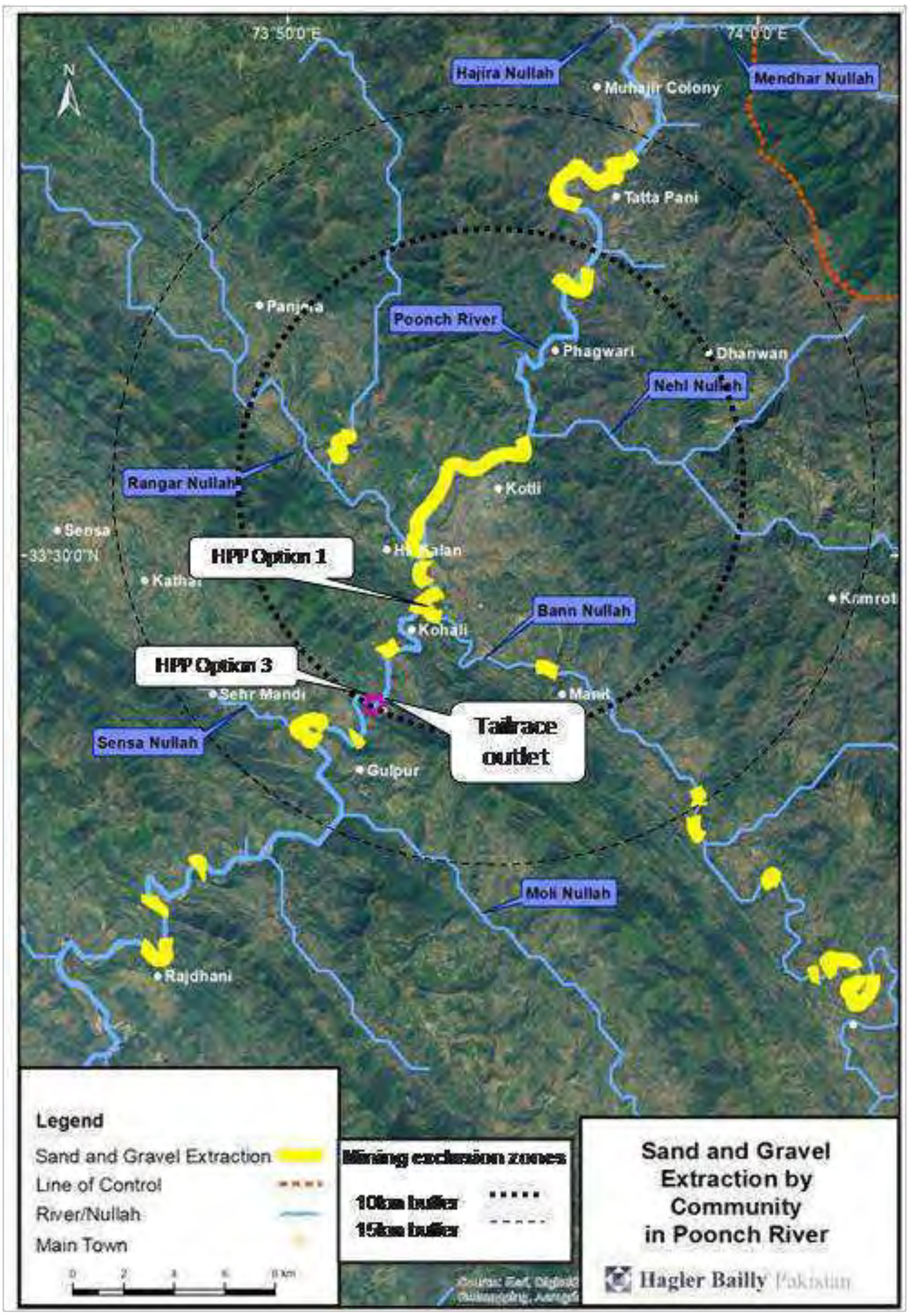
- the quantities likely to be deposited annually will exceed the (very) preliminary estimates of 2013 demand for sediment and probably exceed demand for quite some time to come.
- roads could be constructed/existing roads improved to allow for easy and safe access to the area.
- since sediment loads are highest in the wet season, much of the sediment would probably be deposited above the normal operating level as reservoir levels and backup effects tend to extend upstream in the wet season.
- if necessary, access to the sediments, particularly the smaller size fractions, could be enhanced by lowering the operating level of the weir in the dry winter months.
- current mining operations within a 10-15 km radius of the backup zone could be relocated to the backup zone without subjecting the miners to undue additional travel or transport costs (**Figure 7-3**).
- Outside of the 10-15 km radius, mining operations can also be focused on fewer, better controlled areas that avoid the sensitive habitats.
- it possible that some (or all) of the activities further afield than the 10-15 km radius, such as those of the upper Bann Nullah (**Figure 7-3**), can also be relocated to the back-up of Gulpur weir, depending on the location of the target market for sediments mined in these areas.

- similar initiatives have been successfully implemented elsewhere.
- The selection of appropriate sites for sediment mining could be based on local knowledge or information regarding aggradation (sediment deposition) rates; where the proposed operation can minimize disturbance and maximize stability of channel to avoid impact on river ecology.

792. In view of the business value and household use of this commodity, the impact consequence is rated as 'High'. A Sediment Mining and Management Plan will be prepared and implemented as a part of the BAP. Terms of reference for the plan are included in **Appendix F.** Monitoring of sand and gravel mining and its impact on river ecology is included in the monitoring plan of the BAP. Considering the implementation of the Sand and Gravel Mining Management Plan as a part of the BAP, residual impact due to the Project will be Low in consequence as alternate sites will be provided for sand and gravel miners to continue their activities.

Impact LW4: Loss of income from sand and gravel mining due to change in pattern of sediment deposition following construction of the dam.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Major	Long-term	Extensive	High	Definite	High	-	High
Mitigation measures: • A Sediment Mining and Management Plan will be prepared as a part of BAP, which identifies possible sand and gravel mining spots along the Poonch River. • Through BAP and annual CSR Plan of MPL, controlled sand and gravel mining practices will be established at the alternate locations identified in the Sediment Mining and Management Plan.								
Residual Impact	Minor	Long-term	Small	Low	Possible	Low	-	Low

Figure 7-3: The 10 and 15 km radii Around the Backwater Areas of the Gulpur Reservoir



7.5.3 Socio-cultural Impacts

793. The Project stakeholders expressed concerns on the potential sociocultural changes that can be induced by the Project including enhancement or possible degradation of social and economic landscape, and hindrance in mobility of the people due to location of project facilities such as construction camp and storage areas.

Pressure on Social Infrastructure and Services

794. There is a potential for an influx of job seekers in the Study Area due to the jobs created by the Project and by service providers to the Project as well as due to the prevalence of unemployment and a lack of job opportunities in the Study Area. Greater influx of in-migrants is expected in the Study Area due to its vicinity to the Project. Some service providers to the Project may open new offices in Kotli, which is situated at a distance of about 18 km from the Project site. The potential in-migration in Kotli due to the Project will be negligible in comparison to the present population of Kotli. The influx of job seekers will pose pressure on the availability of infrastructure and services, such as those pertaining to education, health care and medication, water and communication in the Project area.

Impact SC1: Increase in population due to in-migration of job seekers (in-migrants) leading to pressure on existing social infrastructure and services in the Study Area.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Medium	Intermediate	Medium	Possible	Medium	-	Medium
Mitigation measures: • See LW1. **Good practice measures:** • Encourage local communities to use the grievance procedure for concerns related to deterioration of local services. • Support local government in the implementation of infrastructure projects. • Support NGOs specializing in development of infrastructure to assist local government.								
Residual Impact	Minor	Medium	Intermediate	Low	Possible	Low	-	Medium

Conflicts Due to Provision of Employment to Outsiders

795. A potential source of conflict is real or perceived unequal access to Project opportunities. Complaints can be expected from local communities residing in the Study Area if the distribution of jobs among local communities is perceived to be unfair. Objections can also be expected if people from outside the Study Area are seen to usurp opportunities created by the Project, as the Study Area inhabitants may consider themselves as the rightful owners to the Project benefits owing to their vicinity to the Project. This increases the need for open communication between MPL and the various community heads, as well as within the community heads themselves. The communication plan with local communities will be outlined in the annual CSR plan of MPL.

Impact SC2: Disputes over distribution of Project employment within and between Study Area inhabitants and the in-migrants resulting in social unrest.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Moderate	Medium	Inter-mediate	Medium	Possible	Medium	-	High

Good Practice Measures: • Refer to measures under Impact LW1. • Implement MPL’s Stakeholder Engagement Plan, contained in the annual CSR Plan that includes: ○ maintaining regular communication with local communities and other stakeholders to minimize tensions arising from Project activities; ○ maintaining a grievance procedure (to be outlined in MPL’s annual CSR plan), and encourage and facilitate stakeholders to use the mechanism to express concerns; and ○ providing sufficient resources to the community relations officers to enable them to monitor negative perceptions and associated tensions, and to address them in a timely fashion.								
Residual Impact	Minor	Short	Intermediate	Low	Possible	Low	-	Medium

Conflicting Socio-cultural Norms

796. The influx of job seekers in the Study Area could give rise to ethnic and cultural diversity in the Study Area. There could be cultural conflicts between the in-migrants and the Study Area inhabitants due to their conflicting traditions and norms. The likelihood of this impact is low given that Project facilities are not located in immediate vicinity of local communities and where the facility borders local communities, proper fencing and barriers are provided to avoid unnecessary interaction.

Impact SC3: Potential social unrest in the Study Area due to conflicting socio-cultural norms amongst the inhabitants and in-migrants.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Minor	Short	Small	Low	Possible	Low	-	Medium
Enhancement measures: • Refer to measures under Impact SC2.								

Health Facilities

797. During the socioeconomic consultations, locals, especially in smaller settlements such as Kameli and Rehmani Mohallah noted the lack of basic health facilities in the area. Due to improper communication infrastructure, it was difficult for them to respond to emergency health situations and access health facilities in Kotli or other larger settlements.

798. The annual CSR Plan to be prepared by MPL will include plans for supplementing the existing health care services and facilities for the local communities around the Project Area. Due to the enhancement of basic level health care facilities at the Project Site, locals will be facilitated, especially in terms of emergency health issues or first aid. The impact consequence is therefore rated as ‘High’.

Impact SC4: Better access to better health facilities by the local communities.								
Applicable Project Phase								
Construction								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
Initial Impact	Minor+	Medium	Inter-mediate	Low	Possible	High	+	High
Enhancement measures: • Annual CSR Plan will outline mitigation measures and implementation responsibility for this impact. • Allow access of local communities to the health infrastructure constructed for Project employees. • Provide health care services to the local community for instance polio vaccination, dispensary facilities and local clinics if possible.								
Enhanced Impact	Moderate+	Medium	Inter-mediate	Medium	Definite	Medium	+	Medium

Recreational Fishing

799. As discussed in (**Section 6,** Environmental Flow Assessment), the catch of fish catch upstream and downstream of the dam will increase due to creation of favorable habitat for the fish in Poonch River through the implementation of the Biodiversity Action Plan. During the community consultations and socioeconomic survey, it was noted that fishing was not an important means of livelihood at the local level and recreational fishing was not that widespread. However, as the potential for fish harvesting in the river increases due to the implementation of the BAP, livelihood and recreational opportunities will be created in the locality. The impact of recreational fishing has been rated as medium in consequence.

Impact SC5: Increase in opportunities for recreational fishing due to increase in population of fish.								
Applicable Project Phase								
Operation								
Impact Rating								
	Magnitude	*Duration*	*Scale*	*Consequence*	*Probability*	*Significance*	+ /-	*Confidence*
	Moderate+	Long	Intermediate	Medium	Possible	High	+	High

7.6 Cumulative Impact Assessment

7.6.1 Introduction

800. There are currently five hydropower projects planned on the Poonch River, four of which fall in the AJK, and one is located in the Indian Administered Kashmir. The projects are (from upstream to downstream; **Figure 7–4**):

- Parnai HPP: a 37.5-MW diversion plant in Indian Administered Kashmir. Available design details indicate that the project will divert water through a tunnel into Mendhar Nullah, which flows into the Poonch River in AJK about 15 km downstream of the Line of Control (LoC)[20].

[20] Parnai HPP: Project Design Document, 37.5-MW Parnai Hydroelectric Project, submitted to UNFCCC by Jammu and Kashmir State Power Development Corporation Limited and IT Power Consulting Private Limited, September 2013

- Sehra HPP: a 130-MW RoR plant just downstream of the LoC[21].
- Kotli HPP: a 100-MW RoR plant just upstream of Kotli[22].
- Gulpur HPP: a 100-MW RoR plant just downstream Kotli[23].
- Rajdhani HPP: a 132-MW RoR plant just upstream of Mangla reservoir[24].

801. Of these, design is complete for Parnai and Gulpur HPPs, and both of these projects are at an advanced stage of development at award of engineering, procurement, and construction (EPC) contracts is expected in the near future. The feasibility study has been prepared for the Sehra HPP. Prefeasibility studies have been completed for the Kotli and Rajdhani HPPs, and a right to construct has also been granted for the Kotli HPP. If built, in all likelihood the five projects will be operational in a period of five to seven years.

802. A Draft Rapid Cumulative Impact Assessment was completed in January 2014. Results of the stakeholder consultations for cumulative impact assessment of proposed hydropower projects on the Poonch River will be included in the Final Rapid Cumulative Impact Assessment that will be completed in early November. This section provides an analysis of various development and resource use projects and activities planned in the Poonch River basin in the context of the 'development space' in which the resources can be utilized in a sustainable manner. The following areas and aspects are covered in this section:

- The Strategic Environment Assessment (SEA) perspective for development of hydropower in the AJK.
- Hydropower projects planned in Poonch River basin.
- Impact of current utilizations of ecosystem services:
- Mining of sand, gravel, and boulders from the river bed by the communities.
- Subsistence and recreational fishing.

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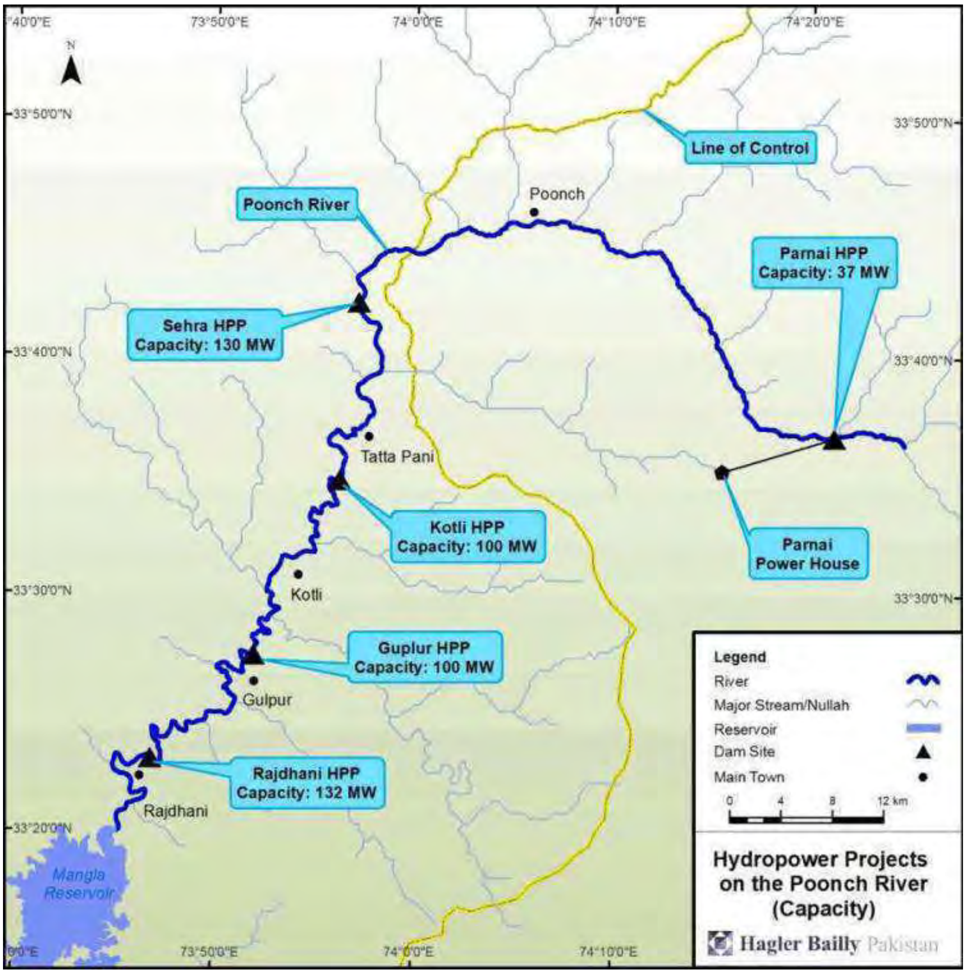
21 Sehra HPP: Feasibility Study, Tamavan Company, Iran, November 2009.

22 Kotli HPP: Project Profile, 100-W Kotli Hydropower Project, Private Power and Infrastructure Board, Government of Pakistan, December 2013

23 Gulpur HPP: Basic Design Report and other design details for Gulpur Hydropower Project prepared by Mira Power Ltd.

24 Rajdhani HPP: Feasibility Report, Rajdhani Hydropower Project, MWH, December 2003.

Figure 7–4: Proposed Hydropower Projects on the Poonch River and their Status



803. Aspects that are not included in the discussions in this section and reasons for their exclusion are outlined below.

804. *Impact on traffic volumes:* Implementation of the hydropower projects planned on the Poonch River will involve major construction activities in the basin over the next 10 to 15 years. Construction of individual projects is expected to happen in series with intervals of c. 12 months between each, and the impacts of individual projects on traffic volumes are expected to be minor. Thus, provided peak travel times for individual projects do not coincide, the overall impact on traffic volumes is expected to be small and acceptable.

805. *Impact on river water quality:* All the planned projects are so-called RoR, and as such are not expected to significantly alter change the temperature regime or water chemistry of the river, other than within the reservoirs themselves.

806. *Impact of migrant labour:* Construction of the hydropower projects planned on the Poonch River would provide employment for skilled and un-skilled labourers, and could attract an influx of migrant labour from outside the basin. However, provided construction of individual projects is staggered (as suggested in traffic above) then it should be possible to limit this influx. Once operational, each power project will employ c. 120 skilled and semi-skilled people. While this should provide some employment

opportunities for locals in the basin, it is probably insufficient to represent a draw-card for unskilled labour from outside the basin.

807. *Increase in supply of electricity:* The availability of electricity in the Poonch basin is likely to improve if the proposed hydropower projects are implemented, despite the fact that the bulk of the power produced would be transmitted to the national grid. The hydropower generation potential of the Poonch River basin, however, is less than 5% of that of AJK and less than 1% of the potential in the country[25]. As such, even if all the projects proposed for the Poonch River are implemented, they would not result in a significant increase in electricity supply for the country as a whole on a long term basis.

808. *Direct and induced economic development:* During the construction period each project will employ about 700 skilled and unskilled persons. In the near term, the demand for local goods such as construction materials and services such as supply of food and other services for the project and work force will temporarily increase. However, in the long term each project will provide direct employment for c. 120 people (see above) once the projects go into operation. While this level of employment will contribute to the local secondary economy, given the population of the area and size of the local economy the relative contribution of the hydropower projects is unlikely to be significant.

7.6.2 SEA Perspective on Development of Hydropower Potential in the AJK

809. In 2014, IUCN prepared a '*Strategic Environmental Assessment of Hydropower Development Projects in Azad Jammu and Kashmir*'[26], which recommended the preparation of strategic plans, policies and guidelines for hydropower development in AJK that recognized both the economic and environmental value of the regions rivers and guided their development in a sustainable manner.

810. In the SEA:

- The hydropower potential of Poonch River in AJK was estimated at c. 474 MW[27].
- The hydropower potential of the Jhelum and Neelum Rivers in AJK was estimated at c. 7 000 MW.
- The entire Poonch River was classified as a 'Highly Sensitive Zone', mainly in recognition of the diversity of fish, the presence of endangered fish species, and status of the river as a National Park.
- Segments of the Jhelum and Neelum Rivers were classified as 'Moderately Sensitive Zone' and 'Least Sensitive Zone'.

811. The SEA also suggested that the hydropower potential of the Jhelum and Neelum rivers could be developed at a significantly lower cost to the environment than that of the Poonch River, and that caution needed to be exercised in developing the potential of the Poonch River in view of its relatively high environmental value and relatively smaller contribution to the national economy.

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[25] Potential for hydropower development for Pakistan and AJK is estimated at 60,000 MW by Pakistan Private Power and Infrastructure Board. Current hydropower capacity is 6,800 MW.

[26] IUCN 2014, Strategic Environmental Assessment of Hydropower Development Projects in Azad Jammu and Kashmir.

[27] This estimate is higher than the combined capacity of 462 MW for the projects in AJK listed in Section 7.1. It is likely that these are overestimates of hydropower potential as they were calculated

812. Two hydropower plants on the Neelum/Jhelum are presently in advanced stages of construction, viz.: the 330 MW Kishenganga HPP, which is due for completion in 2016, and will supply power to the national grid in India; and the 969 MW Neelum-Jhelum HPP, which is due for completion by end 2015 and will supply power to the national grid in Pakistan.

7.6.3 Approach for this Cumulative Assessment

813. This cumulative assessment is based on the approach used and results obtained for the assessment of the environmental flows (EFlows) for the Gulpur HPP (**Section 6,** Environmental Flow Assessment). The assessment is based on consideration of the impacts related to flow changes, including:

- The effects of habitat modification within the reservoir created by the HPP dam.
- The effects of reduced flows between the HPP dam and the tailrace[28].
- The effects of increased flows in the Mendhar Nullah as a result of releases from Parnai HPP. These include increased erosion, armouring, disruption of breeding cues, destruction of habitats and nests[29].
- The effects of flow regime changes downstream of the tailrace, particularly where peaking-power releases are considered likely.
- The effects of changes in sediment supply and transport as a result of the HPP dams and changes in the flow regime;
- The barrier effects of the HPP dams on fish.

814. In the case of each, results obtained for Gulpur HPP were extrapolated to the other HPPs[30]. While it is entirely possible that the impacts associated with the other HPPs may differ based on HPP design and localized river characteristics, it is unlikely that these differences will materially affect the outcome of this desktop cumulative impact assessment. Furthermore, it is assumed that the individual projects will conduct their own cumulative impacts assessments making appropriate assumptions on the status of the projects at the time of assessment.

815. The following assumptions were made in this cumulative impact assessment:

- The normal operating level (NOL) of Mangla reservoir will be 390 m.
- With respect to peaking power generation:
  - Sehra, Kotli and Gulpur HPPs will be limited to baseload power generation (i.e., no peaking power production).
  - Rajdhani HPP, which discharges into Mangla reservoir, may be operated in a peaking mode but this is will not significantly increase its ecological impacts.

[28] For Parnai HPP, this river reach is from the Parnai dam to the confluence between the Poonch River and Mendhar Nullah.

[29] Gulpur Hydropower Project, Environmental Flow Assessment, Geomorphology Specialist Report, Fluvious Environmental Consultants and Southern Waters.

[30] Modeling of the impacts of an additional four HPPs using DRIFT was outside the scope of this study.

  - The design of Parnai HPP specifies a peaking operation in winter, and thus the potential impacts of Parnai with and without peaking are considered here.
- Management procedures for the mitigation of the existing impacts were assumed for the basin in AJK. These corresponded to Protection Level 2 (Pro 2) as described in (**Section 6**).
- EFlow releases will be c. 40% of the natural 5-day minimum dry season flow, with the exception of the Rajdhani HPP where the tailrace will discharge directly into Mangla reservoir. Results from similar RoR projects suggest that this level of EFlow will probably translate into c. 10% less power generation than without an EF release. Higher level of EFlows could require higher level of supporting electricity tariffs, which may make the projects uneconomic[31].

816. The assessment took into account the potential beneficial effects of introducing management procedures for the mitigation of the impacts of over-fishing, sediment mining, harvesting of riparian vegetation and effluent disposal on condition of the riverine ecosystem.

7.6.4 Delineation of the Study Area

817. The Poonch River shares a number of fish species common with the Mangla Reservoir (**Section 3** of **Appendix B**, Biodiversity Baseline). In addition, the Poonch River provides a breeding ground for the fish fauna of the reservoir. Thus, there is connectivity between the Poonch and Mangla aquatic ecosystems and changes in the physical, chemical or biological characteristics of the Poonch River will impact the ecological resources of both the Poonch River and Mangla Reservoir. Based on ecological contiguity, the Study Area for CIA is defined to include the entire stretch of the Poonch River, its tributaries as well as the Mangla Reservoir.

7.6.5 Identification of Valued Environmental Components

818. The Valued Environmental Components (VECs) of the Study Area were selected on the basis of results of literature review of EIAs and conservation studies carried out on the rivers of AJK, as well as baseline field surveys, data analysis and stakeholder consultations carried out for the Gulpur Hydropower Project.[32] The VECs are the components that are likely to be the most sensitive receptors to the potential cumulative impacts from the construction of the planned hydropower projects. The following VECs were selected:

- Surface water quality and quantity (flow)
- Sediment (sand and gravel)
- Resident and migratory fish species
- Landscape

[31] Where river flow is diverted into tunnels leading to a powerhouse, release of water at the dam to maintain an environmental flow in the river downstream of the dam normally results in reduced power generation. Where technically and economically feasible, this impact on power generation can be reduced or avoided by installing a small turbine at the dam to recover energy from the environmental flow release.

[32] Hagler Bailly Pakistan, 2014, Rapid Cumulative Impact Assessment, Gulpur Hydropower Project, Mira Power Ltd.

7.6.6 Cumulative Impacts on Selected VECs

819. This section summarizes the cumulative impacts of the planned hydropower projects on the selected VECs.

Impacts Related to Flow Changes

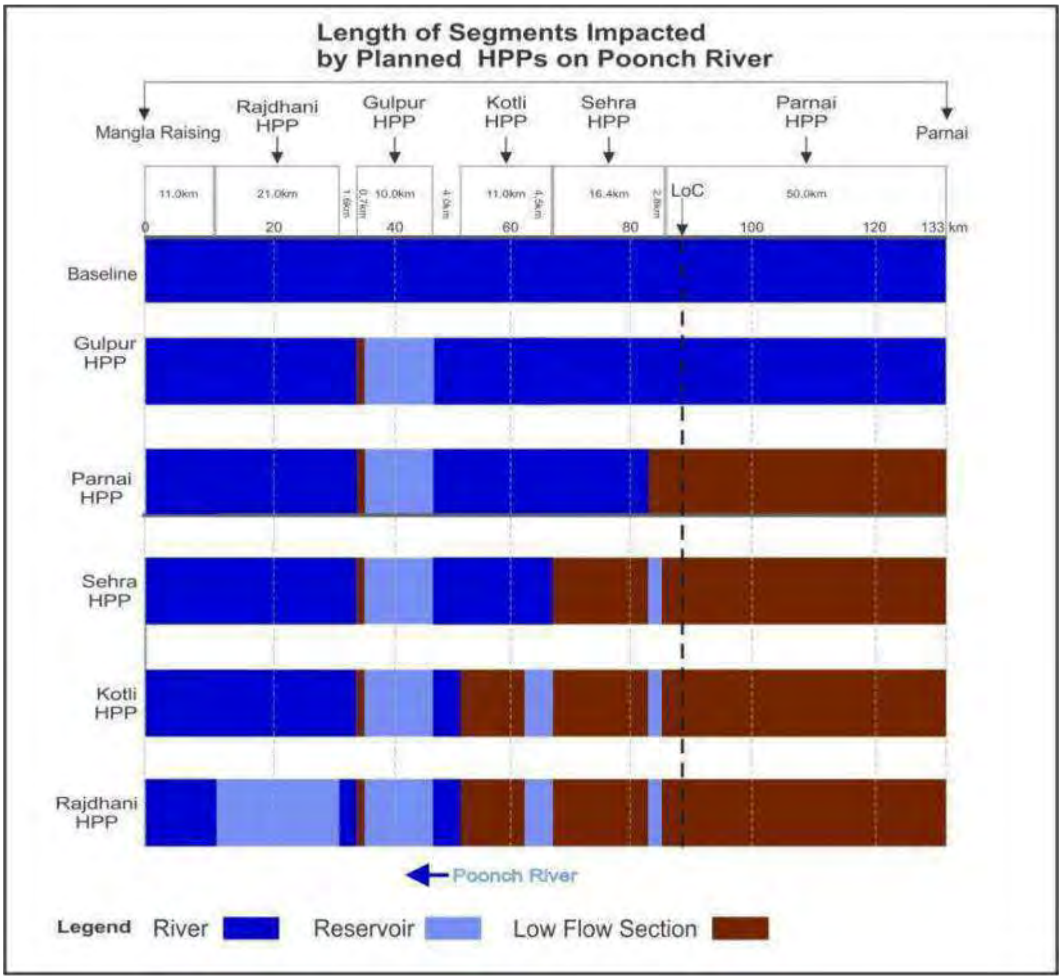
820. In combination, flow changes as a result of the proposed HPPs will severely impact c. 87% of the Poonch River (between Parnai HPP and Mangla reservoir) and 94% of the Mendhar Nullah. These impacts are (**Table 7–6, Figure 7–5, Figure 7–6**):

- 36.8 km of river lost as a result of inundation; 68.1 km impacted by reduced dry season flows; and
- 40.0 km of the Mendhar Nullah impacted by unnaturally high flows.

Table 7–6: Length of river Habitat Severely Impacted by Flow Changes Associated with the Five Proposed HPPs

HPP	River	Reach	Absolute Distance (km)	Cumulative Distance on Poonch
Parnai	Poonch	Parnai reservoir	2	2
	Poonch	Parnai dam to Mendhar Nullah	50	52
	Mendhar Nullah	Parnai tailrace to Poonch River	40	52
Sehra	Poonch	Sehra reservoir	2.8	54.8
	Poonch	Sehra dam to tailrace	16.4	71.2
Kotli	Poonch	Kotli reservoir	4.5	75.7
	Poonch	Kotli dam to tailrace	11.0	86.7
Gulpur	Poonch	Gulpur reservoir	10.0	96.7
	Poonch	Gulpur dam to tailrace	0.7	97.4
Radjhani	Poonch	Radjhani reservoir	21.0	118.4
	Poonch	Radjhani dam to tailrace	0	118.4
	Poonch	Radjhani tailrace to Mangla NOL	11.0	129.4
n/a	Poonch	Parnai reservoir to Mangla reservoir	148	
% of Poonch River affected				87.4%

Figure 7–5: Change in Flow in the Poonch River with Sequential Implementation of Planned HPPs



Note: The sequence for the projects in AJK is based on the discussion of the current status of development included in (**Section 8.1.1**).

Figure 7–6: Extent of River Length that will be Affected by Flow Changes as a Result of the Planned HPPs on Poonch River

821. The distances exclude the river reaches between the tailrace outlets and the reservoir of the next HPP, as these are deemed to be negligible in terms of flow change unless peaking operations are employed. If peaking operations are employed at Parnai HPP and Radjhani HPPP, the extent of these impacts increases to 79.1 km.

822. It may also be noted that:

- the variations in the affected distances reflect the project designs as well the river gradient, which increases towards upstream (see **Figure 5-8, Section 5.1.8**); and
- the outlet of the power house of the Rajdhani project is close to the highest level reached by Mangla reservoir where the habitat already fluctuates between riverine and lake due to seasonal changed in the reservoir level.

The Effects of Changes in Sediment Supply and Transport

823. The dams associated with the planned HPPs will act as sediment traps, causing a loss of sediment supply and distribution downstream (Ibanez *et al*., 1996[33]; Vorosmarty *et al*., 2003[34]; Wohl, 2004[35]; Anselmetti *et al*., 2007[36]; Wang *et al*., 2007[37]). Sediment transported downstream of the dams will be significantly lower than at present (2013) due to the deposition of bedload and suspended load within the reservoirs. Sediment in the water column will be replaced through erosion of the beds, banks, bars and islands in the downstream reaches. Typical effects on habitats include (Petts, 1980[38]; Williams and Wolman, 1984[39]; Ligon *et al*, 1995[40]; Church, 1995[41]; Brandt, 2000[42]): coarsening of the bed material (armouring); incision of the active channel/s; reduced size of the active floodplain; net erosion of the beds and banks; and abandonment of secondary channels and associated loss of islands (since these frequently become joined to the main banks. Each of these habitats changes will have knock-on effects on river biota. For instance, fine sediments on the river bed provide breeding and nursery areas and secondary channels provide refuge from high flows.

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The Barrier Effects of the HPP Dams on Fish

824. The relative importance of the Poonch River mainstem and tributaries (nullahs) for breeding areas for endangered fish is given in **Table 7–7**. Many of the fish that inhabit the Mangla reservoir breed in the rivers upstream, but once the HPPs are constructed fish will be unable to swim upstream of the first dam or will be trapped between dams. Thus, the proposed HPPs will affect not only the biodiversity of the river but also that of Mangla reservoir.

Table 7–7: Relative Importance of the Poonch River Mainstem and Tributaries (Nullahs) for Breeding Areas for Endangered Fish

River/River Reach	*Relative Importance (%)*	*Access from Lower Poonch River Affected by*
Poonch River (upper mainstem)	30	All
Rangar Nullah	18	Radjhani
Bann Nullah	15	Radjhani and Gulpur
Mendhar Nullah	15	Radjhani , Gulpur, Kotli and Sehra. Nullah itself destroyed by Parnai
Nehl Nullah	11	
Hajeera Nullah	11	Radjhani, Gulpur, Kotli and Sehra.

Impact on Landscape

825. Multiple cascading hydropower plants, together with the construction of ancillary facilities such as roads, transmission lines, and the induced development could significantly modify the existing landscape. This could create a significant negative impact on the region’s potential for tourism.

826. Visual impacts and landscape fragmentation because of the unplanned and multiple roads and electric transmission and distribution lines, though still uncertain, could potentially be very significant. The natural beauty of the Poonch River basin could be significantly affected if the landscape is encroached by a number of power houses, multiple transmission lines, towers, cables, and roads.

7.6.7 Summary of Cumulative Impacts on Biodiversity

Ecosystem Condition

827. The ecological categories mentioned in this section are defined in **Table 5-25** in (**Section 5**). The estimated cumulative impact on overall river and tributary condition associated with the proposed HPPs is summarized in **Table 7–8** and discussed below.

828. The Poonch River is by no means an undisturbed system (**Section 5.2.10**). Already the condition of the ecosystem has been affected by:

- inundation, and consequent destruction, of 21 km of river habitat as a result of the construction, and subsequent raising, of Mangla Dam.
- the barrier created by Mangla Dam, which reduced the populations of fish, such as Mahaseer, in the upstream river.
- over-harvesting of riverine resources, such as fish and woody vegetation.
- indiscriminate fishing methods, which compromise macroinvertebrate abundance and diversity.

- pollution for cities and towns in the basin.
- habitat destruction as a result of poorly regulated sediment mining.

829. In recognition of the impact of these pressures on overall ecosystem condition, for the purposes of the EIA, the 2013 river condition downstream of LoC was rated as Category C.

830. For the Gulpur EIA, it was assumed that – as a best case scenario, if implemented, Gulpur HPP would provide funds that could be used to reduce some of the extant impacts on the Poonch River and its tributaries. These measures were referred to as Protection Level 2, and proposed to reduce the impact of the resource harvesting by 50%, thereby leading to an improvement in overall ecosystem condition. Excluding the impacts of Gulpur HPP itself, it was estimated that Pro 2 measures would result in an improvement to a Category B/C in the Poonch River downstream of the LoC.

831. Although there are few data for the river upstream of the LoC, anecdotal accounts indicate that human pressures on the system are both lower and better administered than downstream of the LoC. Thus, it is plausible that the river is in a better condition in its upper reaches. For the purposes of this assessment, the Poonch River upstream of the LOC has been rated Category B.

832. The principle conclusions of (**Section 7.6.4, Section 7.6.5 and Section 7.6.6)** are that the construction of the five HPPs as planned, with no increase in protection (Business as Usual scenario as outlined in **Section 6**) will irreversibly alter the entire Poonch River (bottom row in **Table 7–6**). Downstream of the LoC, the river will comprise a series of lakes and low flow sections completely cutoff from one another by dams. The ecosystem of Poonch River will be permanently degraded and many, if not all, of the essential functions of the original ecosystem will be lost. Residual biota may survive in the tributaries (but probably not in Mendhar Nullah), but even there they will be at high risk from over-harvesting and other disturbances, such as sediment mining.

Fish Biodiversity

833. The fish of a river system frequently represent fairly wide-ranging apex instream predators of that system and, as such, the fish communities tend to reflect an integration of the various prevailing conditions. The Poonch River fish community is comprised of 37 species, and is characterized by:

- a variety of species that feed on algae, macroinvertebrates and other fish, and thus any changes in these biota have a knock-on effect on the fish community.
- 21 species that inhabit Mangla reservoir, and breed in the upper reaches of the basin in the summer, and overwinter in the warmer downstream reaches, including the endangered Mahaseer, the Pakistani Labeo and the Garua Bachwaa. 7 out of these 21 species though migrate in the upstream areas but do not reach to the dam site.
- 15 species that do not migrate, but are reliant on river habitats for survival, including the critically-endangered Kashmir Catfish and the twin-banded loach.
- 1 specie that over-summer in the upper Poonch River, upstream of the LoC and use the lower Poonch River as a refuge from freezing temperatures in the winter, such as the snow trout.
- the difference in their basic biology influences the impact of the planned HPPs on the species making up the fish community.

834. For species such as the Mahaseer, the Pakistani Labeo and the Garua Bachwaa, the construction and raising of Mangla reservoir has already resulted in the division of populations upstream and downstream of the dam wall, plus the loss of c. 21 km of river habitat in the Poonch River that is now inundated by the reservoir. These fish can however survive in impounded waters provided they have access to their breeding areas. If the fish cannot reach their breeding grounds, breed successfully and return to their over-wintering areas they will become extinct in those areas, including in Mangla reservoir. While for the labeo, the options for breeding areas out of Mangla reservoir include both the Poonch and the Jhelum Rivers, for the Mahaseer and Garua Bachua the Poonch River is the only option for breeding. For these kinds of fish, the HPPs planned in the Poonch River will threaten (*inter alia*):

- access to upstream breeding areas through the barrier effect discussed in **(Section 6.7.2)**
- availability of breeding and nursery habitat in the mainstem Poonch River and in the Mendhar Nullah through the flow and sediment changes
- the availability of food for adults and juveniles.

835. The estimated likely consequences of the accumulation of these impacts on Mahaseer is summarised in **Table 7–8**. The consequences provided for Gulpur HPP are those that arose from the detailed investigations in the EIA. The cumulative consequences for the remaining HPPs are extrapolations based on the outcomes for Gulpur HPP and an evaluation of the overall effects on the Mahaseer of the extreme level of river fragmentation that will result.

836. As bad as the situation may appear for Mahaseer, it will be worse for Garua Bachwaa, which is unlikely to colonise the reservoirs, and has the bulk of its breeding areas downstream of Gulpur dam. As a result, Garua Bachwaa would be all but eliminated from the Poonch River if Radjhani HPP is constructed.

837. It is worth noting that these cumulative impacts exclude consideration of the vulnerability of the weakened native populations to threats from exotic species. Experiences from the Jhelum River have shown that, even in the absence of any additional barriers, a shift in habitat from riverine to lake and introduction of exotic commercial fishes such as Grass carp (*Ctenopharyngodon idellus*), Silver Carp (*Hypophthalmichthys molitrix*), *Bighead Carp (Hypophthalmichthys nobilis*), Common Carp (*Cyprinus carpi)* and Tilapia (*Oreochromis mossambicus)* have permanently altered the ecology both upstream and downstream of the Mangla reservoir. With time, these impacts are likely to extend upstream in Jhelum River as far as Muzaffarabad whereafter the cooler waters of the Neelum River result in a change in fish assemblages.

838. For species such as the Kashmir catfish and the twin-banded loach, which require riverine habitat for survival, the loss of running water habitats through impoundment (36.8 km or 25% of the Poonch mainstem between LoC and Mangla) and a reduction in dry season habitat availability as a result of flow changes (68.1 km or 46%) are the main causes of concern. These species will not survive in the impounded sections, and survival rates in the low flow sections is expected to be 10 – 25% for a single project on the river will drop to 0–5% due to habitat partitioning. The remaining 8% of the river where the hydrology will be relatively intact will fare no better in terms of the population of this fish as this condition will occur in four short segments of the river ranging from 1.5 km to 11 km in length. Thus, if all five HPPs were built, these species are likely to become extinct in the Poonch. Indeed the possibility of their elimination even with two or three of the HPPs is extremely high.

Table 7–8: Estimated Cumulative Impact of Planned HPPs on the Overall Integrity of the Poonch River Ecosystem

B = blue, B/C and C = green, C/D = white, D = orange, No river remaining = red

River Reach		2013	Sequential implementation of:				
			Gulpur HPP	Parnai HPP	Sehra HPP	Kotli HPP	Rajdhani HPP
Poonch River upstream of LoC	Parnai weir to LoC	B	B	C/D	C/D	C/D	C/D
Poonch River downstream of LoC	LoC - 5 km	B/C	B/C	C/D	D	D	D
	10	B/C	B/C	C	No river remaining	No river remaining	No river remaining
	15	B/C	B/C	C	D	D	D
	20	B/C	B/C	C	D	D	D
	25	B/C	B/C	C	D	D	D
	30	B/C	B/C	C	C	No river remaining	No river remaining
	35	B/C	B/C	C	C	D	D
	40	B/C	B/C	C	C	D	D
	45	B/C	No river remaining	No river remaining	No river remaining	No river remaining	No river remaining
	50	B/C	No river remaining	No river remaining	No river remaining	No river remaining	No river remaining
	55	B/C	D	D	D	D	No river remaining
	60	B/C	B/C	B/C	C	C/D	No river remaining
	65	B/C	B/C	B/C	C	C/D	No river remaining
	70	B/C	B/C	B/C	C	C/D	No river remaining
	75	B/C	B/C	B/C	C	C/D	D
	80	B/C	B/C	B/C	C	C/D	D
	85	B/C	B/C	B/C	C	C/D	D
	90	B/C	B/C	B/C	C	C/D	D
Mendhar Nullah		B	B	D	D	D	D

Table 7–9: Estimated Cumulative Impact of Planned HPPs on the Population of Mahaseer

Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%. Italicised scenarios are repeats

River reach		2013	Sequential implementation of:				
			Gulpur HPP	Parnai HPP	Sehra HPP	Kotli HPP	Rajdhani HPP
Poonch River Upstream of LoC	Parnai dam to LoC	–	40	-20	-40	-40	-40
Poonch River Downstream of LoC	LoC - 5 km	–	80	-20	-40	-40	-40
	10	–	80	60	-40	-40	-40
	15	–	80	60	-90	-90	-90
	20	–	80	60	-90	-90	-90
	25	–	80	60	-90	-90	-90
	30	–	80	60	60	-90	-90
	35	–	80	60	60	-90	-90
	40	–	80	60	60	-90	-90
	45	–	80	60	60	0	0
	50	–	80	60	60	0	0
	55	–	-90	-90	-90	-90	-90
	60	–	-8	-8	-8	-60	-90
	65	–	-8	-8	-8	-60	-90
	70	–	-8	-8	-8	-60	-90
	75	–	-8	-8	-8	-60	-100
	80	–	-8	-8	-8	-60	-100
	85	–	-8	-8	-8	-60	-100
	90	–	-8	-8	-8	-60	-100
Mendhar Nullah		–	–	-60	-60	-60	-60

7.6.8 Cumulative Impact on Ecosystem Services

839. As discussed in (**Section 6**), the main riverine ecosystem services of concern are sediment mining and fishing.

Mining of Sand, Gravel, and Boulders from the River

840. As illustrated in **Exhibit 5-77** in **(Section 5),** Socioeconomic Uses of the Poonch River, mining of sand, gravel, and boulders is spread over the entire stretch of the Poonch River in AJK, and mainly in downstream segments of three main tributaries, the Bann, Rangar, Hajeera, and Mendhar Nullahs closer to where they join Poonch River.

841. The Geomorphology Specialist Report included in **Appendix E** presents a discussion of patterns of deposition of sediments following the operation of Gulpur HPP. Cobbles would be trapped close to the upstream end of the reservoir or slightly upstream in the wet season backup zone because the lowered flow velocities in this backup area would be too slow to transport very large bed elements. Progressively smaller sediment classes, including sands, which travel as suspended load in high velocities, would be deposited where the river enters the reservoir and flow velocities drop. In the dewatered segment between the dam and the tailrace there will be very low total sediment loads because for most of the year the discharges will be very low, and the availability of cobbles and boulders in particular will be considerably reduced. However, during flushing or sluicing of the reservoir very large peak suspended sediments are likely to occur during high flows.

842. Downstream of the tailrace, the suspended loads will be reduced relative to 2013 because of the sediment trapping effect of the reservoir. As in the upstream dewatered zone, annual flushing of the reservoir may however yield peak suspended sediment discharges higher than normal. The availability of cobbles and boulders is expected to be low immediately downstream of the tailrace but should improve with distance as a result of the replenishment by supply of these sediments from lateral bars, the channel bed and from tributary inputs.

843. Although the feasibility of implementing a large-scale mining operation in the head waters of the Gulpur reservoir is subject to confirmation, initial indications suggest that the quantities likely to be deposited annually far outstrip the current demand for sediment and are likely to do so for quite some time to come Current volume of sand mined is estimated at 324,500 m^3/year (**Section 5.3.8,** Livelihoods and Incomes) , while total sediment load in the catchment of the Gulpur HPP is estimated at 7 million m^3/year[43].

844. As proposed in this ESIA (**Section 7.5.3)** and described in the report **'**Possible Mitigation Strategies with Respect to Impact of Sand And Gravel Mining in The Poonch Basin' included in **Appendix F**, a sustainable Sediment Mining Plan will be devised to minimize the impact of the Project on the river ecology while meeting the requirements of the community. For this approach to work where multiple dams on a river are envisaged, it is important that it be followed in all the dams in the basin. Selective application in a river such as Poonch will result in benefit to the communities located

[43] Gulpur Hydropower Project, Environmental Flow Assessment, Geomorphology Specialist Report, Fluvious Environmental Consultants and Southern Waters. The assumptions regarding sediment deposition locations and volume estimates require validation in the form of detailed backflooding and sedimentation studies of the proposed reservoir. These verification studies would be undertaken as part of a detailed feasibility study of the identified mitigation options.

upstream in the basin at the expense of those living downstream. Most importantly, management mechanisms as outlined in (**Section 11**), Environmental Monitoring and Management Plan will have to be put in pace to implement the sustainable sediment extraction plan.

Recreational and Subsistence Fishing

845. Recreational and subsistence fishing focuses on larger species such as Mahaseer, Pakistan Labeo, and Snow Trout. Discussions with persons engaged in subsistence and recreational fishing suggest that both are likely to cease entirely once the fish populations drop below 40% of 2013 levels as the effort of trying to catch the fish would exceed the reward of fish caught. As illustrated in **Table 7–9**, with all five HPPs in place, the populations of Mahaseer are expected to be below this threshold over at least 90% of the river (red and orange bars in **Table 7–9**), particularly in Parnai HPP is operated as a peaking power plant. Thus, with all five HPPs in place, recreational fishing is expected to cease and subsistence fishing will be confined to a few sections of the river where it is likely to cease as well due to overfishing.

7.6.9 Position of AJK Government on Future Hydropower Projects on Poonch RIver

846. The AJK Department of Fisheries and Wildlife (Department) in a letter (ref no: 1944 – 48, dated 21 May 2014) granted permission for construction of the 100 MW Gulpur Hydropower Project in the Poonch River National Park on the condition that a Biodiversity Action Plan (BAP) be developed that will achieve betterment of the national park. In addition, the Department has taken a principled position in writing that hydropower projects on Poonch river will be allowed only if they can demonstrate betterment of the park or net gain, and for subsequent projects the implemented BAP for the Gulpur project will be considered as a baseline. The Department “suggests that AJK EPA consider the following while reviewing projects proposed in the national parks in the AJK in future:

- The projects should demonstrate achievement of the betterment of the national park over the life of the Project compared to the prevailing baseline conditions.
- Specifically for the Poonch River Mahaseer National Park, the baseline conditions for all future projects will be considered as those that will be achieved in the long term following the implementation of the Biodiversity Action Plan as specified in the EIA for the Gulpur Hydropower Project and as approved by the Department. Subsequent projects if any will therefore have to demonstrate improvement over and above that projected to be achieved by implementation of the Biodiversity Action Plan as part of the Gulpur Hydropower Project.”

7.6.10 Coordination with the Office of Pakistan Commissioner for Indus Waters

847. Given the developments in Kishenganga project where environment has been recognized as an issue under the Indus Water Treaty (see **Section 3.4**, International Treaties and Conventions), environmental impacts related to hydropower developments on either sides of LoC can be discussed by the offices of the Pakistan Commission for Indus Waters (PCIW) and India Commission for Indus Waters (ICIW) established under the Indus Waters Treaty. The Biodiversity Action Plan prepared for the Project includes a provision for the project owner to share the Poonch River environmental monitoring data

and reports with the PCIW, on the basis of which the PCIW could coordinate with the ICIW on management of environmental issues across the LoC.

7.7 Dam Break Analysis

848. The impact of dam-break on downstream areas conducted by MPL is included in the report "Gulpur HPP Numerical Analysis (Impacts of Dam Break on the Downstream River)"[44]. This section provides a summary of the methodology and results in the report, and provides risk and hazard classification in the case of dam failure.

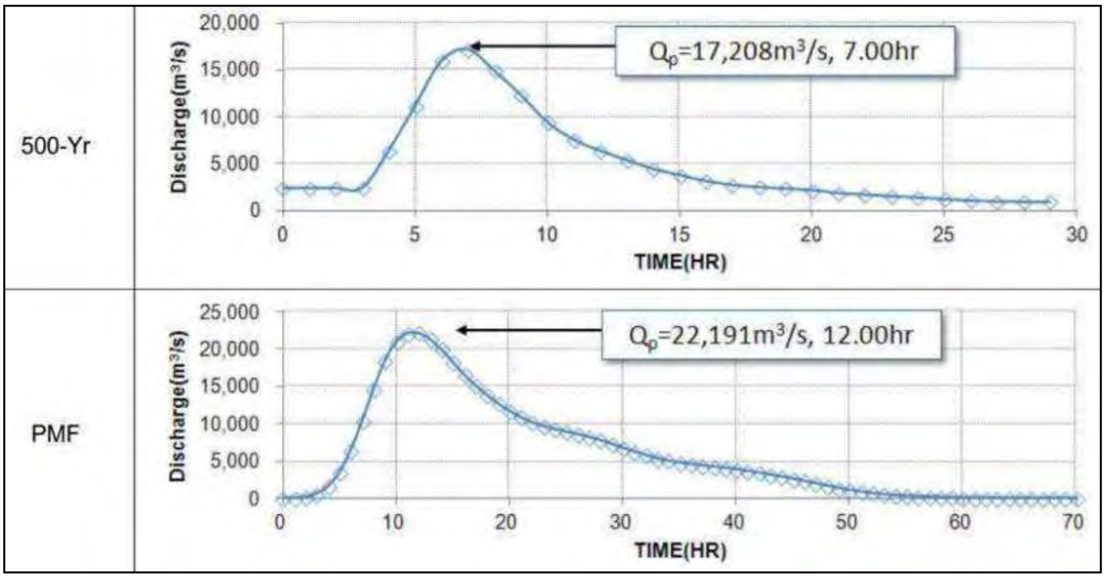
7.7.1 Summary of Methodology

849. A range of scenarios were modelled for the dam-break analysis. These include:

- two flooding scenarios: the 500-year average recurrence interval (ARI) flood and the Probable Maximum Flood (PMF) (see hydrographs in **Figure 7–7**); and
- three dam breakage durations (i.e. time taken for breach to develop): 0.2, 0.3 and 0.5 hours for each flooding scenario.

850. The analysis assumes that the left abutment of the non-overflow section of the dam is completely destroyed, while the remaining portion including the spillway remains functional. Additional assumptions apply to the flood calculations; detailed information on estimation of floods are provided in the Gulpur Hydropower Basic Design Report[45].

Figure 7–7: Inflow hydrographs for 500-yr ARI flood and PMF



7.7.2 Summary of Results

851. The result of a dam break is the generation of a flood wave that progresses downstream that is greater than the flood that caused the dam break. Peak runoffs and the spillway overflow at the dam location for each breakage scenario are shown in **Table 7–10**.

[44] Daelim, Sambu & Lotte E&C, 2014, GULPUR HPP NUMERICAL ANALYSIS (Impacts of Dambreak on the Downstream River)

[45] Sambu & Lotte E&C, 2013, Gulpur Hydropower Project Basic Design Report - Progress

852. Dam breakage begins at 7.00 and 11.22 hours in the case of the PMF and 500-yr ARI floods, respectively. The breakage occurs due to overtopping of the dam. The peak flow for all breakage durations and floods occurs at 0.2 hours after the initial dam breach. Higher peak flows are observed where the breakage duration (i.e. time taken for a complete breach to develop) is shorter.

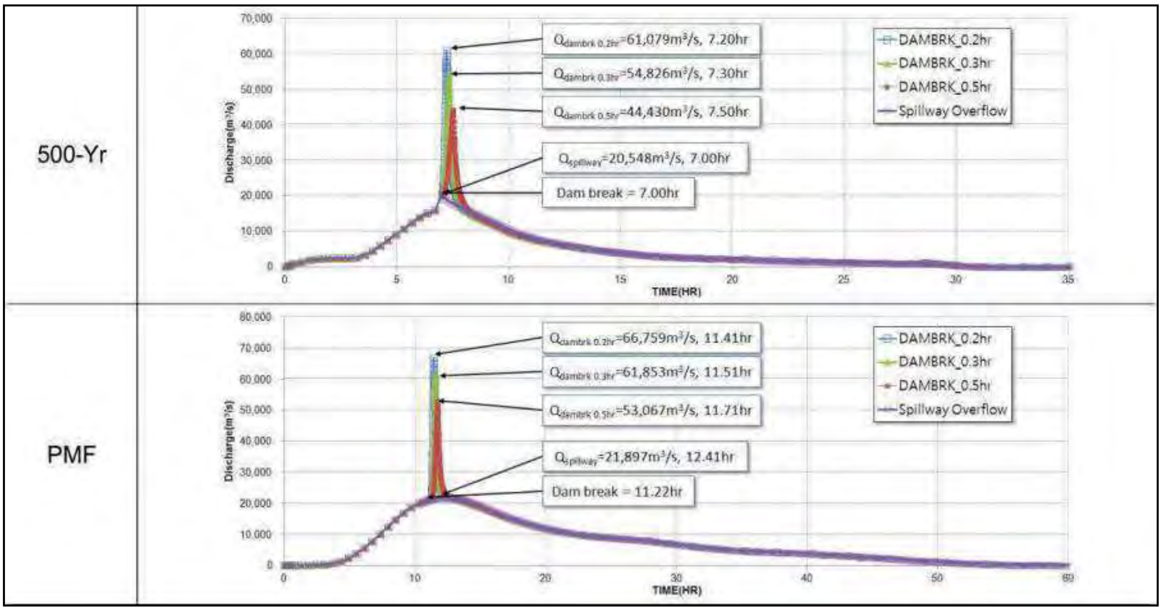
853. The corresponding flood hydrographs are shown in Figure 7–8.

Table 7–10: Maximum Runoff at Dam in Case of Breakage

Breakage Duration (hours)	PMF Peak Runoff (cumec)	500-Year ARI Peak Runoff
0.2	66,759	61,079
0.3	61,853	54,826
0.5	53,067	44,430
Spillway Overflow	21,897	20,548

Source: Dam Break Analysis Report

Figure 7–8: Hydrographs for Dam Break Conditions



Source: Dam Break Analysis Report

854. In the case of dam breach, downstream areas will be inundated. **Figure 7–9** shows the maximum downstream inundation due to the spillway discharge during the PMF, under the dam break scenario. **Figure 7–10** and **Figure 7–11** show the maximum downstream inundation due to the total discharge under the 0.2 hour dam breakage. It is noted that the 0.2 hour dam breakage scenario results in the highest peak flows and is therefore the worst-case. Additionally, the PMF is the maximum possible flood in the catchment and is also the extreme worst-case scenario.

855. The zones highlighted in **Figure 7–9, Figure 7–10** and **Figure 7–11** correspond to the infrastructure in **Table 7–11.**

Table 7–11: Infrastructure within Inundation Areas

Zone	Possible Damage to
1.	A Bridge
2.	A Bridge
3.	Houses
4.	Houses & Cultivated lands
5.	Houses & Cultivated lands
6.	Houses & Cultivated lands
7.	A Bridge
8.	Houses

Figure 7–9: Maximum Inundation due to Spillway Discharge during PMF

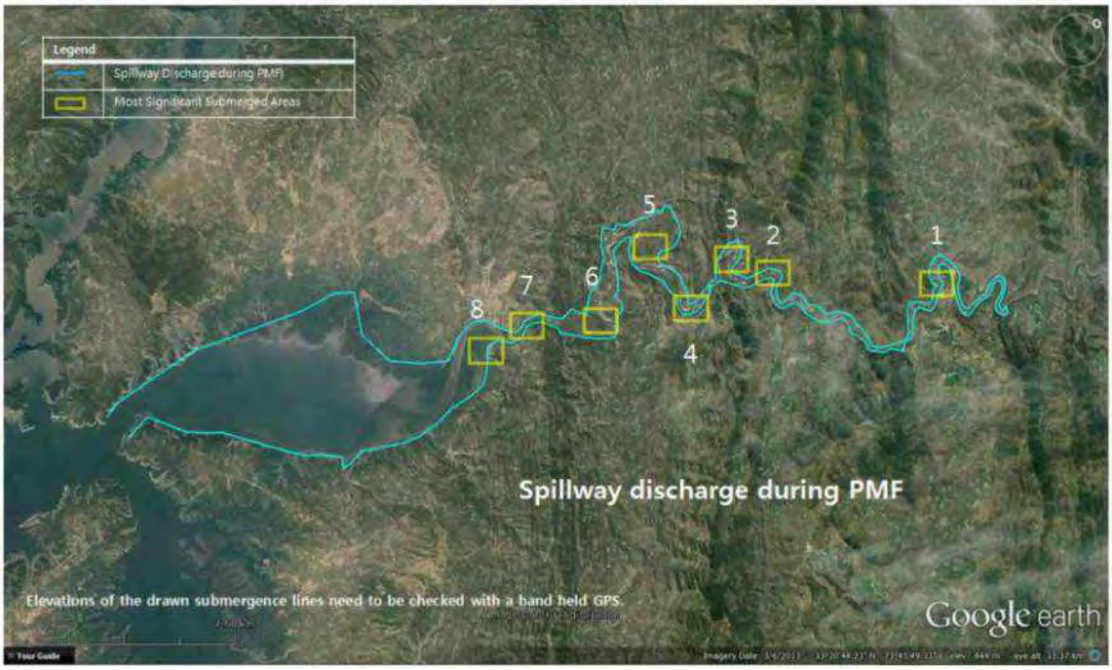


Figure 7–10: Maximum Inundation due to Total Discharge during PMF under 0.2 hour Breakage Duration Scenario

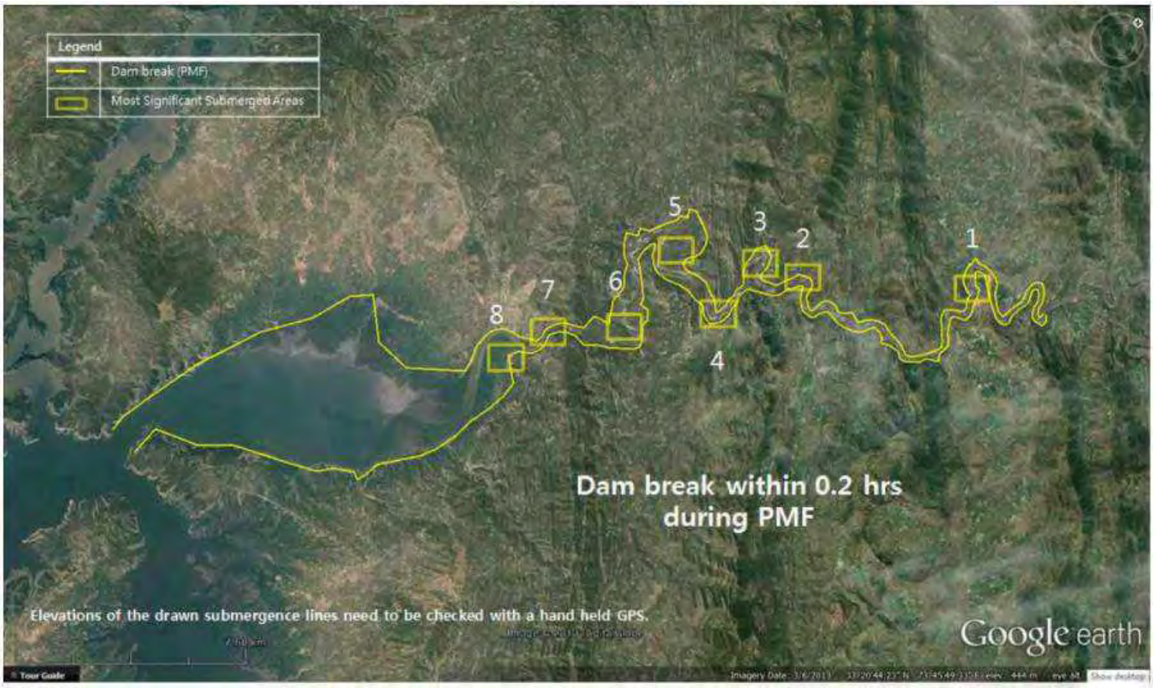
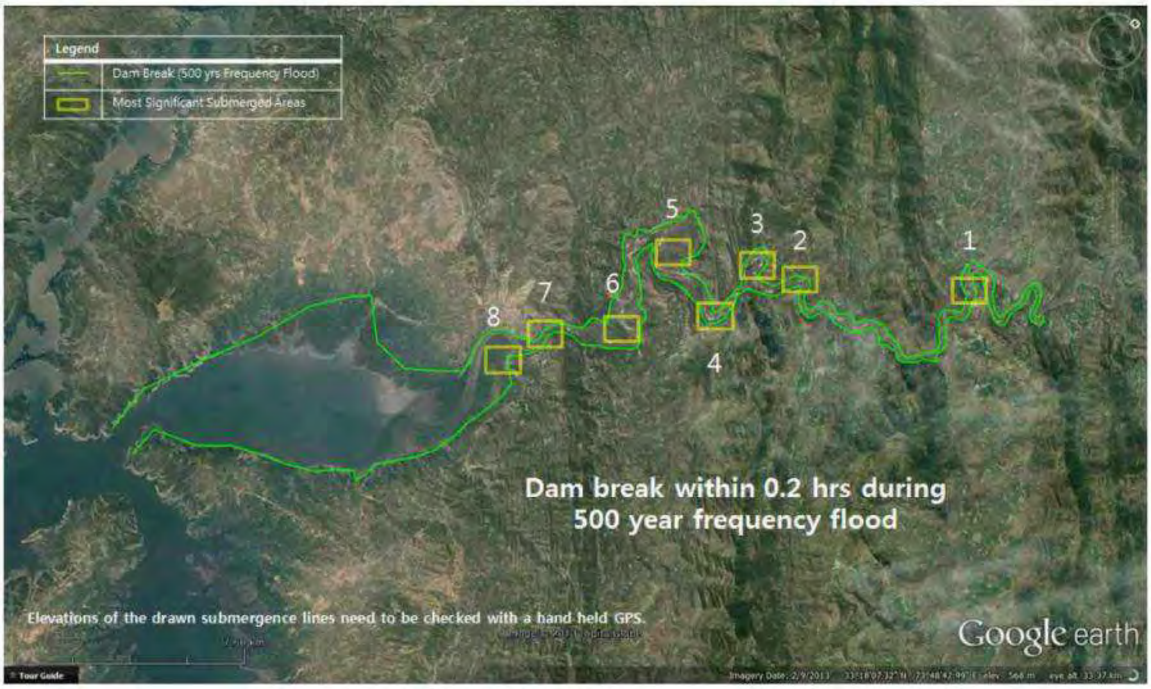


Figure 7–11: Maximum Inundation due to Total Discharge during 500-yr ARI Flood Under 0.2 hour Breakage Duration Scenario



7.7.3 Impact Analysis

856. The risk and hazard classification associated with dam breakage under the two modelled scenarios are provided below.

857. It is noted that the results shown in **Figure 7–9** which approximately present the peak conditions under a natural PMF, i.e. without the dam, are similar to the results of **Figure 7–10** and **Figure 7–11**. No additional major areas are inundated due to dam break (also see Dam Break Analysis Report) compared to a condition with a PMF without the dam.

Table 7–12: Risk and Hazard Classification for Modelled Design-Flood Events

Flood	Flood Risk (Annual Exceedence Probability)	Hazard/Consequence in Case of Dam Break
500-YR ARI	Low (0.002)	Catastrophic (potential loss of life)**
PMF	Very Low (0.0001*)	Catastrophic (potential loss of life)**

* Annual exceedence probability (AEP) for the PMF is approximate and based on comparative results presented in the Basic Design Report. The PMF is not formally associated with an AEP.

** Note, however, that in case of dam break due to a PMF, the results are similar to the case of PMF without the dam.

7.8 Climate Change Study

858. The purpose of the climate change study was to provide an evaluation of climate change and its potential impacts on issues that are relevant to the operation of the hydropower plant. The complete detailed Climate Change Risk Assessment Study is given in **Appendix I**. The Study included an initial risk screening, analysis of downscaled GCM results, analysis of hydrological changes, estimates of reservoir sedimentation, projected climate change impacts on water supply, greenhouse gas (GHG) emissions from the Gulpur HPP Reservoir, and evaluation of disease risks. The following sections reproduce the summary of the methodologies and major findings of the study.

7.8.1 Initial Risk Screening

859. The screening process established the baseline conditions which the design of the proposed Gulpur HPP should be prepared to address. With its location in Pakistan, the project area has a history of extremely hot weather in the summer and moderately cold weather in the winter. The region receives most of its annual rainfall during the summer monsoon season, primarily in July and August. The historical natural hazards relevant to the project include flood, landslide, drought, and disease. The diseases addressed are those that are endemic in Pakistan: malaria, dengue fever and CCHF. The initial risk screening has a hazard and vulnerability component. The screening considers the frequency, severity and magnitude, as well as the project's vulnerability, including sensitivity and exposure to each hazard. Based on historical experience with current climate conditions, the frequency for floods is high; for disease, the frequency is medium; and for drought and landslides, the frequency is low. However the magnitude of the drought hazard is high, and can be ranked as medium for flood, landslide and disease hazards.

860. The Gulpur HPP project area can be considered to be at moderate risk of flood and disease and at low risk for drought. Landslides are a current problem and will remain a risk for the Gulpur HPP and conditions could produce landslide events as a cascading effect. The proposed site on the Poonch River has steep slopes and loose soils around the power generating and support facilities and is located in landslide-susceptible areas.

7.8.2 Analysis of Downscaled GCM Results

861. Global climate models (GCMs) do not provide sufficient spatial resolution to fully understand climate impacts at the scale of the Poonch River watershed due to their coarse spatial resolution and rough approximations of local topography. A “downscaling” procedure is needed to evaluate impacts at the watershed scale. This can be done either through statistical methods or by using the GCMs as boundary conditions for regional climate models (RCMs) that provide better spatial resolution (i.e., through dynamical downscaling). The first step was to obtain the detailed output of available dynamical downscaling efforts provided by the “Numerical Modeling Group of Research and Development Division, Pakistan Meteorological Department (PMD), Islamabad, Pakistan.” The PMD data provides results for the A1B scenario as defined by the IPCC from one of the GCMs, downscaled to a resolution of 25 km for Pakistan using the “PRECIS” and “REgCM4” RCMs. Climate change effects were developed for two future 30-year time periods, with mid-points of 2025 and 2055, respectively, using a base period of 1961 to 1990.

862. The results show that temperature predictions tend to indicate increases with each time horizon for both RCMs. Annual average temperatures increase over time with both PRECIS and RegCM4 models. Annual average temperature increase at Kotli for the PRECIS scenario for 2025 was 0.8°C and 2.1°C for 2055, whereas for RegCM4 it was 0.5°C and 2.2°C. Overall for the entire watershed (based on area weighting) the PRECIS model showed an increase of 1oC and 3.05°C for 2025 and 2055, whereas the RegCM4 model showed an increase of 0.74°C and 2.65°C.

863. Seasonal precipitation for the PRECIS scenario compared to the baseline indicates an adjustment in the monsoon season, with precipitation peaks shifting by a month from July to August, with a duration extending slightly longer than the experience during the baseline period. The maximum percent changes were observed during the spring season in March during the 2025 period; however, these were relatively less for the 2055 period. Note that seasonal summaries are provided only for the PRECIS scenario because the RegCM4 scenarios only had annual decadal data available.

864. The available dynamically downscaled data are based on one GCM, and results are likely to differ for other GCMs. Therefore, the future climate results are also discussed in the context of Annex I of the Intergovermental Panel on Climate Change Fifth Assessment Report (IPCC AR5), which provides information on projected results for the 2050s using 16 statistically downscaled GCMs. The central tendency of the 16 models over the project area suggests little overall change, consistent with the regional analysis. These results suggest that the project area will likely experience an air temperature increase of around 1°C by the 2020s and more than 2°C by the 2050s, while average annual precipitation changes are likely to be small.

7.8.3 Hydrologic Analysis Results

865. Although the annual results suggest a relatively small impact on temperature and precipitation from climate change, many studies show that climate extremes may be more pronounced. This is evaluated for the Gulpur HPP by examining key measures of extreme climate events, including changes to the probable maximum flood (PMF), probable maximum precipitation (PMP), daily changes in temperature and precipitation, extreme water flows, and sediment transport, as well as the related risks of flood and landslide events.

866. A conservative estimate of the PMF as a result of climate change is estimated by evaluating daily discharge data computed using a GCM that predicts wetter conditions for the project area (Hadley Centre Model, HadGEM2-ES), coupled with the variable infiltration capacity (VIC) hydrologic model. Model output was available from 1970-2100. The relatively coarse scale of the VIC model does not allow for an exact estimate of flow volume in a single small catchment, such as the Poonch River. However, the relative changes between scenarios in VIC model predictions provide a reasonable indication of the relative changes expected in actual catchment flows. The PMF is projected to increase by 10.1 percent 2040 and 36.6 percent by 2070 based on a Gumbel extreme-value analysis. This increase in PMF will need to be accounted for in the design of the hydropower plant as it will result in a larger floodplain in the future. Computation of the PMP involved an approach widely recommended for use in hydrologic planning (Koutsoyiannis, 1999; Chin, 2005). Typically, PMP estimates are based on the maximum possible rainfall that can occur over a specific location, and based on meteorological evaluations. Where data are limited, statistical approaches may be used. The results indicate higher daily precipitation values are more extreme in the 21st century periods compared to historical values (model to model comparisons; observed values are higher than modeled). The results for the watershed indicate that the magnitude of the PMP is expected to increase by 30 and 47 percent for the 2040 and 2070 time horizons, respectively. More broadly, multiple models and studies suggest that there might be an increase in the extreme precipitation in the Project region, which may suggest the need for a more detailed the climate change analysis for the Gulpur HPP Project.

867. In addition to the uncertainties in the climate model and discharge model projections, it is important to highlight that this report also presents the extrapolation of the extreme value probability distribution to a return period with very little data. This adds uncertainty but is inherent in extreme event projections, which by their nature have very few observations associated with them.

868. The overall scale of the Gulpur HPP, the Project can be considered to be at medium risk from climate change. As the Gulpur HPP is currently designed, there is no provision for adding spillway capacity in the future. The dam is designed to withstand current PMF (i.e. design flood), which is a highly conservative design parameter. If a flood were to be larger than the design flood in the future, one would expect overtopping. Analysis performed by the Project engineers suggests that even in the case of catastrophic failure of the dam, downstream water flows would not reach inhabited locations. Furthermore, because this is a run-of-the river Project, with limited water storage, it allows some resiliency through changing operational criteria to adapt to future flow conditions that differ from historical patterns. Therefore the design and operation will provide some resilience to climate change.

Overtopping of spillway by a flood larger than the design flood due to climate change								
Operation								
Impact Rating								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Initial Impact	Major*	Short term**	Intermediate	Medium	Unlikely ***	Low	-	Medium
Enhancement Measures: • Ensure minimal damage to dam structure from small amount of overtopping of spillway through design. • Resiliency to increased design flood value due to climate change through changing operational criteria to adapt to future flow conditions that differ from historical patterns.								
	Magnitude	Duration	Scale	Consequence	Probability	Significance	+/-	Confidence
Residual Impact	Moderate	Short term	Intermediate	Medium	Unlikely ***	Low	-	Medium

* Refers to magnitude of damage to dam and structures associated with an extreme amount of overtopping.

** Refers to duration/frequency of design flood (historically the major flood in 1992 had a duration of 42 hours) and as an example a 500-Year Average Recurrence Interval (ARI) flood has a probability of occurrence of 0.0020 in any year.

*** Assuming a Probable Maximum Flood (PMF) or 500 YR ARI flood.

869. Besides the flood risk analysis, the hydrologic analysis also considered changes in streamflow quantities and timing, using the WATERGAP model, which are influenced by changing precipitation patterns and snowmelt timing. The change in the timing and seasonality of the discharge is of much greater consequence to the future operation of the dam in comparison to the potential human demands upstream which constitute about 5% of the discharge. Flows in February and March are higher and flows in May and June are lower, both as a result of earlier snowmelt. This change is an important consideration for future hydropower operations, because some of the peak demand months in May and June also correspond to low flows.

870. The hydrologic analysis was performed in a streamlined manner to highlight key changes using a modeling framework, including the most recent downscaled climate data from a representative model and coupled hydrologic models. Wherever possible, additional support was developed from ensembles of model results in the recent published literature. If the issues raised here require further evaluation, additional hydrologic modeling assessment may be performed, considering site-specific analysis for a larger number of model scenarios. Going further, more local-scale data collection on flows and precipitation at different altitudes may support this modeling. Not all of this is practical in the time frame and project scope of this report; however, the general direction of potential future work is summarized in **Appendix I**.

7.8.4 Reservoir Sedimentation

871. For consistency, the same daily discharge data used in the PMF calculations (from the VIC model, coupled with the HADGEM2-ES GCM) to estimate changes in suspended sediment load entering the Gulpur HPP reservoir. The changes in monthly suspended sediment loads display a non-uniform seasonal pattern. Future projections are larger than baseline values in March, April, and August but generally smaller in May and June. The 2040 and 2070 climatologies generally display increased variability relative to the baseline period. At the yearly level of aggregation, the baseline and 2040 climatologies display a very similar distribution. The suspended sediment load data for

the 2070 climatology have a median value comparable to the other two periods, but the variability of the data is increased with more instances of large annual loads relative to the baseline and 2040 periods. However, in light of existing plans to flush sediment build-up every eight years, it appears that the risks of substantial increases in reservoir sedimentation rate due to climate change are small.

7.8.5 Future Precipitation and Landslide Risk

872. From a modeling perspective, it is reasonable to assume that extreme flood volumes in the basin may be higher than historical levels. To address uncertainty in flood risk estimates and improve calibration of models it is recommended that the following monitoring be carried out:

- continuous flow measurements at selected dam site.
- sub-daily precipitation in upstream locations within the catchment.

873. Data from monitoring will allow more accurate estimates of PMF using catchment-specific unit hydrographs and storm temporal patterns, particularly if a flood event is observed.

874. From a qualitative perspective, the conditions exist for a rise in frequency and magnitude of landslide events. The future vulnerability conditions look similar since development will probably occur as it has in the past. A landslide could directly impact Mira Power facilities or the sediment produced by the landslide could be transported into the reservoir, also impacting Mira Power. With wetter conditions and the potential for more extreme events, there is a greater risk of landslides.

7.8.6 Projected Climate Change Impacts on Water Supply

875. Any impacts of climate change on water demands may potentially affect inflows into the dam, but other large-scale demand changes downstream of the Gulpur HPP are likely to be addressed through the major multipurpose dams in the system that are downstream. This section focuses on the increase in water demand for irrigation as a function of climate change, while also acknowledging that population growth clearly has the potential to further exacerbate the problem. Given Pakistan's unique situation as a country with low rainfall in the lower elevations and with intensive irrigation, the focus on changes in irrigation demand is appropriate.

876. The potential effects of climate change on the supply of water is introduced first at the global level and then considered at the watershed level in the context of upstream and downstream competing uses. The primary watershed focus is on the irrigation needs of the agricultural sector; the potential impact of climate change on drought risk is also presented. The analysis approach used here includes evaluation of climate change model results for evapotranspiration at different points in time, for periods two to six decades into the future. Large-scale analyses of changes been reported in the literature provide a strong basis for this assessment. In an analysis highly relevant to this work, Wada et al (2013) show the impact of climate change on future irrigation water demand (IWD), using a set of seven global hydrological models (GHMs) to quantify the impact of projected global climate change. They also assessed the resulting uncertainties arising from both the GHMs and climate projections. The resulting ensemble projections generally show an increasing trend in future IWD, but the increase varies substantially depending on the degree of global warming and associated regional precipitation changes. In Pakistan, the irrigation water demand is expected to increase by more than

20 percent for warming by 2°C or more. Using a suite of seven global hydrological models, forced with multiple climate projections, Haddeland et al. 2013 estimated irrigation water consumption with and without taking into account impacts of human interventions such as dams and water withdrawals on the hydrological cycle. Model results were analyzed for different levels of global warming. It was shown that irrigation water consumption is generally projected to increase with higher global mean temperatures. Irrigation water scarcity was found to be particularly large in parts of southern and eastern Asia, including Pakistan, and is expected to become even larger in the future. There is a strong indication across most of the model frameworks examined that there will be greater incidence of drought by more than 10 percent over South Asia. Assuming agricultural production needs to be sustained over these periods indicates an increase in irrigation water demand across most of the models examined.

877. Analysis shows the Gulpur HPP watershed itself is not a major user of irrigation water and irrigation demand change upstream is unlikely to reduce inflows into reservoir. Evaporation changes in the Gulpur HPP basin may occur as a result of climate change, even in the absence of irrigation demand.

878. In assessing the potential impact of climate change on droughts, a study was conducted in 2009 by the PMD to analyze regional changes to precipitation and temperature including frequency of “consecutive dry days”. A “dry day” is any day with precipitation totaling less than 1 millimeter (mm). A review of future precipitation values and consecutive dry days indicate conditions exist for an increase in frequency of future drought events. Furthermore, increases in population will also add pressures for water directly in cities and villages, and for food production through irrigation. It is well understood in current water balance studies, even in the absence of climate change, that Pakistan is a water stressed country with no known sources of new water to address future growth needs. Climate change, combined with development pressures, population growth, and conservation needs may increase the risk of this hazard in the future.

7.8.7 GHG Emissions from the Gulpur HPP Reservoir

879. Among stakeholders concerned about climate change, hydropower projects are routinely cited as having clear GHG benefits compared to fossil-fuel-fired power plants due to the relatively high carbon content of fossil fuel as compared to the absence of carbon in the fuel (water) for HPPs. It is increasingly understood that GHG emissions from hydropower reservoirs can be substantial – especially in tropical climates – to the degree that they may emit more GHGs than a comparably sized fossil fuel plant, particularly in the first 10 years or so.

880. It is widely acknowledged among scientists and policymakers that the scientific community has not reached agreement regarding the methodology that is appropriate for projecting GHG emissions from a proposed hydropower project (IPCC SRRES, 2011). Therefore, this report provides further insight into the factors that are relevant to the calculation for the Gulpur HPP and an initial estimate of these emissions based upon a review of relevant literature. Detailed data collection and analysis specific to the Gulpur HPP will further improve upon these estimates. The amount of GHGs that is released from the reservoir changes over time due to a variety of factors that include climate, water flow through the reservoir, and the composition (i.e., carbon content) of the submerged biological matter. Review of relevant literature confirms that a reliable set of calculations and emission factors are not available for estimating GHG emissions for a potential reservoir. Collected data from existing reservoirs do not provide the basis for reliable estimates. However, analysis of seven key studies provides some useful insight

into the likely range of GHG emissions from the Gulpur HPP reservoir, as well as the sources of uncertainty in the estimates. Of the studies presented, the range of annual emissions of a HPP similar in size and location to the Gulpur HPP could be between 1,407 tons and 27 million tons[46]. In light of the acknowledged limitations of applying existing data to new reservoirs, the applicability of this wide estimate range to the Gulpur HPP can be further questioned. However based on terrain, dry weather and limited organic matter (7% coverage largely scrub vegetation), it is likely that reservoir's GHG emissions will fall on the lower end of the spectrum. To validate this, an estimation of CO2-eq was carried out; an expected 278,000 tons CO2-eq[47] will be generated due to inundation of existing vegetation. These emissions will be outweighed by the reduction in carbon emissions due to displacement of fossil fuels in power generation in the country (see **Section 8.2**, Alternative Technologies and Scale for Power Generation).

7.8.8 Evaluation of Disease Risk

881. The potential disease impacts of climate change are examined for three key diseases: malaria, dengue fever and CCHF. The climate change results from the prior chapters are assessed to provide qualitative observations of potential increases in disease risk based on factors such as temperature, precipitation, and flood events. The IPCC has concluded that climate change is likely to expand the geographical distribution of several vector-borne diseases, including malaria, dengue and leishmaniasis to higher altitudes (high confidence) and higher latitudes with limited public health defenses (medium/low confidence), and to extend the transmission seasons in some locations (medium/high confidence) (IPCC, 2001).

882. For some vector-borne diseases in some locations, climate change may decrease transmission by reductions in rainfall or temperatures creating conditions that are not conducive to vector transmission (medium/low confidence) (IPCC, 2001). A changing climate will alter physical and ecological conditions for a variety of disease-carrying insects and parasites. Mosquitoes and ticks are sensitive to physical conditions, such as humidity, daily high and low temperatures, rainfall patterns, and winter snowpack. The distribution and growth-rate of vector populations have been correlated with ambient temperature. Numerous studies have concluded that an increase in ambient temperature will lead to net increases in the geographical distribution of many vector organisms, including several species of mosquitos that carry malaria and dengue fever. The PRECIS model dynamically downscaled climate results (based on the ECHAM5 GCM simulations under the A2B emissions scenario) discussed in Chapter 2 indicate that the average annual temperature in the project area will increase from the baseline of 13.5°C by approximately 1°C for 2025 and by approximately 3°C for 2055. Area-weighted precipitation values showed an overall 14 percent increase for 2025 and 2 percent decrease 2055. Increased air temperature and possibly increased precipitation could both increase malaria risk. The Liverpool Malaria Model (LMM) was used to better determine malaria risk to the project area under future climate conditions. The LMM is a mathematical-biological model of malaria parasite dynamics using daily temperature and precipitation data.

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[46] These numbers correspond to the operation phase of the Project. HBP has estimated a total emission of 110,000 tons of CO2-eq (GHG) during the construction phase, taking into account use of vehicles and heavy machinery, transport of construction materials including cement, sand and steel, and the emissions due to manufacturing of steel and cement.

[47] Based on an estimated dry biomass per unit area for shrub and grasses of 0.75 kg/m^2 in the reservoir submerged area and complete decomposition by methanogenic bacteria.

883. Studies compiled by the World Health Organization (WHO) have linked outbreaks of dengue fever with high rainfall, elevated temperatures and humidity, as well as to other intrinsic factors such as population immunity. Based on these findings, the WHO (2003) concluded that climate change could increase the range of the relevant mosquito species (*Aedes aegypti*) and rates of transmission. Similar to mosquitoes, tick life cycles depend on a complex combination of variables. Climate affects tick development and mortality, as well as their activity rates. In addition to climate factors, host availability and vegetation significantly impact tick populations.

884. The risk assessment analysis for these diseases shows that the project area is currently impacted by endemic malaria, and experiences sporadic cases of dengue fever and CCHF. Climate change temperatures and precipitation will provide a more suitable habitat for malaria in the project area, particularly in the 2050 time horizon. It is possible that warmer temperatures will also extend the range and incidence rate of dengue fever and CCHF. In the case of CCHF, other factors such as landscape and number of domestic animals are also important.

885. The simplest method of approximating the impact of climate change is to assume that proportional changes in exposure (e.g., proportion of people livening in areas climatically suitable for malaria), are directly related to proportional changes in disease burden. For example if climate change in a particular region is estimated to cause a 20% increase in the number of people living in areas that are defined as climatically suitable for malaria transmission, then this is most likely to lead to a 20% increase in the disease burden, compared to the situation if climate change did not occur.

7.8.9 Conclusions

886. As with other infrastructure projects, the Gulpur HPP can benefit from an understanding of the potential risks to it that are posed by climate change. This study provides an initial review of these issues, including summaries of relevant literature and assessment of local impacts. While the future remains uncertain with regard to a precise projection of the nature and extent of these risks for specific locations, the general scientific relationships are increasingly well understood and strongly suggest that each major project stakeholder should continue to anticipate and evaluate the effects of a changing climate, particularly the potential for adverse effects.

887. Temperature is expected to increase by about 1° to 3°C; average annual precipitation is expected to remain similar to past experience. Of critical importance for precipitation, however, is the fact that average annual values fail to reveal potentially large intra-annual changes. This report suggests that the timing of the seasonal monsoon may be delayed by up to one month by 2100 and that annual precipitation may be delivered in fewer, larger events. Climate change, development pressures, population growth and environmental conservation needs could increase the risk of drought and drought-related stresses in the future. This information, as well as global studies spanning multiple models supports the likelihood of greater magnitudes of extreme floods in future decades. An assessment of flood hazard supports a flood frequency ranking of high risk. Reviewing the future hazard screening, the conditions exist for a rise in frequency and magnitude of landslide events (ranked as a medium risk). A review of future precipitation values and consecutive dry days indicate conditions exist for an increase in frequency of future drought events (ranked as a medium risk). Of the four diseases in Pakistan addressed by this report, the projected temperature and precipitation impacts of climate change could increase the future risk of malaria, dengue fever and CCHF (ranked as a medium risk).

888. GHG emissions from reservoirs are difficult to estimate in advance of the existence of the reservoir. It is increasingly understood that GHG emissions from hydropower reservoirs can be substantial – especially in tropical climates – to the degree that they may emit more GHGs than a comparably sized fossil fuel plant, particularly in the first 10 years or so. The impacts of climate change will have a complex set of impacts on the Gulpur HPP reservoir. A review of the current state of the science indicates that several international, multi-stakeholder efforts are increasingly focused on developing a consistent, rigorous approach for GHG quantification. Participation in the multi-stakeholder efforts, coordinated by respected bodies, may provide a dual benefit to Gulpur HPP project proponents – such participation could allow issues of importance for the Gulpur HPP to be acknowledged and incorporated into these international efforts; at the same time, Gulpur HPP representatives may gain useful insight into their quantification efforts for the Gulpur HPP.

889. The present analysis serves to highlight the most important climate-related issues for the project based on the most current scientific data (including data that are being used to develop the regional studies for the upcoming IPCC report, expected later in 2014). As the Gulpur HPP is developed and becomes operational, additional local data collection, on meteorological, socioeconomic, and ecological metrics will no doubt improve these analyses, and are strongly recommended to better understand and manage future risks in coming years.

8. Analysis of Alternatives

890. A key component in the ESIA process is the consideration of alternatives. Most guidelines use terms such as 'reasonable', 'practicable', 'feasible' or 'viable' to define the range of alternatives that should be considered. Essentially there are two types of alternatives:

- incrementally different (modifications) alternatives to the project; and
- fundamentally (totally) different alternatives to the project.

891. Alternatives are essentially, different ways in which the developer can feasibly meet the project's objectives, for example by carrying out a different type of action, choosing an alternative location or adopting a different technology or design for the project. At the more detailed level, alternatives merge into mitigating measure where specific changes are made to the project design or to methods of construction or operation to avoid, reduce or remedy environmental effects. All ESIA systems also require developers to consider mitigation (i.e. measures to avoid, reduce and remedy significant adverse effects).

892. Alternatives and mitigation therefore cover a spectrum ranging from a high level to very detailed aspects of project design. The "No Project" scenario must also be considered as the baseline against which the environmental effects of the project should be considered.

893. This section presents an analysis of the following alternatives from the perspective of economic and environmental considerations:

1. No project option
2. Alternative options for power generation
3. Options for project location and layout
4. Peaking vs non-peaking operation
5. Non-Flow or management alternatives
6. Balance between environmental degradation and economic benefit
7. Options for transportation of equipment to project site

8.1 No Project Option

894. The no project alternative will have the following economic and environmental consequences:

- AJK and Pakistan are going through an acute power shortage. The gap between supply and demand has crossed 5,000 MW. The proposed Project will supply the much needed power to reduce the current gap. Thus in the absence of this project, the gap in power supply and demand will continue to grow.
- Environmentally, this Project will contribute towards improving the air quality as in the long run it will displace fossil fuels used in power generation such as coal and fuel oil which increase the concentrations of pollutants in the air in the surrounding areas. The project will also reduce greenhouse gas emissions in the atmosphere due to this reason.

- A literature review of long term regional trends in fish richness and abundance in absence of protection and with anthropogenic factors is summarized in (**Section 5.2.4**), Aquatic Ecological Resources. Based on this review, fish populations over a fifty year period are expected to reach a fraction of Present Day levels with Mahaseer population declining to about 10% of Present Day level (90% decline).
- As discussed in (**Section 5.2.6**), the present level of protection corresponds to protection with limited resources and intermittent availability of funds that the AJKFWD is presently managing with assistance from the Himalayan Wildlife Foundation. Experience from the past five years from this level of protection indicates that the fish richness and abundance has remained practically stagnant. In absence of the Project and without a sustainable resource base for protection as envisioned under the Project, the ecology of the Poonch River runs a high risk of decline possibly corresponding to the Business as Usual scenario as discussed above.
- As discussed in (**Section 8.6**), the Project aims to achieve 'net gain' for biodiversity consistent with ADB and IFC guidelines for management of biodiversity when projects are located in Critical Habitats (**Section 5.2.10**). Under the Business as Usual (BAU) management scenario (see **Section 8.5**, Non Flow Management Alternatives) with poor protection as at present, the ecosystem integrity of the river will deteriorate significantly over the next 52 years (**Section 6**, Assessments of Impacts on Aquatic Ecology). A Biodiversity Action Plan (**Section 11,** Environmental Management and Monitoring Plan) has been prepared and will be implemented as a part of the Project to achieve this objective. With the exception of a 0.7 km of the section of the river downstream of the dam which will experience low flows, the integrity of the river ecosystem will improve as protection measures are put in place consistent with the basin level strategy adopted in the Biodiversity Action Plan.

895. Therefore, unless an economically and environmentally more viable options can be found, which appears unlikely (see **Section 9.2**), the 'no project' option will have a negative impact on the economy as well as on the environment in the Poonch River.

8.2 Alternative Technologies and Scale for Power Generation

896. The alternatives to the proposed run-of-the-river (RoR) hydropower project include power generation from LNG/imported natural gas based combined cycle gas turbines (CCGTs), coal fired steam plants, and fuel oil based diesel engines. In addition, other technologies such as nuclear, and wind and solar renewable energy power plants could also be considered as alternatives. An analysis of the life cycle average cost of generation from the competing technologies was carried out to assess the least cost generation alternative of the project.

897. **Table 8–1** illustrates the calculation of life cycle average cost for the competing technologies for power generation in Pakistan. The analysis was carried out at the delivered prices of US$ 696 per ton for fuel oil[1] and US$120/ton for imported coal. The price of LNG/imported natural gas was also worked out with reference to the Brent crude oil price. The cost data of alternatives for thermal power generation were taken from recent industry experience in Pakistan.

1 Corresponding to Brent Crude oil price of US$102/bbl

Table 8–1: Life Cycle Average Cost of Power Generation from the Project Alternatives

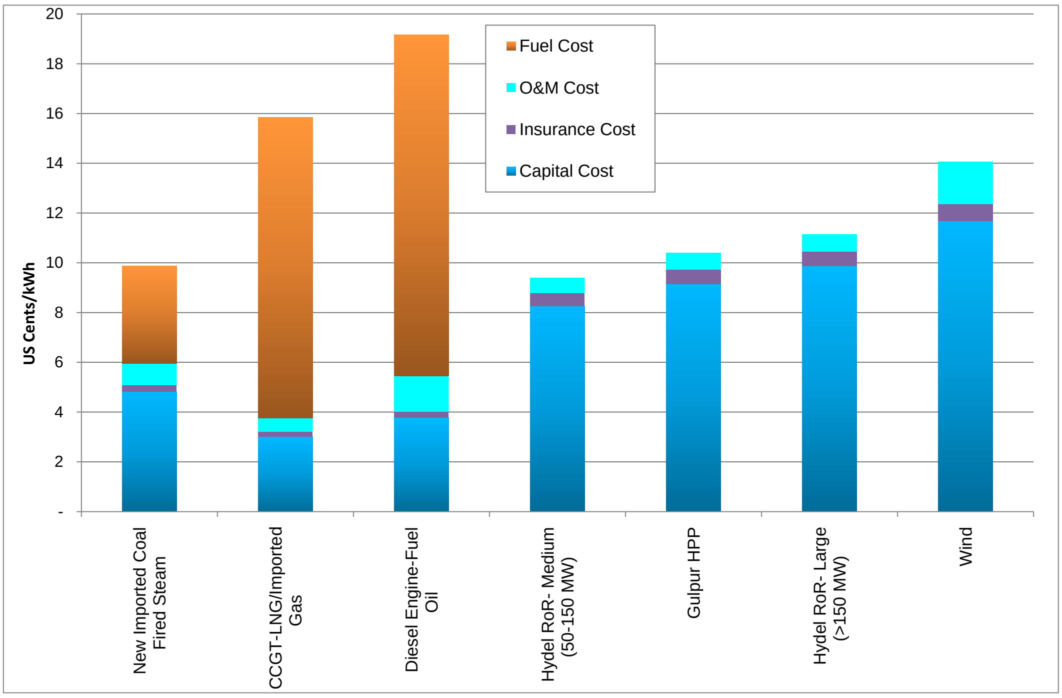
Cost Parameters	Cost Units	New Imported and Local Coal Fired Steam	CCGT-LNG/Imported Gas	Diesel Engine-Fuel Oil	Hydel RoR- Medium (50-150 MW)	Hydel RoR- Large (>150 MW)	Wind
Assumptions							
Project Life	Years	30	30	25	30	30	20
WACC/IRR		17%	15%	15%	16%	16%	16%
Plant Factor		60%	60%	60%	51%	46%	30%
Plant Efficiency		39.50%	48.15%	44%			
Insurance (% of Capital Cost)		1%	1%	1%	1%	1%	1%
Fuel Price	$/MMBtu	4.54	17.03	17.70	-	-	-
Power Plant Capital Cost	$/kW	1,473	1,038	1,283	2,286[2]	2,471	1,842
Annualized Capital Cost	$/kW	253	158	199	370	400	311
Annual Insurance Cost	$/kW	15	10	13	23	25	18
Life Cycle Average Cost							
Capital Cost	Cents/kWh	4.81	3.01	3.78	8.27	9.86	11.68
O&M Cost	Cents/kWh	0.88	0.56	1.43	0.61	0.68	1.69
Insurance Cost	Cents/kWh	0.28	0.20	0.24	0.51	0.61	0.69
Fuel Cost	Cents/kWh	3.92	12.07	13.72	-	-	-
Average Cost of Generation	Cents/kWh	9.88	15.84	19.17	9.39	11.15	14.07

Source: Hagler Bailly Pakistan Estimates

[2] Total investment for the Gulpur Hydropower Project is estimated at $315 million, of which about 70% is for the plant and equipment, corresponding to about $2,200/kW

898. **Figure 8–1** shows the comparison of cost of generation from various technology alternatives. Cost of power generation for the proposed medium sized run of river (RoR) project is lower than that for LNG and fuel oil based options, and comparable to that for coal based power generation. Cost of power generation for the project is also lower than that for wind energy projects where power generation is intermittent and weather dependent, and requires back up fossil fuel based power generation capacity to maintain supply in the grid. Large hydropower projects such as Diamer-Basha Dam can produce power at a slightly lower cost than the medium sized RoR hydropower projects. Such large projects, however, generally involve extensive resettlement and technical studies, tend to be delayed for these reasons and can take 7-12 years to complete, and frequently face cost overruns[3]. In addition, investment is difficult to mobilize in Pakistan and AJK at present due to risk rating of the country. Smaller projects are therefore more appealing to the international investors in the prevailing investment climate in the country. Given the risk of delays and cost over runs in large dams, shortage of power in the country, and investment constraints, the Project as a medium capacity RoR that can be completed in four years is an acceptable option amongst currently available alternatives in terms of technology and scale of projects.

Figure 8–1: Comparison of Cost of Power Generation from the Project Alternatives



8.3 Options for Project Location and Layout

899. The cost of individual RoR projects varies with location, hydrology, and special features of the site. As stated in (**Section 7.6.2**), SEA Perspective on Development of Hydropower Potential in AJK, 'the hydropower potential of the Jhelum and Neelum rivers could be developed at a significantly lower cost to the environment than that of the Poonch River, and that caution needed to be exercised in developing the potential of the

[3] Should we build more large dams? The actual costs of hydropower megaproject development, Atif Ansara, Bent Flyvbjergb, Alexander Budzierb, Daniel Lunnc, Energy Policy, Volume 69, June 2014

Poonch River in view of its relatively high environmental value and relatively smaller contribution to the national economy'. Projects in Jhelum and Neelum rivers will generally be comparatively larger in capacity given the flow in these rivers, and therefore likely to be comparatively less desirable for reasons discussed above. While the possibility of other medium sized hydropower projects in AJK and Pakistan cannot be ruled out, a unique feature of this Project is the achievement of net gain in biodiversity in the Poonch River as a whole, and increase in population of the Endangered Mahaseer and Critically Endangered Kashmir Catfish. This will be realized through collective mobilization of the government and other stakeholders for implementation of a Biodiversity Action Plan, for which the Project is committing to provide financial and technical support. Other environmental risks for this Project have also been addressed and mitigations proposed in this ESIA.

900. The following three options were considered for the location and layout of the Gulpur Hydropower Project viz. Option 1, Option 2 and Option 3:

- **Option 1:** Dam located just downstream of the confluence of Bann Nallah and Poonch River, and a 3.1 km diversion tunnel located in Bann Nallah.
- **Option 2:** Dam located about 3 km downstream of the location proposed under Option 1, and a diversion tunnel located in the Poonch River.
- **Option 3:** Dam located about 6 km downstream of the location proposed under Option 1and upstream of the power house in Option 1, with two or three 180 m diversion tunnels connecting to the power house.

901. All three options could produce 100 MW of electricity using a run-of-the-river (RoR) type hydropower configuration. Option 2 was an intermediate configuration in terms of the location of the dam and the tunnel, and offered ecological advantage over Option 1 by reducing the length of the river impacted by low flows from 6 km to 3 km. Option 2, however, was not considered to be technically feasible following geotechnical studies In addition, compared to Option 1, Option 2 did not offer any significant social advantage in terms of resettlement, and did not improve the economics of power generation. Option 2 was therefore discarded early in the analysis. Given below is a brief discussion of the two options that were considered.

Option 1

902. According to Option 1 (**Figure 8–2**), a dam would be constructed on the Poonch River just downstream of its confluence with Bann Nullah, a tributary of Poonch River. The dam would create a reservoir in the Poonch River and the Bann Nullah. The height of the dam from the foundation up would be 45 m. The water from the reservoir will be diverted to a 3.1 km headrace tunnel. The intake of the tunnel would be located in the Bann Nullah about 2 km upstream of the confluence of the Bann Nullah with the Poonch River. A powerhouse would be constructed on the left bank of Poonch River about 6 km downstream of the dam. The water after passing through the powerhouse would be discharged back into the Poonch River.

903. The Normal Operating Level (NOL) of the dam would be an elevation of 540 m and the dam crest level would be set at El. 545 m. There would be eight orifice type radial gates with dimensions: 11.5m wide x 25.0m high. The operation of the Project would create a reservoir upstream of the dam and the total submerged area (including the present river) would be approximately 320 hectares of which about 74% is public land.

904. Three Francis 33.33-MW turbines would be used for power generation, each with an operational discharge range of 33-66 m^3s^{-1} (where 66 m^3s^{-1} is the installed capacity)

Option 3

905. According to Option 3 (**Figure 8–3**), the Project would be a run-of-the-river (RoR) type and would require construction of a dam on a bend of the Poonch River, about 6.1 km downstream of the Option 1 location. The height of the dam from the foundation up will be 67.5 m (66 m excluding the foundation). A surface powerhouse would be located about 1 km downstream of the dam in the Poonch River. Two or three tunnels (depending on the number of units chosen) each about 180 m long, would connect the water inlet to the powerhouse. The water after passing through the powerhouse would be discharged back into the Poonch River.

906. The Normal Operating Level (NOL) of the dam would be an elevation of 532 m and the dam crest level would be set at El. 539.5 m. There would be seven orifice type radial gates with dimensions: 11.5 m wide x 26.0 m high. The operation of the Hydropower Project would create a reservoir upstream of the dam and the total submerged area (including the present river) would be approximately 292 hectares. There would be no flooding of occupied land.

907. Power would be generated with the help of two Kaplan turbines[4], each with flow of 102 m^3s^{-1} at full capacity and a minimum rated flow of 20 m^3s^{-1}. Compared to Option 1 where Francis type turbine with a minimum rated flow of 33 m^3s^{-1} were planned, the minimum rated flow of turbines in this option would be lower. This would result in an improvement in power generation from the Project as the turbines will not have to shut when the flow is in the range of 20-33 m^3s^{-1} under this option.

8.3.1 Impacts on Biodiversity under Different Project Options

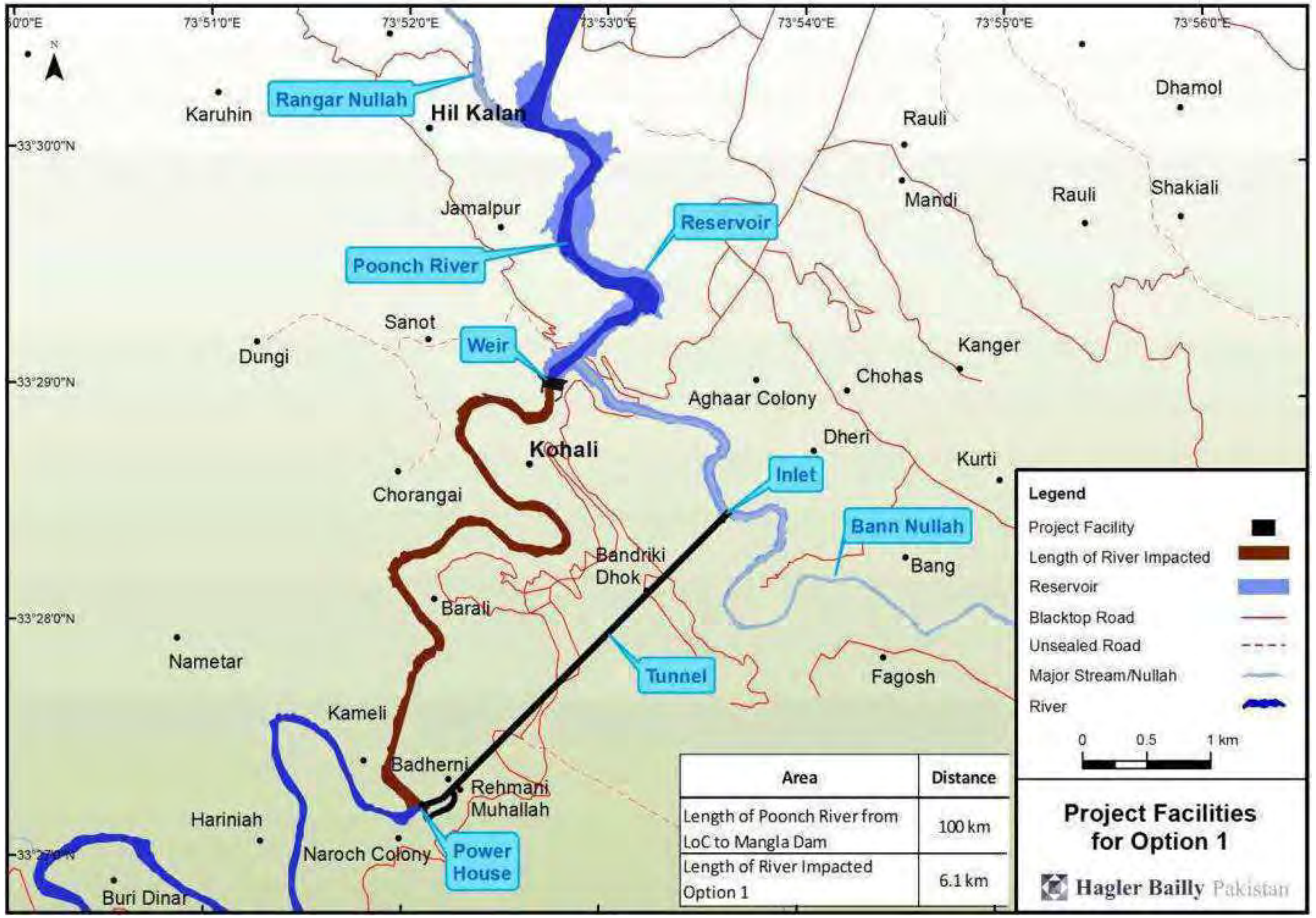
908. This section compares the impacts on biodiversity of Option 1 and Option 3 for Project location and layout.

Length of River that will be Impacted by Low Flows

909. **Figure 8–4** shows a comparison of the length of the river impacted by low flow under Option 1 and Option 3. Both the options will utilize the waters of the Poonch River by creation of a dam that will lead to creation of a reservoir. The water from the reservoir will be diverted into a headrace tunnel and the water after passing through a powerhouse will be discharged back into the Poonch River. The stretch of the River from the tunnel inlet to the outlet will be dewatered or experience low water flows.

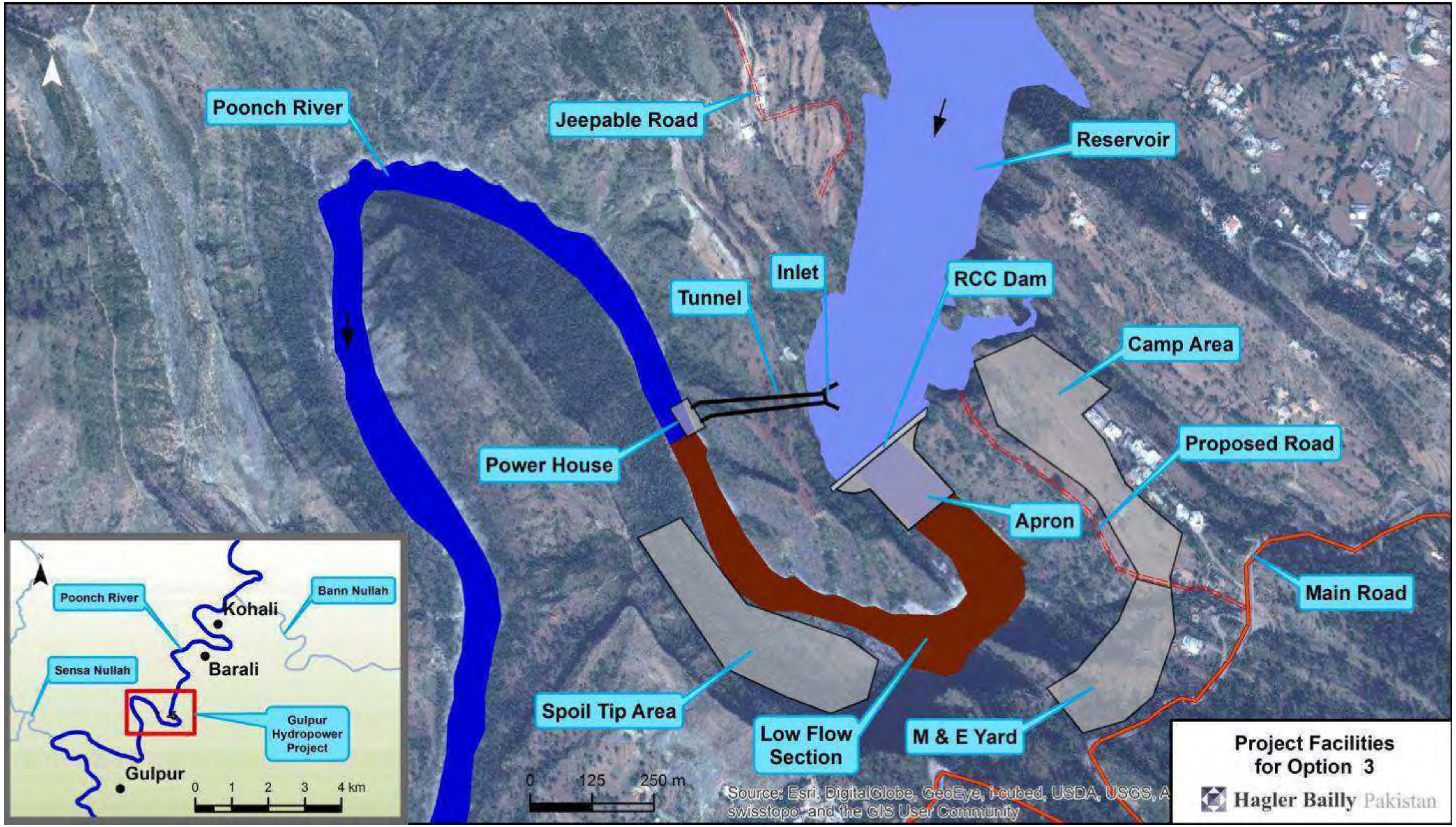
[4] The turbine configuration is subject to optimization at the detailed engineering stage, where three Francis type turbines with identical or varying flow and power generation capacities may be considered.

Figure 8–2: Project Facilities for Option 1



Area	Distance
Length of Poonch River from LoC to Mangla Dam	100 km
Length of River Impacted Option 1	6.1 km

Figure 8–3: Project Facilities for Option 3



910. The Poonch River provides habitat for 37 fish species, several species of macro-invertebrates and algal flora species. In addition, there are riparian vegetation species that depend on the river. At least 12 of the fish species are species of special concern as they are endemic to Pakistan, are included in the IUCN Red List 2013[5] or have importance as being commercially important food fish (**Section 5,** Description of Environment). One fish species Mahaseer ***Tor putitora*** is listed as Endangered in the IUCN Red List 2013 while the Kashmir Catfish ***Glyptothorax kashmirensis*** is listed as Critically Endangered. The aquatic ecological resources such as fish, macro-invertebrates, algal flora and riparian vegetation will suffer negative impacts in the stretch of the River that experiences low water availability caused by operation of the Project. This is because both the spatial and temporal responses of plants and animals to changing conditions are usually set within quite specific limits. Any physical or chemical change to an ecosystem outside of its natural range will disrupt relationships between species, probably reduce biological diversity and abundances, and potentially cause community shifts characterized by loss of sensitive, often rare, species and proliferation of robust, often common, species.

911. Under Option 1, approximately 6.1 km of the River will experience low flows due to operation of the Project (6% of the Poonch River length from LOC to Mangla) while in Option 3, only 0.7 km of the River will be affected by these low flows (0.7% of the Poonch River length from LOC to Mangla (**Figure 8–2**)).

912. Clearly, from an ecological standpoint, the negative impact on the ecological resources of the Poonch River will be less for Option 3 compared to Option 1 as the impacted length of the river is less for Option 3.

Breeding Areas for Endangered Fish Species: Mahaseer *Tor putitora*

913. The Poonch River provides habitat for the Endangered (IUCN Red List) fish species Mahaseer ***Tor putitora*** that is an important sport and food fish. During the breeding season, this fish migrates into the tributaries (nullahs) of the Poonch River for spawning including the Bann Nullah and Rangar Nullah (**Figure 8–2**). The construction of a dam, as envisaged in Option 1, at the confluence of Poonch River and the Ban Nullah will disrupt this breeding migration and negatively impact the population of the Mahaseer ***Tor putitora.*** Under Option 3 of the Project location, the Project facilities will be located about 6 km downstream of Option 1 location. Therefore, the breeding grounds particularly the Ban Nullah will not be directly affected by Project operations and therefore the negative impact on the Endangered (IUCN Red List) fish species Mahaseer ***Tor putitora*** will be substantially lower.

Area of Terrstrial Habitat Disturbed

914. Site clearance for construction of Project infrastructure will destroy the terrestrial habitats in, and in the immediate vicinity of the Project footprint and ancillaries. The ecological receptors i.e. floral and faunal species will be lost and the terrestrial ecosystems will be disturbed. The habitats identified in the vicinity of the Project site including Pine Forest, Scrub Forest, Agricultural Fields and Riparian are likely to be affected. The Area of Habitat Loss is defined to include the areas that will be inundated due to construction of Project infrastructure including the area that will be submerged under water due to creation of the dam reservoir.

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5 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 26 October 2013.

915. For Option 1 of the Project location, the length of the power tunnel will be approximately 6 km whereas for Option 3, only a 180 m long power tunnel will connect the dam to the power house. Even though this will be an underground tunnel, the construction of the tunnel may impact the over-ground flora and fauna due to noise, vibration, dust, air emissions as well as disturbance of the underground water table. A smaller tunnel length means lower disturbance for ecological resources (as is the case for Option 3).

916. Keeping in view the smaller length of the power tunnel, the Project facilities such as dam, power house will be constructed in proximity for Option 3 compared to Option 1 where two locations will be disturbed. Therefore, there will be lesser disturbance of terrestrial habitat, and a smaller negative impact on ecological resources for Option 3 of Project location and layout.

917. The operation of the Hydropower Project will lead to the creation of a reservoir and some terrestrial habitats will be submerged under water. The total submerged area (including the present river) will be approximately 320 hectares for Option 1 and 292 hectares for Option 3. Thus for Option 3, less terrestrial habitat will be submerged and consequently there will be a lower negative impact on the terrestrial ecology.

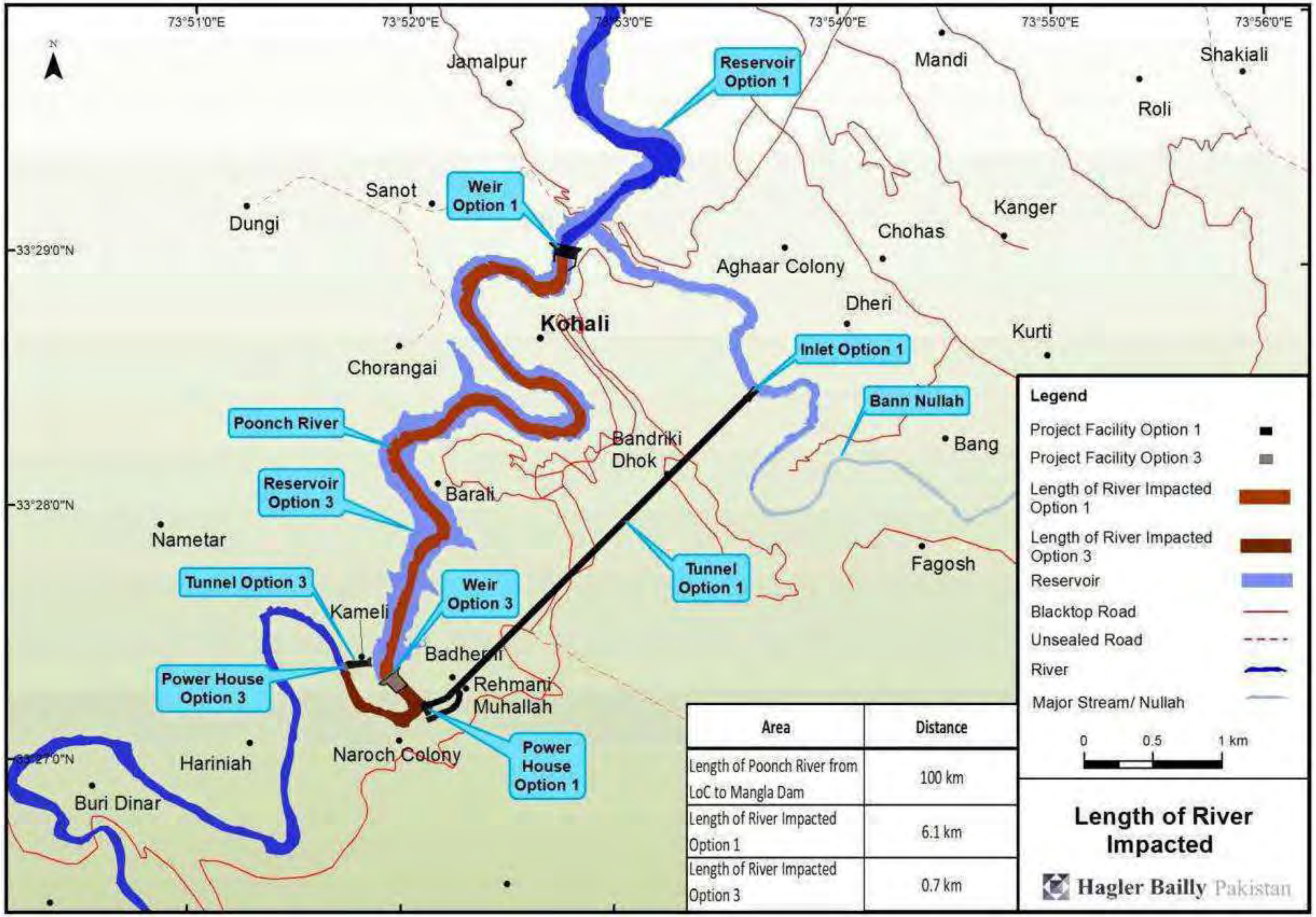
Construction of Road

918. For the Project location and layout considered for Option 1, a new road approximately 1.5 km long was planned to be built from the existing blacktop road to the inlet of the power tunnel (**Figure 8–2**) in relatively undisturbed pine and scrub forest. For this, vegetation would have to be cleared, trees cut, and the ensuing habitat loss and habitat fragmentation would have negatively impacted the ecological resources at the planned road site. For Option 3, a much smaller road of 650 m is required, and the negative impacts on ecology from road construction as well as increased traffic on the newly constructed road can be reduced with this option.

8.4 Peaking vs Non-Peaking Operation

919. Peaking in hydropower generation is defined as an operating mode in which water from the dam is released for only part of the day corresponding to peak demand for power in the system. In Pakistan this period is typically 6 pm to 11 pm, with some variations between summer and winter seasons. This situation occurs during the low flow or dry season in the country, typically during the winters. Run of River (RoR) hydropower projects such as Gulpur Hydropwer Project are typically designed with a storage capacity of one to two days in the reservoir, which allows for accumulation of the water in the reservoir during the day, late evening, and morning. The stored water is then released to generate power during the peak demand period. In addition to matching the demand profile of the system, peaking permits operation of turbines at a higher capacity. As the efficiency of hydropower turbines declines significantly below 50% of capacity, peaking provides greater flexibility in optimizing the power generation from hydropower projects.

Figure 8–4: Comparison of Length of River Impacted in Option 1 and Option 3



Area	Distance
Length of Poonch River from LoC to Mangla Dam	100 km
Length of River Impacted Option 1	6.1 km
Length of River Impacted Option 3	0.7 km

920. A peaking operation, however, can be detrimental to the ecology downstream of the dam. Low flows normally occur in the section of the river starting just below the dam, and extending to the point where water is added back into the river at the outlet of the tail race tunnel of the power house. However, with a peaking operation low flows are extended downstream of the power house as well during the period the power house is shut down to accumulate water in the reservoir upstream. The river ecology which is adapted to normal daily and seasonal variations in flows is severely impacted by the daily long dry spells. The following is a summary of the impacts of a peaking operation which was studied as a scenario in DRIFT modeling discussed in detail in (**Section 6**, Environmental Flow Assessment).

921. A peaking operation will result in deterioration starting from a Mid Category C river (Moderately Modified from Reference Condition), under which loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged to a Mid-Category E river (Seriously Modified) under which the loss of natural habitat, biota and basic ecosystem functions is extensive. These impacts are similar to those at EF Site 2 just downstream of the dam where the flows are reduced. In other words, the impact of peaking downstream of the power house outfall will be quite similar to that of reduced flows, as the river will experience only minimum flows released from the dam for a greater part of the day when the water is being stored in the dam and no flow is released from the power house.

922. With a peaking operation all the downstream section of the river to the Mangla Reservoir will more or less face degradation of the type that Site 2 or the low flow section just downstream of the dam will experience. Under Option 3 the low flow section will only be of the order 0.7 km, which is small compared to the entire length of the river. With peaking operation this will get extended to about 35 kilometers. There will therefore be no possibility of achieving net gain under a peaking operation. Furthermore, stocking of Mahaseer in the downstream section of the dam will be useless as the fish will never survive the severe variations in daily flows all the way down to Mangla Reservoir. Peaking operation was therefore not considered as environmentally feasible for the Project.

8.5 Non-Flow or Management Alternatives

923. As discussed in (**Section 6.6**), the EFlow assessment included consideration of flow scenarios with EFlows of 4, 6, 8, 12 and 16 m^3/s (cumec) minimum dry season release from the reservoir. Additionally, each scenario had a ‘protection’ (Pro) and a ‘Business as Usual (BAU) option, which referred to the influence of non-flow related impacts on the integrity of the riverine ecosystem. These impacts are related primarily to un-regulated fishing, and mining of sand and boulders that damages river habitats. The protection levels incorporated into the scenarios address pressures on the river ecosystem that are not related to flow changes. Three protection levels as defined in (**Section 6.4** Construction and Selection of Scenarios) were studied:

- Protection Level 1 (Pro 1) or Moderate Protection = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time.
- Protection Level 2 (Pro 2) or Enhanced Protection = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over time.

- Business as Usual (BAU) or Poor Protection = - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years.

924. The analysis presented in (**Section 6**) indicates that:

925. **Without dam in place**, with poor protection or Business as Usual (BAU) case, the ecosystem integrity of the river which is presently Mid-Category C (moderately modified) will deteriorate to a Low Category D (largely modified) over the next 52 years (see **Table 6-2** (**Section 6.2**) for definition of ecosystem categories). With protection at current levels (Pro1), the river will still deteriorate to a mid-Category D. A good level of protection (Pro2) will lead to an improvement of about 0.5 in ecological integrity of the river resulting in low Category B river. In other words, though the river ecosystem has suffered degradation due to anthropogenic activities, the basic elements of the ecosystem still exist and the ecological condition of the river can be improved by putting in a good level of protection in place.

926. **Upstream of the dam inundated area**, the ecological integrity and the levels of the indicators evaluated will deteriorate only slightly with dam in place. In other words, a good level of protection (Pro2) will lead to an improvement of about 0.5 in ecological integrity of the river resulting in low Category B river, and with poor protection or business as usual (BAU) case, the ecosystem integrity of the river which is presently mid-Category C will deteriorate to a low Category D

927. **Just downstream of the dam**, the flows will be lower due to diversion of the river water into tunnels. The river will deteriorate to a mid-Category E under all BAU scenarios. In other words, the impact of poor protection will be far higher than that of the reduced flows, and increasing minimum flow release from 4 cumec to 16 cumec will not result in any noticeable improvement in the ecological condition of the river. However, with good protection in place (Pro2), the ecological degradation can be limited to Mid-Category D.

928. **Downstream of the power station,** under BAU or poor protection levels, the river will deteriorate to a low Category D under all minimum release scenarios, for reason similar to those indicated for just downstream of the dam. However, under Pro2 or good protection levels, the conditions will improve to border line between Category B and C, similar to those at EF Site 1 upstream of the dam. In other words, the contribution of good protection measures will more than compensate for harm done by the dam.

929. In conclusion, achievement of net gain at basin level as required under ADB and IFC guidelines will be possible only if good protection levels as envisaged under Pro2 scenario are put in place. Preparation and successful implementation of a Biodiversity Actin Plan (BAP) that makes this possible was therefore considered essential for compliance with ADB and IFC guidelines and made a part of this project.

8.6 Balance between Environmental Degradation and Economic Benefit

930. The stretch of the river downstream of the dam to the outlet of the tail race tunnel form the power house will experience low flows due to Project operations. Environmental flow (EFlow) refers to the minimum flow that will be released to this stretch of the river to manage environmental impacts.

931. Five different flow regimes of 4 cumecs, 6, cumecs, 8 cumecs, 12 cumecs, and 16 cumecs were considered for release into the river. DRIFT methodology was used to analyze the effects of these three flows scenarios under different levels of protection

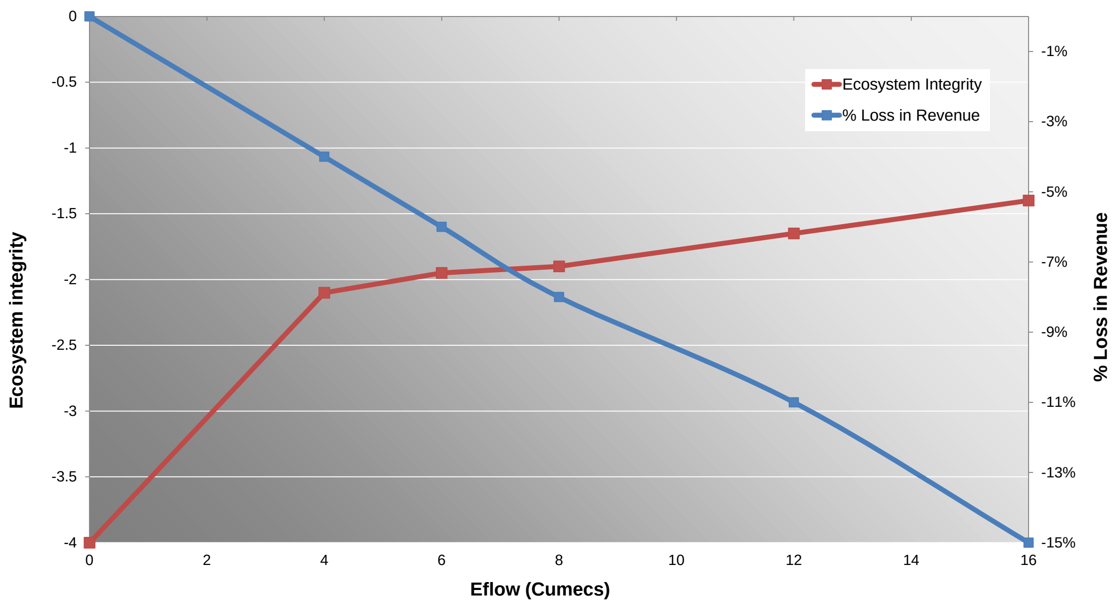
(conservation) on the river ecosystem at three EFlow sites. The objective was to describe the present condition of the river ecosystem and then, through scenarios, predict how this could change with different design and operation of the Gulpur HPP. Details are presented in (**Section 6**) of this report, 'Environmental Flow Assessment'.

932. To compare the economic impact and ecological benefit expected by increasing the minimum environmental flow, loss in power generation was calculated for varying levels of EFlows and compared with ecosystem integrity and decline in populations of Mahaseer and Kashmir Catfish (**Section 6.6**, 'Additional Scenarios') in view of their conservation importance (**Section 5.2.1,** Endangered and Threatened Species). Loss of power generation was calculated on the basis of the operating rule described in (**Section 3.2.4**)**,** Turbine Operating Rule using the hydrological model developed for EFlow assessment, configuration of the powerhouse including heads available, and turbine efficiency curves. Results of impacts of varying levels of EFlow on power generation are included in **Section C.3**, of the EFlow Report[6], 'Power Generation Results for Scenarios',

933. The results of combined ecological and economic analysis are presented in **Figure 8–5**: Economic Benefit vs Ecosystem Integrity[7].

934. **Figure 8–5** and **Figure 8–6** shows that the improvement in ecosystem integrity of the river is more or less linear when EFlow is varied from 4 to 16 cumec. **Figure 8–6** shows that when minimum flow is increased from 4 cumecs to 8 cumecs, the benefit to Mahaseer and Kashmir Catfish is not significant. However, when the minimum flow is increased from 8 cumecs to 16 cumecs, a noticeable benefit to their survival in the low flow segment of the river downstream of the dam area is predicted. The financial impacts however increase on a linear scale as the EFlow is increased. Loss in power generation is estimated at 4.0%, 7.8%, and 14.8%, for EFlows of 4, 8 and 16 cumecs respectively.

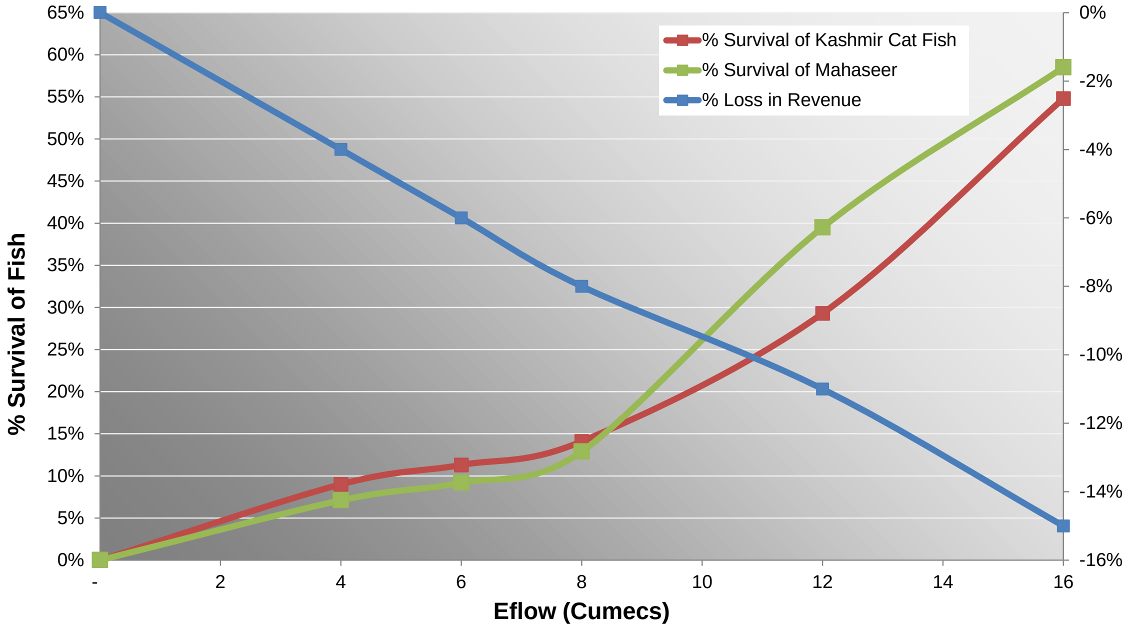
Figure 8–5: Economic Benefit vs Ecosystem Integrity



6 Environmental Flow Assessment, Technical Report, and Southern Waters in Association with Hagler Bailly Pakistan, March 2014. Report is included in **Appendix H** of this ESIA.

7 See **Section A.2.2 Appendix H** 'Environmental Flow Assessment' for definition of Ecological Integrity.

Figure 8–6: Economic Benefit vs Survival of Fish Populations



935. Impact of varying levels of EFlow on project economics and ecosystem integrity were discussed by the owner with the key stakeholders (**Section 9**) to select an EFlow regime that achieves a balance between the benefits to the ecosystem and the financial loss to the Project and economy. Given that:

- the relatively small segment (700 m) of the river impacted under Option 3;
- adoption of a non-peaking mode of operation for the powerhouse to maintain flow in the downstream section of the river to Mangla reservoir; and
- a gain in ecosystem integrity and populations of key fish species through establishment of protection under scenario Pro 2.

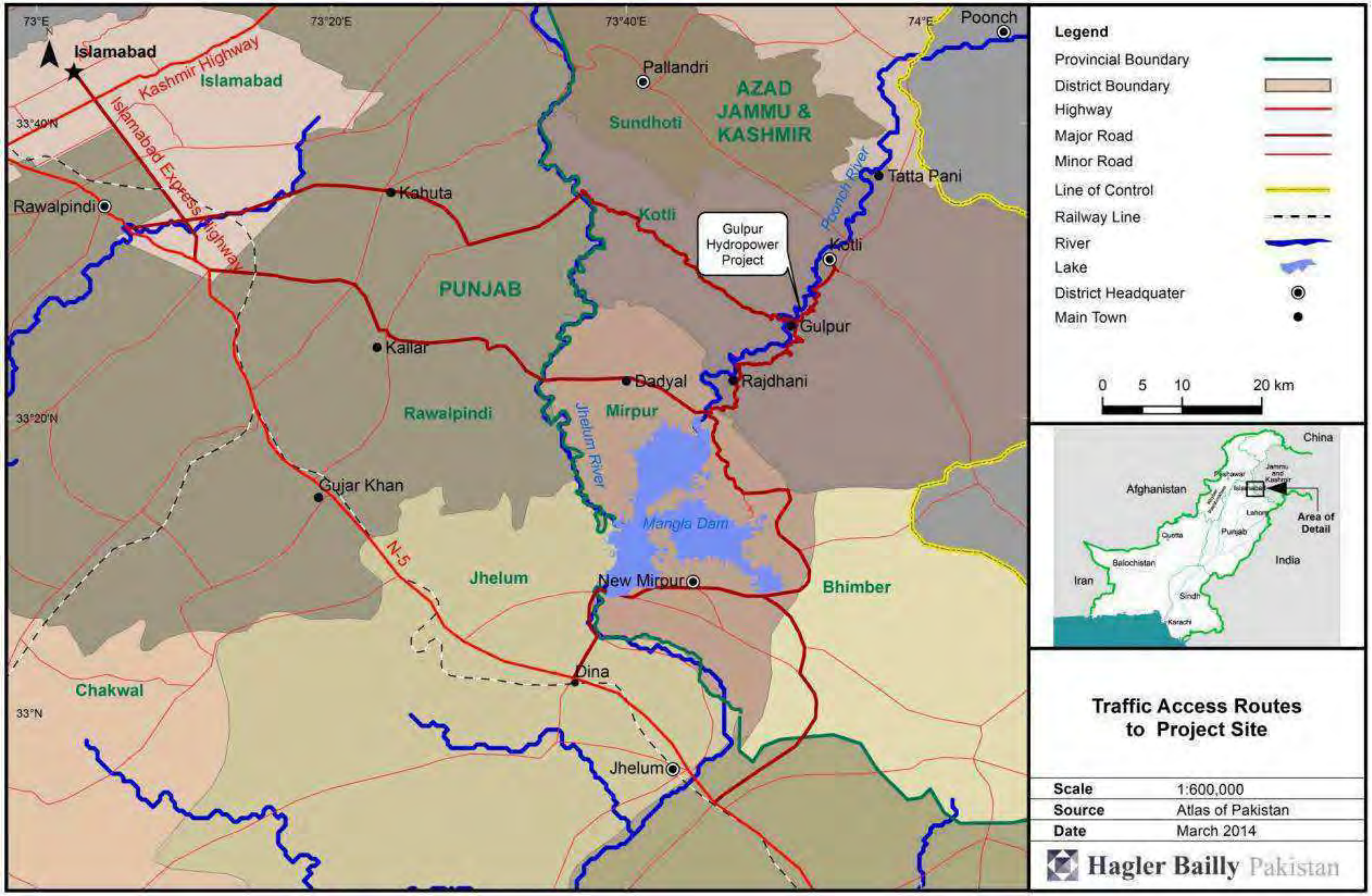
936. An EFlow of 4 cumec was proposed in view of basin wide ecological improvements expected through the implementation of the BAP and economic impacts associated with varying level of EFlows.

8.7 Options for Transportation of Equipment to Project Site

937. Heavy equipment for the Project will be off loaded at Karachi port and transported by road to the project site. Some construction materials such as cement and aggregate may be sources from locations around Rawalpindi and Islamabad. As illustrated in **Figure 8–7**, access to the project site will be through the National Highway N-5 or the Grand Trunk (GT) Road that connects Rawalpindi and Islamabad towards the north-west to Lahore towards the south- east, form where it turns south and connects to Karachi. There is no rail connection to the Project area. The following is a summary of the route options and their suitability for transportation of equipment and materials to the project site:

938. **Figure 8–7** illustrates the options for transporting the equipment to the project site from N-5. The routes from Rawalpindi/Islamabad going through either Kahuta (the northern most routes in **Figure 8–7**) or Rawat – Kallar Syedan-Dudhial (just south of the Kahuta route) involve an additional transportation distance of about 300 km. Furthermore the Kahuta road passes by some strategic installations and access from that route can be limited without prior notification which would then hamper project activities. These two options are therefore not recommended. The access route from Jhelum is also not recommended as this width of the road on this route is comparatively lower and there curves are sharper. The Dina-Mangla-Mirpur-Kotli was selected for transportation of heavy equipment and bulk materials for the project in view of the transportation distance and the constraints on the other routes.

Figure 8–7: Traffic Access Routes to Project Site



9. Information Disclosure, Consultation, and Participation

939. As part of the Environmental Impact Assessment process, consultations are undertaken with communities and institutions that may have interest in the proposed project or may be affected by it. This section documents the consultation process for the ESIA of the proposed Project.

9.1 Framework for Consultations

940. The ESIA of the proposed Project is undertaken in compliance with relevant national legislation set by Pakistan Environmental Protection Agency, IFC performance standards[1] on social and environmental sustainability, and the environmental and social safeguards laid out under ADB's safeguard policy (SPS 2009)[2].

9.2 International Requirements

9.2.1 IFC Requirements

941. IFC Performance Standards are designed to manage social and environmental risks and impacts and to enhance development opportunities. Eight Performance Standards are established which are described in (**Section 3.6.1)**. Clients of IFC, or other financial institutions electing to apply them to projects that it is financing, are expected to meet these standards throughout the life of an investment by IFC or other relevant financial institution. The Performance Standard 1 (PS1) relevant to information and disclosure is described below.

PS 1 Social and Environmental Assessment and Management System

942. The PS1 establishes the importance of integrated assessment to identify the social and environmental impacts, risks, and opportunities in the project's area of influence. PS1 requires Social and Environmental Assessment and Management Systems for managing social and environmental performance throughout the life cycle of this Project and runs through all subsequent PSs. Community engagement or stakeholder engagement is one of the seven elements of PS1. The specific requirements of the stakeholder engagement are summarized below.

- **Stakeholder Analysis:** Clients should identify the range of stakeholders that may be interested in their actions and consider how external communications might facilitate a dialog with all stakeholders. Where projects involve specifically identified physical elements, aspects and/or facilities that are likely to generate adverse environmental and social impacts to Affected Communities the client will identify the Affected Communities.
- **Engagement Planning:** The client will develop and implement a Stakeholder Engagement Plan that is scaled to the project risks and impacts and development stage, and be tailored to the characteristics and interests of the Affected Communities. Where applicable, the Stakeholder Engagement Plan will include differentiated measures to allow the effective participation of those

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1 IFC Performance Standards, International Finance Corporation, January 2012

2 Safeguard Policy Statement, Asian Development Bank, June 2009

identified as disadvantaged or vulnerable. When the stakeholder engagement process depends substantially on community representatives, the client will make every reasonable effort to verify that such persons do in fact represent the views of Affected Communities and that they can be relied upon to faithfully communicate the results of consultations to their constituents.

- **Disclosure of Information:** The client will provide Affected Communities with access to relevant information[3] on: (i) the purpose, nature, and scale of the project; (ii) the duration of proposed project activities; (iii) any risks to and potential impacts on such communities and relevant mitigation measures; (iv) the envisaged stakeholder engagement process; and (v) the grievance mechanism.
- **Consultation:** When Affected Communities are subject to identified risks and adverse impacts from a project, the client will undertake a process of consultation in a manner that provides the Affected Communities with opportunities to express their views on project risks, impacts and mitigation measures, and allows the client to consider and respond to them. Effective consultation should: (i) begin early in the process of identification of environmental and social risks and impacts and continue on an ongoing basis as risks and impacts arise; (ii) be based on the prior disclosure and dissemination of relevant, transparent, objective, meaningful and easily accessible information which is in a culturally appropriate local language(s) and format and is understandable to Affected Communities; (iii) focus inclusive engagement on those directly affected as opposed to those not directly affected; (iv) be free of external manipulation, interference, coercion, or intimidation; (v) enable meaningful participation, where applicable; and (vi) be documented. The client will tailor its consultation process to the language preferences of the Affected Communities, their decision-making process, and the needs of disadvantaged or vulnerable groups.
- **Informed Consultation and Participation:** For projects with potentially significant adverse impacts on Affected Communities, the client will conduct an Informed Consultation and Participation (ICP) process that will build upon the steps outlined above in Consultation and will result in the Affected Communities' informed participation. ICP involves a more in-depth exchange of views and information, and an organized and iterative consultation, leading to the client's incorporating into their decision-making process the views of the Affected Communities on matters that affect them directly, such as the proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues. The consultation process should (i) capture both men's and women's views, if necessary through separate forums or engagements, and (ii) reflect men's and women's different concerns and priorities about impacts, mitigation mechanisms, and benefits, where

[3] Depending on the scale of the project and significance of the risks and impacts, relevant document(s) could range from full Environmental and Social Assessments and Action Plans (i.e., Stakeholder Engagement Plan, Resettlement Action Plans, Biodiversity Action Plans, Hazardous Materials Management Plans, Emergency Preparedness and Response Plans, Community Health and Safety Plans, Ecosystem Restoration Plans, and Indigenous Peoples Development Plans, etc.) to easy-to-understand summaries of key issues and commitments. These documents could also include the client's environmental and social policy and any supplemental measures and actions defined as a result of independent due diligence conducted by financiers.

appropriate. The client will document the process, in particular the measures taken to avoid or minimize risks to and adverse impacts on the Affected Communities, and will inform those affected about how their concerns have been considered.

9.2.2 ADB Safeguard Policy Statement

943. Public consultation is mandated under Asian Development Bank's Safeguard Policy Statement (SPS 2009)[4].

> **SPS 2009 on Pubic Consultations**
>
> ***The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. Meaningful consultation is a process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle; (ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues. Consultation will be carried out in a manner commensurate with the impacts on affected communities. The consultation process and its results are to be documented and reflected in the environmental assessment report.***

9.2.3 Pakistan Environmental Protection Act 1997

944. Public consultation is mandated under Pakistan's environmental law. The Federal Agency, under Regulation 6 of the IEE-EIA Regulations 2000, has issued a set of guidelines of general applicability and sectoral guidelines indicating specific assessment requirements. These guidelines have been adopted by the AJK-EPA for use in its jurisdiction. This includes Guidelines for Public Consultation, 1997 (the 'Guidelines'), that are summarized below:

- **Objectives of Public Involvement:** 'To inform stakeholders about the proposed project, to provide an opportunity for those otherwise unrepresented to present their views and values, providing better transparency and accountability in decision making, creating a sense of ownership with the stakeholders'.
- **Stakeholders:** 'People who may be directly or indirectly affected by a proposal will clearly be the focus of public involvement. Those who are directly affected may be project beneficiaries, those likely to be adversely affected, or other stakeholders. The identification of those indirectly affected is more difficult, and to some extent it will be a subjective judgment. For this reason it is good practice to have a very wide definition of who should be involved and to include any person or group who thinks that they have an interest. Sometimes it may be necessary to consult with a representative from a particular interest group. In such cases the choice of representative should be left to the group itself. Consultation should include not only those likely to be affected, positively or negatively, by the outcome of a proposal, but should also include those who can affect the outcome of a proposal'.

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4 Safeguard Policy Statement, Asian Development Bank, June 2009

- **Mechanism:** 'Provide sufficient relevant information in a form that is easily understood by non-experts (without being simplistic or insulting), allow sufficient time for stakeholders to read, discuss, consider the information and its implications and to present their views, responses should be provided to issues and problems raised or comments made by stakeholders, selection of venues and timings of events should encourage maximum attendance'.
- **Timing and Frequency:** Planning for the public consultation program needs to begin at a very early stage; ideally it should commence at the screening stage of the proposal and continue throughout the ESIA process.
- **Consultation Tools:** Some specific consultation tools that can be used for conducting consultations include; focus group meetings, needs assessment, semi-structured interviews; village meetings and workshops.
- **Important Considerations:** 'The development of a public involvement program would typically involve consideration of the following issues; objectives of the proposal and the study; identification of stakeholders; identification of appropriate techniques to consult with the stakeholders; identification of approaches to ensure feedback to involved stakeholders; and mechanisms to ensure stakeholders' consideration are taken into account'.

9.3 Consultation Methodology

945. Consultations with the Project stakeholders were undertaken during the third and fourth week of February 2014. The main document for distribution to stakeholders during the consultations was the Background Information Document (BID) that informed the stakeholders about the ESIA process and provided a background about the Project. The BID was made available in English and Urdu to suit the language preferences of different stakeholders. The BID for the Project is included in **Appendix J**. The feedback from the communities was recorded and the detailed log of consultations with the attendees list is attached in **Appendix J**. Separate meetings with institutional stakeholders were arranged in Kotli, Islamabad and Muzaffarabad. The presentation given to them and the materials shared with them are attached in **Appendix J**.

9.3.1 Stakeholders Consulted

946. Stakeholders are groups or individuals that can affect or take affect from a project's outcome. SPS 2009 specifically identifies affected people, concerned nongovernment organizations (NGOs) and government as prospective stakeholders to a project. Affected communities include population that is likely to be affected by the Project activities. Potential impacts of the Project on the local environment include disturbances and changes to the physical and biological environment, such as, land transformation, noise disturbances, and air and water quality issues. These disturbances can result in indirect socioeconomic impacts, such as, physical or economic displacement. These impacts are expected to reduce with the increased distance from the Project facilities. A basin wide study approach was used for the ESIA of Gulpur Hydropower therefore 11 rural communities were consulted along the Poonch River. In addition to the Potentially Affected Communities, local government and local NGO officials were also consulted.

947. **Table 9–1** lists the Project stakeholders consulted. Consultation were conducted in representative number of communities while ensuring that people from various segments of the society participate in the consultation, to ensure proper coverage of

possible stakeholder concerns. **Figure 9–1** shows location of stakeholders consulted near Project site.

Table 9–1: Stakeholders Consulted

Group	Stakeholders	Consulted / Invited	Date Consulted (DD/MM/YY)	No. of Participants (Men)	No. of Participants (Women)
Community: Villages	Aghar	C	08/02/14	16	8
	Phagwari	C	15/02/14	15	13
	Gulpur	C	12/02/14	30	32
	Kohali	C	09/02/14	12	25
	Rajdhani	C	12/02/14	15	16
	Rehmani Muhallah	C	10/02/14	17	10
	Hill Killan	C	11/02/14	15	26
	Kameli	C	11/02/14	10	7
	Barali	C	15/02/14	9	14
	Naroch Colony	C	10/02/14	17	20
	Bialian	C	09/02/14	11	10
Government and related	Deputy Commissioner, Kotli	C	12/02/14		
	Superintendent Police, Kotli	C	12/02/14		
	Private Power Infrastructure Board (PPIB)	C	19/02/14		
	Environmental Protection Agency (EPA) AJK	C	20/03/14		
	Forest Department AJK	C	20/03/14		
	Hydroelectric Board (HEB)	C	20/03/114		
Academics and NGOs	Kotli Traders Association	C	11/02/14		
	World Wildlife Fund (WWF)	C	19/02/14		
	International Union for Conservation of Nature (IUCN)	I			
	Himalayan Wildlife Foundation (HWF)	C	19/02/14		
	Snow Leopard Foundation (SPF)	C	19/02/14		
	ZB Mirza (ZBM) (Ecologist)	C	19/02/14		

C – Consulted; I – Invited but did not participate

Figure 9–1: Consultation Locations

9.3.2 Consultations Mechanism

Community Consultation

948. The Potentially Affected Communities were visited and consultations were conducted with the community members within their settlements to encourage and facilitate their participation. Representatives, notables and other interested groups from the Potentially Affected Communities were invited. A total of 11 settlements were consulted. Separate consultations were conducted with community women of all 11 settlements.

Stakeholder Consultation

949. Letters to inform experts/institutional stakeholders about the objective of the consultation process and to arrange meetings with the stakeholders were dispatched in advance. BID and a detailed Institutional Stakeholder Consultation documents were enclosed with the letters for the information of the stakeholders.

950. For institutional consultation, HBP organized one meeting in Muzaffarabad for the government departments and agencies and one in Islamabad for the remaining institutions. Invitations for the meetings were sent a week before the meeting and these were followed up with phone call to ensure maximum participation. A presentation given to the participants is attached in **Appendix J**. The presentation was followed by a question-answer session. Individual meetings with the Traders Association of Kotli and the Deputy Commissioner of Kotli were also conducted on February 11th and 12th 2014 respectively.

951. The key agenda items for the meetings with the communities, experts/institutional stakeholders, fishermen and sand miners communities included:

- An overview of the Project description to the community representatives;
- Description of the ESIA process that will be undertaken for the Project and presentation of a structure of the ESIA report to facilitate understanding of the report;
- A list of the possible environmental and social impacts of the Project.

952. Individual meetings with stakeholders based in Kotli were also undertaken.

9.3.3 Consultation Team

953. An ESIA specialist led the team, which comprised of stakeholder consultation experts and male/female social assistants that were familiar with the area and the local languages.

9.3.4 Future Consultations

954. Further consultations to be undertaken as part of the Project ESIA process include the Project public hearing. The AJK EPA will require that one or more public hearings are held to assess public opinion on the environmental impacts of the Project. Within 10 days of receipt of the ESIA report for the Project and subject to acceptance of the ESIA for review, the AJK EPA will notify the Project proponents that one or more public hearings must be held. The AJK EPA will advertise the public hearings in a newspaper. The legal requirement is advertisement in at least one English or Urdu national newspaper, but in practice, advertisements are usually placed in two national

newspapers and also in local newspapers. The public hearings will be held at least 30 days after the public notice. Copies of the ESIA report and a non-technical summary have to be made accessible to the public during the notification period.

Consultation beyond the ESIA Process

955. The Project management will continue community engagement activities throughout the life of the plant. Visits will be undertaken in all the communities twice or more times in a year, depending on the number of concerns raised under each consultation. Ongoing community engagement activities relevant to the ESIA include:

- Ongoing reporting on progress on the implementation of environmental and social management measures identified during the ESIA process and recording of comments on the effectiveness of these measures;
- Updating communities about new project developments and recording comments on these; and,
- Ongoing operation of the grievance mechanism (ESIA **Section 10**).

9.4 Summary of Consultations

9.4.1 Community Consultation

956. **Table 9–2** summarizes the key concerns emerging from community consultations and explains how each concern was addressed in the ESIA. The dates on which the consultations took place are given in **Table 9–1**. The detailed log of consultations is provided in **Appendix J.**

957. The photographs of the consultations are given in **Figure 9–2**.

9.4.2 Institutional Consultation

958. **Table 9–3** summarizes the key concerns emerging from institutional stakeholder consultations and explains how each concern was addressed in the ESIA. The dates on which the consultations took place are given in **Table 9–1**. The detailed log of consultations is provided in **Appendix J.**

959. The photographs of the consultations are given in **Figure 9–3**.

Table 9–2: Summary of Concerns Expressed in Scoping Consultation and How They Have Been Addressed in the ESIA

Issues raised by Community Stakeholders	Addressed in the ESIA
Resettlement and Related	
If anyone is losing their land/property due to the reservoir or camping site, adequate compensation should be provided to them	Will be addressed in Land Acquisition and Resettlement Plan (LARP)
Physical Environment and Related	
There may be noise and disturbance during construction and blasting. Contractors should ensure that blasting activities are avoided at night and controlled blasting is carried out	Baseline sound measurements are taken at the receptors to ensure that the sound levels are below the tolerance levels during construction and operation period. (**ESIA Section 5.1.7 Noise**)
Construction activities may increase dust in the area and the local people may get sick	Ambient air quality monitoring has been carried out to establish baseline levels. Strict measures will be adopted to make sure that the health and livelihood is not affected in any way due to excessive dust and particulate matter in the air. (**EIA Section 7.2.5 Fugitive Dust Emissions and 7.2.6 Vehicular and Machinery Dust Emissions**)
Social and Other issues	
The Project authorities will not follow mitigation measures proposed for the project.	Implementation of the EMMP is a legal and contractual obligation of the project proponent (**ESIA Section 11 EMMP**)
Villagers should be given employment opportunities in the project	Recruitment from nearby communities will be given preference provided they meet the requirements for the job (**ESIA Section 11.1 Mitigation and Management Plan Table 11-1**)
Local villages should get uninterrupted supply of electricity at subsidized rates. The power produced from the Gulpur Hydropower Project should first attend to the local power demand.	Power distribution is not in legal mandate of MPL.
Construction of reservoir and changes in flow may result in limited availability of sand mining sites. Alternate sites should be provided to the local community depending upon sand mining for livelihood.	Sand Mining Plan will be prepared by experts and alternate mining sites will be provided to the local community whose livelihood will be affected (**Section 11.7 Sediment Mining Plan**)

Issues raised by Community Stakeholders	Addressed in the ESIA
In most of the villages, the stakeholders expressed the problems due to lack of development. The amenities that were demanded included link roads, school, teachers in school, clean drinking water, health facilities, sewerage system, rehabilitation of disabled people, and improvements of housing.	Although these issues are not in the scope of MPL, the Company is proposing to invest for social augmentation of the area (**ESIA Section 11.9 Social Augmentation Plan**).
Wildlife/ Biodiversity Issues	
Reduced flow downstream of the dam may result in lesser habitat available for the fish	MPL has specified a minimum Environmental flow in the low flow section (**ESIA Section 6 Environmental Flow Assessment**)
Reduced flow downstream may increase the concentration of contaminants in river water	The concentration of the toxic metals in the effluent from the Project were all found to be within the NEQS limits for liquid effluents as well as those for the drinking water. (**ESIA Section 5.1.13 Water Quality**). Mitigation and good practice measures have been identified and will be applied (**ESIA Section 7 Impact Assessment**)
Issues specific to women	
Adequate water and access should be available for washing purposes	Access to the river for locals will not be obstructed and minimum flow will be released in the low flow stretch of the river (**ESIA Section 6 Environmental Flow Assessment**)
The project management of the power plant should ensure that the health and livelihoods of the locals are not be affected by the project.	Mitigation measures have been proposed to ensure that national and ADB standards for air and water quality are met (**ESIA Section 11 EMMP**).

Figure 9–2: Photographs of Community Consultations


Consultation with Men at Aghar


Consultation with women at Aghar


Consultation with men at Barali


Consultation with women at Barali


Consultation with men at Bialian


Consultation with women at Bialian


Consultation with men at Gulpur


Consultation with women at Gulpur


Consultation with men at Hill Killan


Consultation with women at Hill Killan


Consultation with men at Kameli


Consultation with women at Kameli


Consultation with men at Kohali


Consultation with women at Kohali


Consultation with men at Naroch Colony


Consultation with women at Naroch Colony

Consultation with men at Pagwari

Consultation with women at Pagwari

Consultation with men at Rajdhani

Consultation with women at Rajdhani

Consultation with men at Rehmani Mohallah

Consultation with women at Rehmani Mohallah

Table 9–3: Summary of Institutional Stakeholder Consultations and Comments

Issues raised	Stakeholder	Comments
PPIB awarded the contract for the development of Gulpur Hydropower Ltd in 2005 and the Poonch River was declared a national park in 2010 without consulting the PPIB or their counterpart in AJK (Azad Jammu and Kashmir). In view of the ongoing electricity shortages and load shedding, power generation is very important for the economy.	PPIB	The Poonch River provides habitat for two fish species, Mahaseer (***Tor putitora***) and Kashmir Catfish (***Glyptothorax kashmirensis***) listed as Endangered and Critically Endangered respectively in the IUCN Red List 2013. Therefore, the Poonch River is a Critical Habitat according to ADB and IFC Guidelines whether or not it is declared a national park. Communication gaps between PPIB and AJK Government is not a Project concern. If EIAs were done on time then PPIB and developers would have known the environmental concerns.
How far back will the reservoir extend upstream of the Project location?	HWF	The Project is a run of river (RoR) type hydropower project so no reservoir like the Mangla reservoir will be created. The water level in the River will rise but will not go beyond the flood line. No houses will be submerged and no agricultural land will be lost
The Poonch River is an ecologically sensitive river, and provides habitat for fish of conservation and socio-economic importance. So PPIB should not authorize any more projects on this river.	HWF	The Cumulative Impact Assessment of the planned hydropower projects on the Poonch river is being investigated. Only when this is done, we can determine if there is room for any more projects. Keeping in view the ecological sensitivity of the Poonch River, it seems unlikely that more hydropower projects can be built and can achieve the net gain for conservation as proposed in the ADB and IFC guidelines. If any more Projects are to be sanctioned on the Poonch River at all, it is recommended that they be considered first downstream of the Gulpur Hydropower Project. This will avoid blocking the important fish breeding areas located in the Ban Nallah and Rangar Nallah
The information document provides information only about baseline biodiversity assessment surveys done in October. How will seasonality be captured?	WWF-P	In addition to literature reviews, field surveys have been conducted in June (for the ESIA), October and December (fish survey). Spring surveys are scheduled for April 2014. So seasonal variations in biodiversity will be captured. Full details are available in the Baseline Biodiversity Assessment Report that can be shared with the stakeholders upon request.

Issues raised	Stakeholder	Comments
Local communities in the Poonch River basin will be affected by decline in fish resources. They are also dependent on sand and gravel extraction from the river bed for construction. How will this be dealt with?	HWF	A draft Biodiversity Management Plan has been developed and work is in progress for the Biodiversity Action Plan. Measures to conserve the fish resources include reactivation and rehabilitation of the Mangla hatchery and stocking the fish like Mahaseer upstream of the Project location. If the protection measures outlined in the Pro 2 scenario are implemented and the Biodiversity Action Plan is implemented, a net gain for conservation can be achieved. However, the 0.7 km stretch of the River that will experience low flows due to Project operations is likely to suffer negative ecological impacts. But this is only 0.7% of the total length of the Poonch River in Pakistan. As for sand and gravel extraction, a sand and gravel mining plan will be developed and locals will be allowed to extract the sand and gravel trapped upstream of the dam (of the Project).
Have fish ladders been incorporated in to the Project design	Independent Ecologist	According to the feedback provided by local and international fish experts, fish ladders are seldom successful, and are not going to be useful for protecting the fish species of the Poonch River especially considering the gradient of the landscape.
We are depending on the AJK Fisheries and Wildlife department to implement the environmental conservation and protection measures while we know that they are inefficient. The Poonch River is already a national park yet conservation measures are presently inadequate.	HWF	Subject to agreement with government of AJK on the Biodiversity Action Plan (BAP) for the project, The AJK Fisheries and Wildlife Department will have to sign an agreement for effective implementation of the conservation and protection measures outlined in the BAP. In addition, there will be external third party monitoring to ensure that goals are being met. Training and capacity building measures for the AJK Wildlife and Fisheries Department will be included in the BAP.
What about the impacts of Project construction and operation on the terrestrial biodiversity of conservation importance such as the Common Leopard, vultures as well as the aquatic mammals particularly the Otter?	WWF-P	Terrestrial Impact Assessment of the Project has been completed, and no significant impact of the Project on the terrestrial ecological resources is expected, considering the small size of terrestrial habitats that will be inundated due to Project construction. Signs of otters were absent from the Project location and vicinity. Otters are present upstream and downstream of the dam but they are not likely to be impacted. Otters depend on impact on fish population as fish is the main source of food for the otter. If fish abundance increases assuming Pro2 Scenario, then the

Issues raised	Stakeholder	Comments
		otters will benefit. The Project design will include adequate facilities for solid waste disposal and waste water treatment to minimize impacts on the terrestrial and aquatic resources.
As long as the BAP assures improvement in ecosystem integrity as defined in the Enhanced Protection or Pro2 scenario, 4 cumecs Eflow is acceptable.	HWF	Noted.
There could be some potential positive ecological impacts in the river stretch that will experience low flows due to Project operations. These may include an increase in the number of waders and birds that prefer to sit on slow moving water with a consequent increase in their predator bird species. The droppings of these birds will increase the organic content in the dewatered river stretch.	Independent Ecologist	Noted. Comments will be incorporated in to the Final Impact Assessment Report.
Data on the forest area that will be damaged by the project has not been provided. Plantation will be required to compensate for the vegetation lost.	Forest Department	The section on terrestrial ecology in the ESIA will provide this detail. There is only scrub cover in the area that will be used by the Project, and only a limited area in the ownership of Forest Department will be required for the project. A budget for plantation and re-vegetation will be allocated in the EMMP.
General opinion of all the participants was that commitments made in ESIA for environmental improvements and CSR are not kept by the project owners. The participants provided examples of other hydropower projects in AJK where this had occurred. Concern was expressed that the BAP and CSR commitments will not be implemented		
EPA will not comment on the EFlow at this point. The EPA will review the EIA to be submitted by the Project Owner and will give its opinion after examining the analysis and justification provided for the suggested flow in the EIA	EPA-AJK	Peaking flow which causes substantial damage to downstream section of the river will be avoided. According to the Project design, the low flow section of the river downstream of the dam and upstream of the power house where major impacts will occur is only 700 meters. A net gain will be achieved through implementation of the BAP in the remaining stretches of the river.

Figure 9–3: Photographs of the Institutional Stakeholder Consultations


Consultation with Deputy Commissioner, Kotli


Consultation with Traders Association, Kotli


Consultation with Superintendent Police, Kotli


Consultation with HWF, WWF, SLF, PPIB and Scientists


Consultation with HWF, WWF, SLF, PPIB and Scientists


Consultation with EPA-AJK, HEB-AJK and Forest Department-AJK

10. Grievance Redress Mechanism

960. Timely and effective redress of stakeholder grievances contribute to bringing sustainability in the operations of a project. In particular, it will help advocate the process of forming and strengthening relationships between project management and the stakeholder community groups and bridge any gaps to create a common understanding, providing the project management the 'social license' to operate in the area. The grievance redress mechanism proposed for the Project will help achieve the objectives of sustainability and cooperation by dealing with the environmental and social issues of the Project.

961. The proposed grievance redress mechanism will be designed to cater for the issues of the people that can be affected by the Project. The population that can be affected by the Project is identified in (**Section 5.3**) Description of Socioeconomic Environment, and comprises of the people residing within three kilometers from both banks of the river. The potential impacts of the Project are described in *(**Section 7**).

10.1 Framework for Grievance Redress Mechanism

962. The grievance redress mechanism proposed for the Project will meet the compliance requirements laid out under the relevant national legislation and will be in accordance with the environmental and social safeguards laid out under ADB SPS 2009 and IFC performance standards on environmental and social sustainability.

10.1.1 IFC Requirements

963. IFC applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, the eight Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC or other relevant financial institution are given in (**Section 3.6.1**)**.**

External Communications

964. IFC requires that clients will implement and maintain a procedure for external communications that includes methods to (i) receive and register external communications from the public; (ii) screen and assess the issues raised and determine how to address them; (iii) provide, track, and document responses, if any; and (iv) adjust the management program, as appropriate. In addition, clients are encouraged to make publicly available periodic reports on their environmental and social sustainability.

Grievance Mechanism for Affected Communities

965. Where there are Affected Communities, the client will establish a grievance mechanism to receive and facilitate resolution of Affected Communities' concerns and grievances about the client's environmental and social performance. The grievance mechanism should be scaled to the risks and adverse impacts of the project and have Affected Communities as its primary user. It should seek to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate and readily accessible, and at no cost and without retribution to the party that originated the issue or concern. The mechanism should not impede access to

judicial or administrative remedies. The client will inform the Affected Communities about the mechanism in the course of the stakeholder engagement process.

Ongoing Reporting to Affected Communities

966. The client will provide periodic reports to the Affected Communities that describe progress with implementation of the project Action Plans on issues that involve ongoing risk to or impacts on Affected Communities and on issues that the consultation process or grievance mechanism have identified as a concern to those Communities. If the management program results in material changes in or additions to the mitigation measures or actions described in the Action Plans on issues of concern to the Affected Communities, the updated relevant mitigation measures or actions will be communicated to them. The frequency of these reports will be proportionate to the concerns of Affected Communities but not less than annually.

10.1.2 ADB Safeguard Policy Statement

967. Developing a grievance redress mechanism is mandated under SPS 2009[1]. The requirements for the grievance redress mechanism under the SPS 2009 are laid out below.

SPS 2009 on Grievance Redress Mechanism

ADB requires that the borrower/client establish and maintain a grievance redress mechanism to receive and facilitate resolution of affected peoples' concerns and grievances about the borrower's/client's social and environmental performance at project level. The grievance redress mechanism should be scaled to the risks and impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all segments of the affected people.

10.1.3 Pakistan Environmental Protection Act 1997

968. The Federal Agency, under Regulation 6 of the IEE-EIA Regulations 2000 (see **Section 3** for more details), has issued a set of guidelines of general applicability and sectoral guidelines indicating specific assessment requirements. Under the regulations and guidelines, no specific requirements are laid out for developing a grievance redress mechanism for projects. However, under its Guidelines for Public Consultation, 1997, the proponents are required to consult stakeholders during the implementation phase of the project. In this regards, it is stated that the representatives of local community partake in the monitoring process to promote a stable relationship between the project management and the community.

10.2 Proposed Mechanism for Grievance Redress

969. Under the Project the following will be established or appointed to ensure timely and effective handling of grievances:

- Public Complaints Unit (PCU), which will be responsible to receive, log, and resolve complaints.

[1] Safeguard Policy Statement, Asian Development Bank, June 2009

- Grievance Redress Committee (GRC), responsible to oversee the functioning of the PCU as well as the final non-judicial authority on resolving grievances that cannot be resolved by PCU.
- Grievance Focal Points (GFPs), which will be educated people from each community that can be approached by the community members for their grievances against the Project. The GFPs will be provided training by the Project in facilitating grievance redress.

970. Details of the proposed mechanism are given below.

10.2.1 Function and Structure of PCU

971. PCU will be set up as part of the environment, health and safety department of the Project. The Community Liaison Officer of MPL will lead the unit. During the construction period when the issues are mainly expected to arise, two assistants, one male and one female will be responsible for coordinating correspondence and preparing documentation work and will assist the senior official. The CLO will be responsible to review all documentation.

972. The PCU will be responsible to receive, log, and resolve grievances. Given that the female community members have restricted mobility outside of their villages and homes, the female PCU staff will be required to undertake visits to the local communities. The frequency of visits will depend on the nature and magnitude of activity in an area and the frequency of grievances.

10.2.2 Function and Structure of GRC

973. The GRC will function as an independent body that will regulate PCU and the grievance redress process. It will comprise of:

- Manager of environment, health and safety department, MPL.
- Project Manager that is responsible to oversee the contractors, MPL.
- Two representatives from the communities residing near the plant site.
- A representative of the local government if required.
- A female representative from the local community.

974. The GRC will meet once every three months to review the performance of the PCU; the frequency can be changed depending on the nature and frequency of grievances received. The performance will be gauged in terms of the effectiveness and the timeliness with which grievances were managed. In case there are any unresolved or pending issues, the GRC will deliberate on mechanisms to resolve those and come up with solutions acceptable to everyone.

10.2.3 Grievance Focal Points

975. The GFPs will be literate people from each community that will facilitate their community members in reporting grievances from the Project. The GFPs will be provided training by the Project in facilitating grievance redress. Each community will have a male and female GFP appointed for this purpose.

10.2.4 Procedure of Filing and Resolving Grievances

976. Grievances will be logged and resolved using the following steps:

Step 1: Receive and Acknowledge Complaint

977. Once the PCU receives a complaint, which could be the complainant giving it in person, via letter or email, through phone call, or through a GFP, an acknowledgement of receipt of the complaint has to be sent within two working days to the complainant. The complainant will be issued a unique complaint tracking number for their and PCU's record.

Step 2: Investigation

978. PCU will work to understand the cause of the grievance for which the PCU may need to contact the complainant again and obtain details. The PCU will be required to complete preliminary investigations within five working days of receiving the complaint and send a response to the complainant documenting the results of their investigations and what the PCU plans to do ahead.

Step 3: Resolution through PCU

979. Once the PCU have investigated a grievance, it will share with the complainant the proposed course of action to resolve the complaint, should PCU believe any to be necessary. If the complainant considers the grievance to be satisfactorily resolved, the PCU will log the complaint as resolved in their records.

980. In case the grievance remains unresolved it will be reassessed and GRC will have further dialogue with the complainant to discuss if there are any further steps, which may be taken to reach a mutually agreed resolution to the problem.

981. For minor or less complex grievances, Steps 1, 2 and 3 or Steps 2 and 3 can be merged.

Step 4: Resolution through GRC

982. In case the PCU is unable to resolve the issue, the matter will be referred to GRC. All complaints that could not be resolved within four weeks will by default be referred to GRC. However, the complainant or the PCU can convene the GRC at any point in time, depending on the nature and urgency of the issue.

10.2.5 Operating Principles for PCU

983. The PCU will operate on the principles of transparency, approachability and accountability. To achieve these, the PCU will be required to:

- be equipped to handle grievances in the local languages;
- be equipped to work through all possible modes of communication, such as, emails, by-post and face-to-face meetings at plant site or requiring visits;
- employ female staff, preferably from the nearby communities, to oversee complaints and issues of the female community members;
- maintain a log of all grievances, with record of the date and time of the complaint logged and stakeholder information, such as, name, designation and contact details;

- provide opportunity to the stakeholder to revert with their comments on the proposed plan of action;
- keep the stakeholder informed of the progress in grievance resolution;
- obtain stakeholder consent on the mechanism proposed to redress the grievance and document consent; and
- maintain confidentiality of the stakeholder, if requested so.

10.2.6 Stages of Grievances

984. Once a grievance is logged with the PCU, it could acquire the following stages:

- **Stage 1:** it is resolved by the PCU or if not PCU, by the GRC.
- **Stage 2:** If the GRC cannot resolve the issue, it will inform ADB, IFC and other lenders accordingly, and the lenders will organize a special mission to address the problem and identify a solution.
- **Stage 3:** If the stakeholders are still not satisfied with the reply in Stage 4, they can go through local judicial proceedings.

10.3 Stakeholder Awareness

985. The stakeholders will be informed of the establishment of the PCU through a short and intensive awareness campaign. Under the awareness campaign, the proponent will share:

- objective, function and the responsibilities of the PCU;
- means of accessing the PCU and the mechanics of registering a grievance at the PCU;
- operating principles of the PCU; and
- contact details.

986. Additional awareness campaigns may be organized, if necessary.

11. Environmental Management and Monitoring Plan

987. An Environmental Management Plan (EMP) is the “synthesis of all proposed mitigative and monitoring actions, set to a timeline with specific responsibility assigned and follow-up actions defined”[1]. The EMP is generally recognized as the most important output of the ESIA it ensures that the mitigation measures identified in the ESIA are implemented. The EMP may be considered a separate, stand-alone section within the suite of documents that are being prepared as part of the ESIA process for this Project.

988. This section comprises the Environmental Management and Monitoring Plan (EMMP) for the ESIA of this Project. It summarizes the organizational requirements, management and monitoring plans to ensure that the necessary measures are taken by MPL to avoid potentially adverse effects and maximize potential benefits of the Project as identified in preceding section of the ESIA and to operate in conformance with applicable laws and regulations of AJK, as well as the policies of international financial organizations such as ADB and IFC. Due to the nature and applicability of the EMP it will also be used for contractual purposes through its inclusion as a part of the bid documents for the EPC contractor who has to adhere to it along with other regulatory requirements. The strict implementation of the EMMP and project management’s strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

989. The Environmental Management and Monitoring Plan (EMMP) presented in this section is a component of the overall Environmental and Social Management System (ESMS), for which a framework is provided in **Appendix L**. The EMMP is particularly important with respect to this ESIA report as it presents MPL’s commitments to address the impacts identified by the impact assessment process.

990. The EMMP is based on the baseline conditions and the impact assessment described in previous chapters, plus the results of discussions with the stakeholders. The EMMP is prepared for all the identified environmental impacts during design, construction, and operation of various Project activities. The methodology followed for preparing the EMMP includes the following:

- Deriving mitigation/protection measures for identified impacts using impact evaluation methodology.
- Rationalizing and combining series of mitigation, compensation and enhancement measures from each identified impacts and risks to prepare overall measures.
- Developing a mechanism for monitoring the proposed mitigation measures.
- Estimating budget requirements for implementation, mitigation and monitoring measures.
- Identifying responsibilities of various agencies involved in the Project for implementation and monitoring of mitigation measures.

[1] The World Bank, http://go.worldbank.org/UC9PIUINF0, Accessed April 2013.

11.1 Mitigation and Management Plan

991. The mitigation plan prepared in accordance with the above framework is provided below. The key components of the plan are discussed in the following sections.

992. The environmental management plan includes the following:

- **Impact Reference** – this specifies the impact/s which according to impact assessment methodology followed for the Project has potential influence either negative or positive and needs to be mitigated by the proposed management measure influences as discussed in earlier sections.
- **Description of Impact** – this briefly describe the potential impact which may arise from the Project activities and need a management measures.
- **Mitigation/Management Measure** – a description of the action, which will be clear, concise and specific enough to enable execution of the action. Where relevant, targets, indicators, trigger points and/or threshold levels will be incorporated into the management measure. If a set of management actions is required to meet the objective, the EMMP will be simplified by making a commitment to develop an appropriate supporting document in which the detail will be provided.
- **Project Phase** – indicating the project phase/s when the management measure is applicable.
- **Mitigation Responsibility** – an indication of the institution responsible for the concise implementation of proposed management measures.

993. Specific management plans and frameworks developed are described in (**Section 11.5**). A Draft Biodiversity Action Plan (BAP) has been prepared for enhancement and conservation of biodiversity of the Poonch River basin, the implementation of which will involve support from AJK Wildlife and Fisheries Department, and NGOs. An outline of the Biodiversity Action Plan is presented in (**Section 11.6**).

994. The socioeconomic management presented in this section outlines the measures necessary to minimize the negative impacts on the economic and socio-cultural setting of the region during construction and operation of the Project and enhance positive impacts resulting due to the Project. An annual CSR Plan will be developed for socioeconomic enhancement and grievance redress in the local community. A Land Acquisition and Resettlement Plan (LARP) will be developed by MPL, separately from this report and will include mitigation of impacts related to land acquisition, resettlement and related impacts.

Table 11-1: Mitigation Plan

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
Soil Quality	PE1	Accidental release of solvents, oils and lubricants can potentially result in the contamination of soil and consequent deterioration of groundwater and surface water quality. Soil contamination may also reduce the fertility of soil reducing suitability for agricultural purposes.	• Fuel tanks will be appropriately marked by content and will be stored in dyked areas with an extra 10% of the storage capacity of the fuel tank. The area will be lined with an impervious base. • Grease traps will be installed on the site, wherever needed, to prevent flow of oily water. • Spill cleaning kit (shovels, plastic bags and absorbent materials) will be available near fuel and oil storage areas. • Emergency plan for spill management will be prepared and inducted to the staff for any incident of spill. Good Practice Measure/s: • The bottom of any soak pit or septic tank shall be at least 10 m above the groundwater table. The distance can be reduced, based on the soil properties, if it is established that distance will not result in contamination of groundwater.	Construction	Construction Contractor
Soil Erosion	PE2	• Land clearing, excavation, tunnel boring and other construction activities may loosen the top soil in the Project area resulting in loss of soil and possible acceleration of soil erosion and land sliding, especially in the wet season.	• Vegetation loss will be limited to demarcated construction area. • Areas such as muck disposal area, batching plant, labor camp and quarry sites after the closure shall be covered with grass and shrubs. • Slope stabilization measures will be adopted such as adequate vertical and horizontal drains, drainage along roadsides, cross drainage and retaining walls. • Slope movements will be monitored around excavation work areas. Good Practice Measure/s: • Local species shall be selected for plantation to restore the biodiversity of the area in consultation with Forest Department after completion of respective activities	Construction	Construction Contractor
Waste Disposal	PE3	Water and soil contamination due to releases from the camp during construction and operation such as solid waste and wastewater, and other solid and liquid waste.	• Wastewater treatment system will be made to ensure that the effluents during construction and operation comply with NEQS standards and the conditions of lenders. • Release of camp effluents directly to the water channels or land will be prohibited.	Construction	Construction Contractor

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
			• Waste generated will be collected at designated waste dumping area and cleared from site by contractor during construction and by the company during operation. • Lining of all effluent channels with cement at all working areas will be done to prevent seepage. • During tunneling if ground water is released, it will be tested for pH and sediment content, and will be treated in sediment ponds to bring pH and sediment content to acceptable levels, before the water is released in Poonch river. Good Practice Measures: • All waste shall be collected and recycled or sent to an incinerator.		
Water Resource Depletion	PE4	Use of local water resources for construction activities may reduce the water availability for the local communities.	• Water for different construction activities will not be drained from the local wells and will be arranged from the river or via a water contractor from a source approved by the local authorities. • Water conservation techniques will be developed and implemented by the EPC contractor. • Access of community to water sources shall be kept clear so that the community's ability to meet its water requirements are not compromised. Good Practice Measure/s: • Records of water usage will be maintained.	Construction	Construction Contractor

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
Fugitive Dust Emissions	PE5	Excavation, material storage, material transportation, batching, and vehicular movement will create fugitive dust emissions specially while off road driving.	• Water will be sprinkled on unpaved Project roads in dry weather for fugitive dust control. • Grading operation will be suspended when the wind speed exceeds 20 km/hr. • All storage piles with fine material shall be adequately wetted or covered with plastic to ensure protection of ambient air from fugitive emission during wind storm. • Batching plants and associated machinery will be installed with suitable dust control arrangements. • Speed limits and defensive driving policies will be strictly implemented. • Road damage caused by Project activities will be promptly attended to with proper repair and maintenance.	Construction	Construction Contractor
Vehicular and Machinery Exhaust Emissions	PE6	Exhaust emissions from construction machinery, Project traffic and concrete batching plant may lead to deterioration in the local ambient air quality.	• Equipment and vehicles in good working condition and low emission levels will be used. A visual check will be performed when the equipment is mobilized and periodically later to screen out equipment and vehicles that emit unacceptable levels of smoke. • Batching plant machinery will be maintained and exhaust emissions will be minimized. • Batching plant will be set up considering the wind direction so that the nearby communities are not affected by the emissions from batching plant. • Regular maintenance and service of vehicles and equipment will be conducted. Good Practice Measure/s: • Catalytic exhaust convertors shall be installed wherever available in vehicles and equipment. • All stacks shall be at least 8ft high to protect the labor and passersby from direct exposure to emissions.	Construction	Construction Contractor
Noise Nuisance	PE7	Noise from drilling, blasting, excavation, generators and batching plant may cause nuisance in the vicinity of Project facilities.	• Construction equipment that could potentially generate high noise levels will have an adequate muffler system. • All stationary noise generating equipment such as air compressors and power generators will be placed at least 200 m away from the residential area.	Construction	Construction Contractor

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
			• In case threshold values are exceeded then adjusting the distances for the equipment on the basis of monitoring report. • A preventive maintenance procedure for Project vehicles and equipment will be set and followed which will help prevent noise levels from deteriorating with use. • Provision of Personal Protective Equipment (PPE), i.e. ear muffs and plugs, will reduce noise impact on personnel. • Restriction on pressure horn. • Sirens will be used to warn the locals prior to blasting and will only be carried out during daytime.		
Traffic	PE8	Traffic congestion, reduced road safety, and higher levels of noise, dust and other pollutants.	• Contractor's vehicle will follow strict speed limits within city and all applicable local traffic rules and regulations imposed by National Highway Authority (NHA) especially near sensitive receptors (schools, hospital, mosques, etc) • In no case horn will be used during the day timings near the sensitive receptors. • Over speeding will be subject to disciplinary actions. • Local traffic will be allowed to overtake and drivers will be encouraged to make way for the local commuters, ambulances, army and special persons conveys in all cases. • Contractor's personnel will only use access routes assigned to them for Project activities which will be finalized during meeting with the representatives of MPL and subcontractors. • Trucks and vehicles will not be overloaded and will follow NHA guidelines for loads and size. • Large vehicles that can slow down the local traffic significantly will only travel in the night time or a special permission from the district administration will be obtained. • Contractor's vehicles and equipment will be parked at identified designated area. • Vehicles and machinery will be appropriately parked/placed to avoid inconvenience to local commuters and pedestrians. • Prior communication to residents and safety signs will be installed well before the commencement of any activity at site.	Construction	Construction Contractor

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
			• The vehicles will be encouraged to leave the local area as quickly as possible after the delivery of material to the Project site. • Vehicle maintenance work will only be carried out in designated workshops. Good Practice Measure/s: • Diversion plans shall be developed to minimize disturbance to local population during occasional high activity timings / days. These plans shall be communicated to residents well in advance and proper diversion signs will be placed to inform locals. • Movement of contractor's vehicles for transportation of material and wastes from and to the site shall be restricted to low traffic timings.		
Degradation of Terrestrial Ecology during Construction	TE1	Decline in abundance and diversity of terrestrial flora and fauna caused by construction related activities.	• See PE1, PE2, PE3, PE7, PE5, PE6 and PE8 • Large flood lights should not be installed outside 50 m of the Project fence. • Lights should be directed towards Project facilities and not towards the natural habitats. • Protection and monitoring of vulture populations is included in BAP. • Regulations for Project staff and contractors to avoid illegal poaching to be incorporated in contract documents. • Provide awareness training to staff and contractors on: prevention of injury of animals; identification of likely species found on site; identifications of animal hazards (such as venomous snakes); and what to do if dangerous animals are encountered. • Provide adequate knowledge to the workers on relevant government regulations and punishments for illegal poaching. • Encourage personnel to report sightings of wildlife of conservation importance or incidents of poaching to MPL. • Enforce speed limits in ecologically sensitive areas. • Project staff and contractors to report kills of large mammals particularly designated species of conservation concern. • Source goods/materials locally where possible. • Minimize disturbance to, or movement of, soil and vegetation.	Construction	Construction Contractor for all except implementation of BAP M&E Consultant for BAP

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
			• Prevent soil damage and erosion. • Prevent AIS establishment on exposed stored soil (do not store bare soil near known sources of AIS). • Train and raise awareness regarding AIS among Project staff and contractors. • Retain as much natural vegetation as possible. • Solid waste should only be disposed of at designated sites. • Implementation of Biodiversity Action Plan.		
Degradation of Terrestrial Ecology during Operation	TE2	Project operation leading to animal disturbance, displacement and decline.	• See PE1 and PE3 • Large flood lights should not be installed outside 50 m of the Project fence. • Lights should be directed towards Project facilities and not towards the natural habitats. • Regulations for Project staff to avoid illegal poaching to be incorporated in contract documents. • Provide awareness training to staff and contractors on: prevention of injury of animals, identification of likely species found on site, identifications of animal hazards (such as venomous snakes) and what to do if dangerous animals are encountered. • Provide adequate knowledge to the workers on relevant government regulations and punishments for illegal poaching. • Encourage personnel to report incidents of poaching. • Solid waste should only be disposed of at designated sites. • Solid waste should only be disposed of at designated sites.	Operation	MPL
Loss of Habitat due to Inundation by Reservoir	RE2	Loss of riverine ecosystem due to inundation by Gulpur reservoir.	Implementation of BAP.	Construction and Operation	AJK Fisheries and Wildlife Department with support from an Independent Implementation Organization.

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
River Degradation in Low Flow Segment	RE3	Degradation of the river ecosystem in the low flow Segment downstream of the Gulpur dam.	Implementation of BAP	Construction and Operation	AJK Fisheries and Wildlife Department with support from an Independent Implementation Organization.
Decrease in Mahaseer Downstream of Tailrace Outlet	RE4	Decrease in population of Mahaseer downstream of the Gulpur tailrace outlet to Mangla reservoir.	• Implementation of BAP • AS a part of BAP, supplemental equipment and technical support to AJK Fish and Wildlife Department for a hatchery for breeding of Mahaseer and stocking in Poonch River downstream of Gulpur dam.	Construction and Operation	AJK Fisheries and Wildlife Department with technical support from an Independent Implementation Organization.
Local Livelihoods and Wellbeing	LW1	Direct, indirect and induced employment at the local levels, resulting in increased prosperity and wellbeing due to higher and stable incomes of people.	Enhancement Measure/s: • Ensure preferential recruitment of local candidates provided they have the required skills and qualifications. • Include an assessment of the contractor's demonstrated commitment to domestic and local procurement and local hiring in the tender evaluation process. • Coordinate recruitment efforts related to non-skilled labor, including for non-skilled labor positions required by contractors. Good Practice Measure/s: • Determine what is considered to be 'fair and transparent' in recruitment and in distribution of jobs between different community groups, in consultation with local communities and their leaders. • Set long-term (10 to 15 year) targets for local representation at the managerial level. Implement training and development to meet these target timeframes.	Construction	Construction Contractor
Enhanced Productivity of Local Labor	LW2	Increase in the stock of skilled human capital due to transfer of knowledge and skill under the Project resulting in enhanced productivity of the local labor.	Enhancement Measure/s: • Support a 'vocational training program' to assist local people to qualify for semi-skilled positions focusing on issues such as procurement, involvement of vulnerable groups in Project opportunities and continual	Construction	Construction Contractor

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
			professional development of staff. Good Practice Measure/s: • Assist local people having practical skills but lacking qualifications to obtain their certificates and thus increase their employment opportunities. • Support initiatives promoting a culture of learning in local communities. • Plan and implement training program for vulnerable groups to encourage their participation in economic opportunities created by the Project. • Assist employees and local communities to improve basic personal financial life skills through training and awareness campaigns, respectively. • Consider further training programs to prepare retrenched workers to seek employment in sectors not related to dam construction.		
Income Loss in Sand and Gravel Mining	LW4	Loss of income from sand and gravel mining due to change in pattern of sediment deposition following construction of the dam.	• A Sediment Mining and Management Plan will be provided as a part of BAP, which identifies possible sand and gravel mining spots along the Poonch River. • Through BAP and annual CSR Plan of MPL, controlled sand and gravel mining practices will be established at the alternate locations identified in the Sediment Mining and Management Plan	Operation	MPL
Increased Population during Construction	SC1	Increase in population due to in-migration of job seekers (in-migrants) leading to pressure on existing social infrastructure and services in the Study Area.	• See LW1. Good Practice Measure/s: • Encourage local communities to use the grievance procedure for concerns related to deterioration of local services. • Support local government in the implementation of infrastructure projects. • Support NGOs specializing in development of infrastructure to assist local government.	Construction	Construction Contractor (mitigation measure) MPL (good practice measures)
Distribution of Project Employment	SC2	Disputes over distribution of Project benefits within and between Study Area inhabitants and the in-migrants resulting in	Good Practice Measure/s: • Refer to measures under Impact LW1 • Implement MPL's Stakeholder Engagement Plan, contained in the annual CSR Plan that includes:	Construction	Construction Contractor

Aspect or Concern	Impact Reference	Description of Impact	Mitigation Measure/s, Good Practice Measure/s and Enhancement Measure/s	Project Phase	Mitigation Responsibility
		social unrest.	◦ maintaining regular communication with local communities and other stakeholders to minimize tensions arising from Project activities; ◦ maintaining a grievance procedure (to be outlined in MPL's annual CSR plan), and encourage and facilitate stakeholders to use the mechanism to express concerns; and • Providing sufficient resources to the community relations officers to enable them to monitor negative perceptions and associated tensions, and to address them in a timely fashion.		
Social Unrest due to Conflicting Social Norms	SC3	Potential social unrest in the Study Area due to conflicting socio-cultural norms amongst the inhabitants and in-migrants.	See SC2.	Construction	Construction Contractor
Better Access to Health Facilities	SC4	Better access to better health facilities by the local communities.	Enhancement Measure/s: • Annual CSR Plan will outline mitigation measures and implementation responsibility for this impact. • Allow access of local communities to the health infrastructure constructed for Project employees. • Provide health care services to the local community for instance polio vaccination, dispensary facilities and local clinics if possible.	Construction	Construction Contractor
Increased Opportunity in Recreational Fishing	SC5	Increase in opportunities for recreational fishing due to increase in population of fish.	Enhancement Measure/s: • Implement BAP	Operation	AJK Fisheries and Wildlife Department with support from an Independent Implementation Organization.

11.2 Monitoring and Reporting Plan

995. Monitoring of environmental components and mitigation measures during implementation and operation stages is a key component of the EMMP to safeguard the protection of environment. The objectives of the monitoring are to:

i. manage environmental issues arising from construction works through closely monitoring the environmental compliances; and

ii. monitor changes in the environment during various stages of the Project life cycle with respect to baseline conditions.

996. A monitoring mechanism is developed for identified impact and includes:

- location of the monitoring (near the Project activity, sensitive receptors or within the Project influence area);
- means of monitoring, i.e. parameters of monitoring and methods of monitoring (visual inspection, consultations, interviews, surveys, field measurements, or sampling and analysis); and
- frequency of monitoring (daily, weekly, monthly, seasonally, annually or during implementation of a particular activity).

997. Monitoring program will include regular monitoring of construction and commissioning activities for their compliance with the environmental requirements as per relevant standards, specifications and EMMP. The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction.

998. The monitoring program will be coupled with a series of supporting procedures, yet to be developed, covering:

- sample or data collection;
- sample handling, sample storage and preservation;
- sample or data documentation;
- quality control;
- data reliability (calibration of instruments, test equipment, and software and hardware sampling);
- data storage and backup, and data protection;
- interpretation and reporting of results; and
- verification of monitoring information by qualified and experienced external experts.

999. Environmental monitoring and reporting plan for the construction and operation phases are provided in **Table 11-2** . The Framework for Monitoring of Indicators of State for Biodiversity, which is part of the BAP (**Section 11.8**), is given in **Table 11-3**. The timing and frequency of fish monitoring is based on the preferences for flow–dependent habitat, breeding, and migratory behavior of the indicator fish species outlined in **Section 4** of **Appendix B,** Biodiversity Baseline**.** The timing and frequency of invertebrate monitoring is based on flow related needs and activity calendar of the

indicator macro-invertebrate species outlined in **Section 5** of **Appendix B,** Biodiversity Baseline.

11.2.1 Site Inspections

1000. Site inspections will be undertaken regularly in relevant areas of the Project. The inspections will focus on compliance with the EMMP. The inspections will play an important role in increasing awareness of EMMP.

1001. Minor non-conformances will be discussed during the inspection and recorded as a finding in the inspection report. Major non-conformances will be reported as incidents. Inspection results will be disclosed at management meetings.

11.2.2 Non-conformances and Incidents

1002. Non-conformances include the following:

- exceedances of relevant thresholds as identified during routine monitoring;
- non-conformances with the requirements of the EMMP or supporting documentation identified during an internal inspection;
- non-conformances identified during an audit or by regulatory authorities;
- events, such as spills, resulting in potential or actual environmental harm;
- events that did or could result in injury to staff, visitors to site or surrounding communities; and
- significant complaints or grievances received from any source.

1003. Corrective and preventive actions will be identified and implemented in response to these non-conformances. These actions will address the root cause of the non-conformance and will reduce or prevent repeated non-conformances.

1004. A process will be established for the identification, investigation and tracking of non-conformances, including:

- prioritizing and classifying non-conformances based on the type and severity of the non-conformance;
- recording of non-conformances and the results of corrective and/or preventive actions, including the actions necessary to mitigate or remedy any associated impacts;
- defining results expected from the corrective and/or preventative actions;
- confirming the corrective and/or preventive actions taken to eliminate the causes of the non-conformance are appropriate to the magnitude of problem and commensurate with the impacts encountered;
- reviewing the effectiveness of the corrective and/or preventive actions taken; and
- implementing and recording required changes in the EMMP or monitoring programme resulting from corrective and preventive action.

1005. Serious non-conformances will be classified as incidents. Incidents will be promptly reported to appropriate management. A guideline will be prepared on:

- the types of incidents reportable to internal management at the site, Project and corporate levels, as well as to regulatory authorities and other external stakeholders; and

- standards to be observed when reporting incidents.

1006. During construction, environmental monitoring will ensure the protection of air and noise pollution, community relations, and safety provisions. During operation, emissions, air, noise, and waste water quality monitoring and greenbelt development around the plant will be important parameter of the monitoring program.

1007. The monitoring requirement can only be fulfilled by maintaining the proper documentation records of the findings. Daily checklists, weekly reports and monthly audit will be taken in accordance with construction management plan. Based on the ESIA approval a scheduled audit will be conducted by the MPL and reports will be shared with the regulatory authority and funding agency if required.

11.2.3 Documentation and Reporting

1008. Monitoring elements of the EMMP will be documented and controlled in accordance with a document control system. Records demonstrating compliance with legal requirements and conformance with the EMMP will also be maintained. Client will supervised, establish, implement and maintain procedures:

1009. Documentation and record keeping controls will include:

- measures to enable relevant documents and records to be readily available and identifiable (labeled, dated and properly filed), legible and protected from damage;
- review, revision and approval of documents for adequacy by authorized personnel at least once a year;
- establishment of the electronic document control version as the ‘authorized version’;
- making current versions of relevant documents available at locations where operations essential to the effective functioning;
- suitably identifying obsolete documents retained for legal and knowledge preservation purposes; and
- identification and segregation of confidential and privileged information.

1010. Monitoring data will be documented and analyzed to determine temporal and spatial trends and confirm compliance with relevant thresholds. Monitoring reports will be produced to meet internal and external reporting requirements. If monitoring results indicate non-conformance with stipulated thresholds or if a significant deteriorating trend is observed, it will be recorded as a non-conformance and handled by the non-conformance and incident procedure. The following reports will be produced:

- Based on reports provided by the Construction Contractor as listed in **Table 11-2**, Quarterly and annual reports will be prepared by MPL for monitoring of the physical and social environment and shared with the AJKEPA.
- Reports for biological environment will be produced under the frameworks provided in the BAP. Reporting for the BAP and sharing of the reports is outlined in **Table 11-4**. Quarterly Watch and Ward and Annual M&E Report will be prepared by the Implementation Organization and the M&E Consultant respectively, and shared with the Management Committee for BAP and the AJKEPA.

Table 11-2: Environmental Monitoring Program for Construction and Operation

Aspect	Impact Reference	Type of monitoring	Units	Frequency of Monitoring	Location/s	Records	Reporting Frequency	Monitoring Responsibility	Report Preparation Responsibility	Report Receiving Authority
Construction Phase										
Soil Quality	PE1	Visual inspection for any oil and lubricant spills and leakages in the construction area and presence of oil in the drains at the construction site	None	Daily	Construction area and drains at the construction site	Log	Monthly report during construction	Construction Contractor	Construction Contractor	MPL and AJK EPA
Soil Erosion	PE2	Visual inspection of soil erosion and land sliding, especially in the wet season	None	Once a month in dry season. Once a week in wet season.	Construction sites, rehabilitated areas and water release points	Log	Monthly report during construction	Construction Contractor	Construction Contractor	MPL and AJK EPA
Waste Disposal	PE3	Inspection of waste disposal areas and channels	None	Weekly			Quarterly report during construction	Construction Contractor	Construction Contractor	MPL and AJK EPA
Water Resource Depletion	PE4	Record of water used and source of water supply for construction, sprinkling and camp	m^3/day	Daily	Construction sites, truck filling points and water tanks at camp.	Log	Quarterly report during construction	Construction Contractor	Construction Contractor	MPL and AJK EPA
Fugitive Dust Emissions	PE5	Air quality sampling at social receptors in case any complaints regarding excessive particulate matter in ambient air are received.	$mg/d/m^2$ PM_{10}	As required, in case complaints are received	Social receptors	Logs	Report as required, in case complaints are received	Construction Contractor	Construction Contractor	MPL and AJK EPA

Aspect	Impact Reference	Type of monitoring	Units	Frequency of Monitoring	Location/s	Records	Reporting Frequency	Monitoring Responsibility	Report Preparation Responsibility	Report Receiving Authority
Vehicular and Machinery Exhaust Emissions	PE6	Visual checks of exhaust emissions from vehicles and batching plant machinery to ensure excess pollutants are not being released	None	Monthly	Construction sites and batching plant location	Logs	Quarterly	Construction Contractor	Construction Contractor	MPL and AJK EPA
Noise Nuisance	PE7	Monitoring of the noise levels in the nearest communities against the baseline noise conditions	dBA	Once a month and when a complaint is received	Nearest settlements or area for which complaint is received	Log	Quarterly	Construction Contractor	Construction Contractor	MPL and AJK EPA
Traffic	PE8	Random speed checks and inspections and investigations in case of complaints by community	km/hr	Once a month and in case complaints are received	Different location and different time	Log	Quarterly	Construction Contractor	Construction Contractor	MPL and AJK EPA
Degradation of Terrestrial Ecology	TE1	As specified in the BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	Quarterly Watch and Ward Report Annual M&E Report	Implementation Consultant M&E Consultant for BAP	M&E Consultant for BAP	MPL, Managemen t Committee of BAP, and AJK EPA
Implementation of BAP to Achieve Net Gain in River Ecology	RE1	As specified in the BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	Quarterly Watch and Ward Report Annual M&E Report	Implementation Consultant M&E Consultant for BAP	M&E Consultant for BAP	MPL, Managemen t Committee of BAP, and AJK EPA
Distribution of Project Employment	SC2	When complaint is received or an issue observed	None	When a complaint is received	Construction site, camp and nearby villages	Log	Monthly	Construction Contractor	Construction Contractor	MPL and AJK EPA

Aspect	Impact Reference	Type of monitoring	Units	Frequency of Monitoring	Location/s	Records	Reporting Frequency	Monitoring Responsibility	Report Preparation Responsibility	Report Receiving Authority
Social Unrest due to Conflicting Social Norms	SC3	When complaint is received or an issue observed	None	When a complaint is received	Construction site, camp and nearby villages	Log	Monthly	Construction Contractor	Construction Contractor	MPL and AJK EPA
Operation Phase										
Waste Disposal	PE3	Inspection of waste disposal areas and channels	None	Weekly			Quarterly report	MPL	MPL	AJK EPA
Degradation of Terrestrial Ecology	TE2	As specified in the BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitorin g Program	Quarterly Watch and Ward Report Annual M&E Report	Implementation Consultant M&E Consultant for BAP	M&E Consultant for BAP	MPL, Management Committee of BAP, and AJK EPA
Implementation of BAP to Achieve Net Gain in River Ecology	RE1	As specified in the BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitorin g Program	Quarterly Watch and Ward Report Annual M&E Report	Implementation Consultant M&E Consultant for BAP	M&E Consultant for BAP	MPL, Management Committee of BAP, and AJK EPA
Income Loss in Sand and Gravel Mining	LW4	As specified in the BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitorin g Program	Quarterly Watch and Ward Report Annual M&E Report	Implementation Consultant M&E Consultant for BAP	M&E Consultant for BAP	MPL, Management Committee of BAP, and AJK EPA
Increased Opportunity in Recreational Fishing	SC5	As specified in the BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitoring Program	See BAP Monitorin g Program	Quarterly Watch and Ward Report Annual M&E Report	Implementation Consultant M&E Consultant for BAP	M&E Consultant for BAP	MPL, Management Committee of BAP, and AJK EPA

Table 11-3: Framework for Monitoring of Biodiversity Included in the Biodiversity Action Plan

No	Outcome	Data required	Method	Sampling frequency, timing and locations	Data format	Field equipment	Data analysis
River Hydrology							
1	Discharge time series	Average daily discharge	Obtain from existing gauging stations and dam operation.	Continuous monitoring at EF Site 2 (environmental and operational releases from Dam) and 3 (release from power house and flow from EF site 2).	Excel spreadsheet	None	Assessment of changes in hydrology using principal indicators listed in the BAP.
River Water Quality							
2	In situ measurements of temperature	Time series measurements of temperature	Use of temperature data logger	Continuous at EF Site 2	Temperature time series data	Temperature data logger	Difference in seasonal and diurnal patterns relative to baseline.
3	Laboratory analysis	Concentration of major anions, cations and some heavy metals in collected water samples.	Methodology for Surface Water Collection in USEPA, Environmental Investigations – SOPs and Quality Assurance Manual.	Once a year at EF Site 2 during December/January.	Concentrations of selected variables at selected site downstream of dam.	Bottles, note book, long-arm water sampler, cool box/freezer and preservatives from accredited laboratory.	Compare values with thresholds of concern (e.g. toxicity effects on biota; trophic state changes, drinking water standards); Identify anomalous or unusual patterns e.g. change in data trends which require explanation/raise concern (e.g. heavy metal concentrations).
River Geomorphology							
4	Channel planform	Fixed point photographs of sensitive reaches.	Fixed point photographs.	Once a year during the low flow season (December/January) at EF Site 1, 2 and 3.	Geo-tagged photographs of selected reaches	GPS and camera	Annual assessment of the changes in low flow planform of flow-sensitive multiple channel reaches.

No	Outcome	Data required	Method	Sampling frequency, timing and locations	Data format	Field equipment	Data analysis
5	Channel shape	Surveyed cross-sectional profiles.	As described in Appendix G, Eco-hydraulics of ESIA of Gulpur Hydropower Project	Once every 3 years at EF Site 2 during the low flow season (December/January).	MS Excel spreadsheet	Total station, tripod, prism and poles	Assess changes in the width and/or depth of the active channel relative to the baseline (2014) condition.
6	Bed sediment size	Bed-surface sediment size distribution of sensitive (secondary channel) habitat.	Bed-surface sediment size distribution of sensitive (secondary channel) habitat using the step-point survey.	Annually during the low flow season at EF Site 1, 2 and 3 during the low flow season (December/January).	Sediment size distribution curve.	Tape measure and GPS	Assess changes in the bed sediment distribution relative to the baseline (2014) condition.
Fish							
7	Fish community composition and size distribution	Catch per unit effort and relative abundance of indicator fish species, species diversity, population size structure, fish size distribution.	Cast netting in August/September Gill netting in December/January Measure weight, total length of fish collected.	Twice a year at specified locations in the Poonch River during August/September and December/January.	Species lists and catch per unit effort in Excel Mean weight and fork length in excel.	Cast nets, gill nets, bucket, fish measuring board, scale and plastic bags	Relative abundance, Catch per unit effort of indicator fish species, index of fish community health and condition. Species diversity. using Shannon Weiner index Size frequency distribution and fish weight.
8	Gonad Development	Stage of gonad development	Dissect fish and identify stage of gonad development.	Once a year in May/June in tributaries	Excel	Dissection box	Comparison of stages of gonad development and breeding success with baseline conditions.

No	Outcome	Data required	Method	Sampling frequency, timing and locations	Data format	Field equipment	Data analysis
9	Assessment of available fish habitat	Description of habitat according to flow and substratum size.	Describe habitat at each study site qualitatively according to the estimated abundance of flow and substratum size. Take photographs.	Twice a year in August/September and December/January at specified locations in Poonch River where fish sampling is conducted.	Semi-quantitative description of fish habitat.	100 m measuring tape, notebook, pencil, camera and ruler	Relative proportions of each habitat type.
Macro-invertebrates							
10	Species richness and diversity	Species lists (higher taxonomic levels where unavoidable.)	Field: semi-quantitative (10 min) kick-net samples of invertebrates from two hydraulically different areas (deep fast rapid; shallow rapids with riffle and run) Laboratory: sort invertebrates from debris, identification of species or higher taxonomic level where spp. identification not possible.	Once a year in August/September at specified locations in Poonch River	Species list, annotations on distribution	Sampling jars, 96% ethanol, labels, alcohol-proof marker, kitchen pot scrubbing brush, 250 µm box sampler or net sampler, 250 µm sieve, forceps and data sheets.	Calculate and compare inter-annual change in species richness, diversity, contribution to diversity of higher taxonomic structures e.g. order.
11	Macro-invertebrate community structure	Genus/species lists and abundance; information on Functional Feeding Group (FFG).			Species-by-site/date/habitat arrays for multivariate analysis.		Summaries of the proportion of FFG per site/sampling; Multivariate analysis using PRIMER/PERMANOVA.

No	Outcome	Data required	Method	Sampling frequency, timing and locations	Data format	Field equipment	Data analysis
Periphyton							
12	Periphyton biomass	Five replicate samples of the algae and periphyton covering submerged stones in run biotope: Chlorophyll a and algal ash-free dry weight density per unit area.	Field: Surface material scrubbed from five medium cobbles per site; samples stored on ice in the field, frozen within 24 hours. Measure stone diameter along three perpendicular axes, x,y,z. Laboratory: Prior to freezing, 30 ml sub-sample. removed for A2. Subdivide rem. sample; extract chlorophyll according to specified protocols; filter and obtain dry weights of second half of sample.	Once a year in December/January at specified locations in Poonch River	Chl a and AFDW density (mg m^{-2} stone surface)	Jars, labels, toothbrushes, depth measuring stick, measuring tape, porTable ice-box, syringe, forceps, plastic jug and Lugols solution.	Calculate differences in periphyton biomass between sites and years using a Kruskall-Wallas ANOVA/Dunn's post-hoc comparisons.
Otter							
13	Otter population size estimate	Location and number of Otter latrine sites	Noninvasive Latrine Survey methodology as described in Mowry et al. (2011).	Once a year in dry season (December/January) at specified locations along River and tributaries.	Excel datasheet	GPS, camera and measuring tape	Population size estimated using scats per latrine and latrines per kilometer. Linear regression used to estimate changes in population.

No	Outcome	Data required	Method	Sampling frequency, timing and locations	Data format	Field equipment	Data analysis
Riparian vegetation							
14	Riparian vegetation community structure	Vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the plant species.	Transect method	Once annually in August/September at specified locations along River and tributaries.	Excel	Tape measures/ropes, data sheets, plant press, specimen bags and sample labels.	Multivariate analysis package such as PRIMER.
Terrestrial vegetation							
15	Terrestrial vegetation community structure.	Vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the plant species.	Transect method	Once every three years in April/May	Excel	Tape measures/ropes, data sheets, plant press, specimen bags and sample labels	Multivariate analysis package such as PRIMER
Terrestrial Fauna							
16	Terrestrial fauna community structure.	Species richness (number of species observed) and abundance (number of individuals of each species observed) with a focus on the vulture species.	Transect method	Once every three years in April/May	Excel	Tape measures/ropes, data sheets, identification keys and Sherman troops.	Multivariate analysis package such as PRIMER.

Table 11-4: Monitoring and Evaluation Reports for Biodiversity

Report No.	Title of the Report	Prepared by	Scope	Review by	Frequency and Timing
1	Annual Data Report	M&E Consultant	Data report outlining data sets, graphs, quality control issues and measures implemented.	Management Committee for implementation of BAP	February every year. Frequency may be decreased to once in two or three years if the conditions stabilize and targets are achieved.
2	Biodiversity Assessment Report	M&E Consultant	Review of pressure, state, and response indicators, trends, and key developments Recommendations for adaptive management with focus on response indicators.	Management Committee for implementation of BAP, AJK Wildlife Management Board, key stakeholders	March every year. Frequency may be decreased to once in two or three years if the conditions stabilize and targets are achieved.

11.3 HSE Audits

1011. Formal audits will be undertaken at planned intervals in accordance with the requirements of client and regulatory authorities. Procedures for audits will be established, implemented and maintained. These will cover the audit criteria, scope, frequency and methods, and will address the responsibilities and requirements for planning and conducting audits, reporting results and retaining associated records.

1012. Any negative findings arising from an audit will be treated an incident and dealt with in accordance with the non-conformance and incident procedure. Results from audits and evaluations of compliance with legal requirements will be reported to site and senior management and subject to management reviews. Usually environmental regulatory authorities require a quarterly audit report for large scale projects.

11.4 Institutional Implementation of EMMP

1013. Effective implementation and functioning of the EMMP depends on adequate human and financial resources, clearly defined responsibilities for environmental management, appropriate training and good communication. An outline of how these features will be managed for the Project is presented below

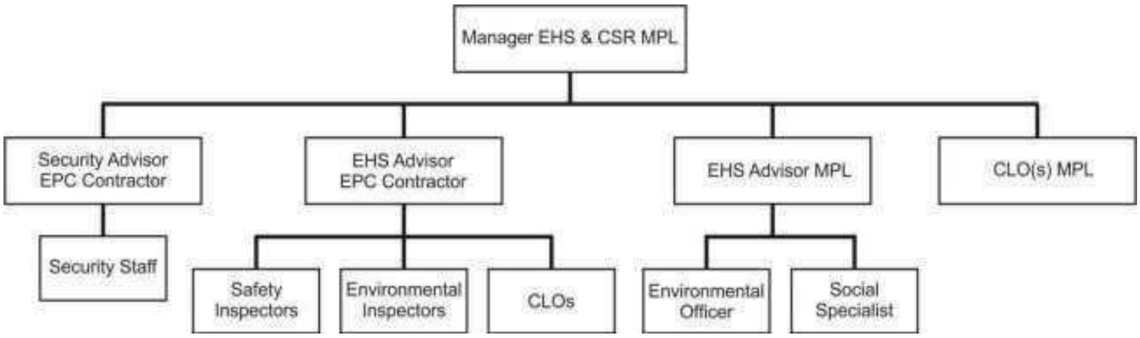
11.4.1 Management Commitment

1014. To be effective, this EMMP must be viewed as a tool reflecting to the contractors and sub-contractors overall commitment to environmental protection. This must start at the most senior levels in the organization. Contractor management must provide strong and visible leadership to promote a culture in which all employees share a commitment to environmental awareness and protection. The following are commitments to be achieved by the highest position in Pakistan from MPL:

- Putting environmental matters high on the agenda of meetings;
- Highlighting the importance of environmental issues in relation to the HSE considerations in business decisions and communication with stakeholders;
- Evaluating environmental aspects, before final decisions are reached;
- Being fully aware of the main environmental hazards associated with the Contractor and Sub Contractor activities and the systems, procedures and field practices in place to manage these hazards;
- Immediately and visibly responding and being involved in investigating incidents or other abnormal events related to environmental and HS issues;
- Seeking internal and external views on environmental issues; and recognizing their achievement.

1015. The organizational setup of MPL for implementation of the EMMP is provided in **Figure 11–1**.

Figure 11–1: Organizational Setup of MPL for EMMP Implementation



11.4.2 Roles and Responsibilities of Key Staff

MPL

1016. With overall responsibility for the Project, MPL will:

- Prepare the ESMS and implement the ESMS and EMMP.
- Minimize any impact the Project may have on the environment through preparation of this ESIA (as being carried out in the design stage).
- Appoint responsible contractors who will comply with this ESIA.
- Approve environmental safe materials for use on site in accordance with the ESIA.
- Ensure all relevant parties receive a copy of the approved ESIA and that it is incorporated into all contractual documentation.
- Obtain the relevant environmental permits, consents and authorizations prior to commencing site works.
- Comply with all requirements of AJK EPA and obtain NOCs related to the Project.

Construction Contractor

1017. The EPC or Construction Contractor will prepare a 'Construction Management Plan' (CMP) demonstrating the manner in which they will comply with the requirements of mitigation measures proposed in the EMP. After completion of the Construction Contractor's contract, MPL will be in charge of the operation and maintenance of the Project and will be responsible for compliance with the monitoring plan during operations. The Construction Contractor's general responsibilities will be to:

- Ensure the implementation of the ESIA/EMMP throughout construction works by all contractor personnel and subcontractors.
- Ensure that adequate resources are available to implement the requirements of this EMMP.
- Undertake quarterly environmental audits and report to MPL on regular basis.
- To coordinate with MPL for all correspondence to AJK EPA.

- Prepare a comprehensive legislation list and ensure compliance to these legislations.

Sub-Contractors

1018. Any Sub Contractor hired directly or indirectly by the Construction Contractor to carry out Project related tasks will be designated as a subcontractor. It will be the responsibility of those sub-contractors, whose activities have at least one interface with identified key environmental aspects, to comply with the ESIA at all times. They must also designate sufficient competent resources to ensure all Sub-Contractor personnel receive the required training. Sub-Contractors directly in charge of activities shall be registered and approved. Registration documentation will be provided to MPL prior to commencement of any activities. Sub-Contractors will be expected to demonstrate a proactive behavior towards environmental concerns. It will be their responsibility to provide information requested by MPL with regard to their scope of activities and to demonstrate compliance with the applicable environmental requirements.

MPL Personnel

Chief Executive Officer

1019. The Chief Executive Officer (CEO) will manage and superintend all office and site activities for the implementation of the Project. In relation to the ESIA and implementation of EMMS and EMMP, the CEO's responsibilities will include:

- Overall responsibility for ensuring implementation of the EMMP in compliance of all legal matters regarding the Project.
- Development and establishment of adequate Environmental, Safety and Quality Management teams, who will ensure the development, communication and implementation of this ESIA across the entire Project, including all activities being undertaken by subcontractors and suppliers working on the site, and all personnel visiting the site.
- Ensure that the Subcontractor has hired an environmental team (see **Figure 11–1**) to address environmental requirements in accordance with the ESIA.
- Develop and establish an organization structure adequate to oversee the whole of the works, including overseeing the appointment of an appropriate qualified HSE Manager and Environmental Manager.
- Ensure that adequate resources are available to implement the requirements of this ESIA.
- Ensure the ESIA is reviewed regularly to correspond with on-going construction activities.
- Coordinate with government agencies and bodies regularly to discuss the Project's construction environmental issues and requirements.
- Attend regular meetings with Manager EHS and CSR in order to discuss the site's environmental issues and requirements.

Chief Technical Officer

- Taking primary responsibility for all activities on site, including those undertaken by direct or indirectly employed personnel or agencies.
- Ensuring the issue of suitable procedures for the definition of working methods and site regulations that take into consideration the requirements within the ESIA.
- Ensuring that construction and erection works are performed in respect of the ESIA requirements.
- Attending regular meetings in order to discuss the site's environmental issues and requirements.

Manager EHS & CSR

1020. The Manager EHS & CSR manages and supervises the Project activities relating to health, safety and environment. The HSE Manager will be responsible for:

- The overall responsibility for the development and implementation of the Project HSE policy/philosophy.
- Coordinating weekly HSE meetings, during which any environmental issues will be discussed and minuted.
- Reviewing and ensuring the implementation of Contingency and Emergency Response Procedure.
- Providing specialized HSE input into engineering, construction and contracts, ensuring requirements are properly integrated into project planning, design criteria, construction plans and specifications and contracts
- Supporting/leading incident investigations as per project procedure and report to all concerned. Follow up and review the corrective and preventive action taken, and close-out the incidences.
- Conducting HSE inspections of project construction activities and monitoring compliance with requirements including contractual commitments, permits and projects HSE plan and other applicable HSE requirements and ensure that the Project HSE inspection plan is implemented.
- Ensuring that all internal as well as external incidents and complaints are appropriately resolved with all applicable forms and records duly filled and maintained.
- Coordinating and organizing regular meetings with the Project Director, Construction Manager and Environmental Manager in order to discuss the site's HSE issues and requirements.
- Coordinating the environmental activities with the higher management time to time.
- Coordinating with the AJK EPA, other regulatory authorities and stakeholders on environmental issues related to construction of the Project.
- Monitoring construction activities and performance to ensure compliance with the ESIA and effectiveness of control measures adopted.

- Ensuring that no works are carried out outside the construction corridor as defined in the ESIA, especially within the protected areas (e.g. forests).
- Ensuring the issue and updating of the Project's environmental plans.
- Coordinating Project document review activities from an environmental standpoint, assuring that the execution of these activities is compatible with development of the Project and reporting any discrepancies between the environmental requirements and other Project objectives to the Head Hydro Power and CEO.
- Supplying essential information for the preparation of the environmental control plan for construction.
- Updating AJK EPA regularly on construction information.
- Coordinate the development of environmental monitoring data relevant to construction activities.
- Performing environmental checks and monthly internal audits of onsite activities, in coordination with the HSE Manager.
- Supporting the higher management in relations with the governmental agencies and with the AJK EPA on environmental matters.
- Implementing the environmental requirements of the project management system including inspection and reporting.
- Monitoring construction activities and performance to ensure compliance with the Construction Management Plan and effectiveness of control measures adopted.
- Developing and implementing of the environmental training program.
- Conducting staff environmental training, inductions and Tool Box Talks (TBT).
- Advise the Project Manager, or in his absence the relevant Construction Manager, to stop work which could, or is, causing unacceptable environmental impacts.
- Communicate with internal and external parties as required.
- Coordinating daily and weekly site inspections and approving the associated environmental inspection report.
- Reviewing daily and weekly checklists to ensure that appropriate recording of site activities and observations.
- Preparing of the monthly environmental reports, quarterly performance reports and incident reports.
- Reporting of any environmental incidents to the higher management.
- Ensuring that major environmental incidents are reported to AJK EPA within a maximum of 3 days.
- Participating in environmental management reviews.
- Reviewing environmental monitoring data.

- Raise non-conformance and issue CAPs reports in coordination with the EHS Manager (MPL).
- Ascertaining that effective measures and relevant actions are undertaken to avoid or minimize adverse environmental impacts.
- Attending regular meetings with the CEO and staff that reports to the Manger EHS and CSR (see **Figure 11–1**) in order to discuss the site's environmental issues and requirements.
- Ensuring that all internal as well as external environmental incidents, emergencies and complaints are appropriately resolved with all applicable forms and records duly filled and maintained.
- Regular reviewing of environmental plans and procedures to assess compliance and recommend revisions, where required.
- Review reports provided by the Construction Contractor and submit periodic reports to AJK EPA
- Review BAP reports and submit to Management Committee for BAP and to AJK EPA.

11.5 Specific Environment Management Plans

1021. Specific management plans, or frameworks, are placed in **Appendix K.** These include:

- Construction Management Plan
- Spill Contingency Plan
- Air Pollution Control Plan
- Waste Management Plan
- Waste Management Activities
- Muck Disposal Plan
- Traffic Management Plan
- Health and Safety Plan
- Emergency Preparedness and Response Plan

11.6 Biodiversity Action Plan

1022. A Biodiversity Action Plan (BAP) is a "plan to conserve or enhance biodiversity", more specifically a set of future actions that will lead to the conservation or enhancement of biodiversity. While an Environmental Impact Assessment (EIA) contributes towards meeting regulatory requirements and helps Project proponents adhere to their commitment of minimizing the impact of their operations on the environment, the objective of a BAP is to remedy or offset any impacts that cannot be reduced or avoided.

1023. The Biodiversity Action Plan is a critical element of the Gulpur Hydropower Project. It has been formulated to address regional biodiversity concerns and to achieve net gain under ADB's Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment and IFC's Performance Standard 6. The draft plan was shared with the relevant stakeholders particularly the AJK Fisheries and Wildlife Department (AJKFWD), the NGOs working in the area and relevant communities for their comments and suggestions, and was finalized after addressing the concerns and comments of the stakeholders. It has now been accepted and agreed upon by all the stakeholders.

1024. The BAP for the Poonch River Basin addresses the implementation of the Protection Level 2 as described in (**Section 6.4**) (Construction and Selection of Scenarios). The implementation of the BAP will focus on protecting the aquatic and semi-aquatic resources, primarily the fish, marginal and flood plain vegetation as well as the mammals and herpeto-fauna dependent on the river, by putting in place a protection system. This protection will not be limited to the river and tributaries alone but will also extend to the adjacent terrestrial habitats and terrestrial species of conservation importance in the Poonch River valley. The objectives of the BAP are outlined below:

- High level baseline of the defined Study Area
- Identification of conservation issues, protected areas, critical habitats and species of conservation importance
- Establishment of priorities for conservation action
- Outline of actions and activities that should be undertaken to protect the biodiversity in the Study Area
- Budget and timelines for implementation
- Institutional partnerships and arrangements for implementing the BAP
- An awareness raising and capacity building program of the relevant stakeholders including Mira Power Ltd, staff of AJK Fisheries and Wildlife Department, relevant communities, and NGOs
- A monitoring and evaluation plan to ensure that the measures outlined in the BAP are implemented

1025. The strategy suggested for implementation of the BAP includes:

- A framework Agreement between government of AJK and MPL defining the roles and responsibilities of the two parties in implementation of the BAP and the specific responsibilities to be assigned to AJKFWD for implementation.
- Putting in place a protection system, consisting of an effective watch and ward for the national park and adjacent areas, to fill the gaps in the existing system
- Establishment of two wildlife management offices along the Poonch River to provide a base for the watch and ward staff to operate
- Advice and support for Mahaseer hatchery to be developed by the AJKFWD near Moli Nullah for stocking of fish downstream of the Project powerhouse
- Implementation by an independent Implementation Organization selected by MPL in consultation with the AJKFWD.
- Active supervision and support from the AJKFWD by making available existing staff for protection, assistance in coordination with other government line departments such as police and district administration
- Commitment by AJKFWD to provide legal authority to the staff of the Independent Organization for exercising powers under wildlife legislation

- Regular oversight and monitoring by a Management Committee set up for implementation of the BAP Monitoring on a long term basis by an independent Monitoring and Evaluation Consultant

1026. Given that it is entirely plausible that the demand for sediment will continue to increase during the operation of the Project, achieving the Protection Level 2 will necessitate management and control that will limit the impact of mining on the river in the face of increased demand/volumes being abstracted. This could be achieved using one or more of the following strategies:

1. Focus mining activities in non-sensitive areas
2. Ban mining in sensitive areas
3. Implement on-site control and management of mining activities
4. Rehabilitate/restore habitats already destroyed by mining
5. Use of alternatives sources of aggregate for the Project including the following:
    a. reuse spoil
    b. quarries for aggregate

1027. A Sediment Management and Mining Plan will be prepared as a part of the BAP to identify appropriate strategies and develop mechanisms for achievement of the objectives of the BAP. Rationale and requirements for this plan are included in the BAP. The Terms of Reference of the development of a Sediment Mining and Management Plan are included in **Appendix F.**

1028. Given the developments in Kishenganga project where environment has been recognized as an issue under the Indus Water Treaty (see **Section 3.4**, International Treaties and Conventions), environmental impacts related to hydropower developments on either sides of LoC can be discussed by the offices of the Pakistan Commission for Indus Waters (PCIW) and India Commission for Indus Waters (ICIW) established under the Indus Waters Treaty. The Biodiversity Action Plan prepared for the Project includes a provision for the project owner to share the Poonch River environmental monitoring data and reports with the PCIW, on the basis of which the PCIW could coordinate with the ICIW on management of environmental issues across the LoC.

1029. The complete Biodiversity Action Plan is given in **Appendix L.**

11.7 Social Augmentation Plan

1030. MPL has established a program of stakeholder engagement for the Project and this will continue throughout the life of the project. Currently, this program includes:

- disclosure of information and consultation with stakeholders as part of the ESIA process; and
- a grievance mechanism, for receiving concerns about the Project's environmental and social performance and for facilitating the resolution of the concerns (the grievance mechanism applies to Project stakeholders, including potentially affected communities and Project personnel.

1031. MPL will prepare a Stakeholder Engagement Plan as a part of the ESMS for the Project. A framework for this plan is included in **Appendix M**. Meanwhile, proposed social augmentation/enhancement measures and their methods of implementation are described below:

Providing a Water Supply Facility

1032. The people living in Kotli and the villages within the project influence area suffer from severe shortage of water for safe drinking and washing purposes. In Kotli, piped water supply by the town management is often insufficient for the residents, especially in the less developed areas. As a consequence, most of the people have to spend considerable amounts of money to install their own pumps, dig wells or bring water pipes from nearby mountain springs. The poorer residents and villagers in the project influence area have to collect water directly from mountain springs or are dependent on neighboring residences' groundwater wells.

1033. Local community, especially the women and children suffer from water borne diseases including Diarrhoea. The EMP under this project proposes to provide potable water by constructing small–scale drinking water supply systems or installing hand–pumps at certain convenient points in the urban and rural communities. Provision of drinking water to communities would contribute to the general health of the women and children and save the families from extra fatigue and water buying costs.

Skills Training and Capacity Building Activities

1034. The people of the Socioeconomic Study Area are dependent on daily wage labour and overseas employment as major means of livelihood. Women in the rural areas are mostly unemployed due to lack of professional skills. The Project will contribute in economic activities by supporting skills training and capacity building activities for these poor communities, especially for the women and youth. By doing this, the project would be enabling the poor families to enhance their earnings and living standards. Vocational Training programs will focus in skill development in construction and power industries.

Health Care Facilities

1035. People living in the some rural areas around the Project Site are devoid of good quality health care system. In case of suburban and rural communities in the villages around Kotli, communities during consultation indicated that the government health facilities are insufficient and inefficient, mainly because of lack of qualified doctors and quality medicines. Furthermore these facilities are located at considerable distance from the smaller rural communities. The people requested for creating an opportunity for their health care under the proposed project. Basic clinic and paramedics will be appointed to check condition of the health of the people three times a week, so that their need for primary health care is taken care of. In addition, the project will attempt to provide financial and technical assistance on health issues of Kotli and rural communities in the project influence area to impart training through an experienced NGO and, especially in preventive measures against water–borne diseases, mother–and–child care, and the like.

Implementation and Operation

1036. Proposed facilities under the social augmentation program require proper operation and maintenance. The following section discusses the operational procedure and maintenance of the facilities.

Setting up the Facilities

1037. All facilities proposed under social augmentation program will be created and implemented by the MPL in association with local NGOs or local government in close collaboration of the beneficiary. Involvement of beneficiary community from the beginning of the augmentation work is critical as without their active involvement the design and implementation will not be as per the requirement of the targeted people.

Selection of NGOs

1038. Selection of NGOs will be done based on their capacity, experience, and interest. Organizations that have experience of carrying out similar assignment will be given priority as operation and management of such types of jobs require capacity and tenacity. A short list of those NGOs can be made first and then proposal may be sought from them for the work.

Imparting Training

1039. The targeted people will be trained in modern sand mining practices, health care, sanitation, gender and development, and HIV/AIDS. The training will be a part of preventive rather than curative measures. All the trainings including good agricultural practices, health care, gender and development, and HIV/AIDS related issues will be conducted by the selected NGO(s). The training will be provided by both male and female trainers, as some of the issues are more suited for female trainers compared to the male trainers.

Corporate Social Responsibility Plan (CSR)

1040. MPL will produce an annual CSR Plan which will include the identified environmental and social impacts, their enhancement/mitigation and proposed budget for the implementation of mitigation measures. The mechanism for employment of locals and stakeholder engagement will also be outlined in this plan. The CSR Plan will ensure that all community issues are addressed and conflicts or social ills do not arise in the area.

1041. As discussed in (**Section 11.6**), a Sediment Mining and Management Plan will be developed that will prohibit uncontrolled sediment mining along the Poonch River and identify alternate mining sites for the local community. In the socioeconomic survey, it was seen that about 7% of the local rural community is dependent on sediment mining as a means of livelihood. The Sediment Mining and Management Plan will not only protect the Poonch Basin and decrease its vulnerability to floods; it will also provide a legal and transparent opportunity to locals to continue the practice in designated areas. In addition to this, training will be imparted to locals to improve the sediment mining practice and yield more economic results using advanced mining techniques.

11.8 Cost Estimates

1042. Cost estimates are prepared for all the mitigation and monitoring measures proposed in the EMMP. The cost presented in **Table 11-5** through **Table 11-8** is indicative only. This budget has been calculated for duration of 48 months of the construction phase. The costs for implementation of environmental mitigations during the operational phase are not included. The operational cost shall be calculated before the completion of construction phase after consultation with stakeholders and regulatory authorities. Staff costs for monitoring and evaluation of the impacts on physical environment during the construction and operation phases are also not included as these activities will be carried out by the permanent staff of MPL and will be accounted for in the operating budget of MPL. The cost for land acquisition and resettlement related activities are not included. This cost shall be calculated on actual basis after detailed and specific surveys and completion of Land Acquisition and Resettlement Plan (LARP).

1043. Estimates are based on the current market rates for similar activities and items, which are implemented in similar projects. Estimations of quantities are based on previous experiences. The cost estimates and the budget for capital and one time expenditures for the mitigation and monitoring measures to be incurred during design and construction phase is estimated to be USD 273,494. Subsequently, annual recurring costs for mitigation and monitoring are estimated at USD 144,355. As explained in the BAP, annual recurring costs for monitoring and evaluation of the BAP may decrease after three years of operation if it is decided to reduce the frequency of monitoring from annual to once in two or three years if BAP targets are fully achieved.

1044. The cost estimates for control measures and some of the mitigation measures that were already part of Engineers estimate are not included in the EMMP. The cost estimates also includes the budget for institutional strengthening and capacity building of project staff and environmental enhancement/compensation measures.

Table 11-5: Summary of Cost Estimates for Mitigation and Monitoring

No	Activity	Amount, USD
Capital and One Time Costs		
1	Implementation of Biodiversity Action Plan (BAP)	186,941
2	Setting up the Monitoring and Reporting System for BAP	43,200
3	Equipment for Monitoring of Impacts on Physical Environment[2]	7,353
	Total, USD	273,494
Annual Recurring Costs		
1	Implementation of BAP	74,955
2	Monitoring and Evaluation of BAP	69,400
	Total, USD	144,355

Table 11-6: Budget for Monitoring and Evaluation of Biodiversity Action Plan

No	Activity	Amount, USD
Capital and One Time Costs		
1	Setting up the Monitoring and Reporting System	43,200
Total, USD		43,200
Annual Data and M&E Report		
1	Hydrology	4,200
2	Hydraulics and channel shape survey (once in three years at EF Site 2)	$8,680
3	Biota and water quality surveys	30,840
4	Assessment of use of river resources	7,200
5	Data report and annual report	18,480
	Total, USD	69,400

2 Equipment for monitoring of noise and dust fall.

Table 11-7: Budget for Capital and One Time Expenses for Implementation of Biodiversity Action Plan

Activity	Units	Qty	Unit Cost PKR	Contribution by Mira Power		Budget Notes
				Total Cost PKR	Total in USD*	
Plantation and re–vegetation in watershed	Ls	1	2,000,000	2,000,000	19,608	Vegetaion using native species in vicinity of Project site
Staff training	Days	18	10,000	180,000	1,765	Three sessions of 6 days each for newly hired and exisitng staff of Implementiong Organization (IO) and AJKFWD
Training material and boarding/lodging	Days	18	10,000	180,000	1,765	Development of training material and training by 3 experts in ecology, law and watch and ward.
Land for field office in Tatta Pani	Ls	1	6,000,000	–	–	Land provided to construct the office
Land for field office and hatchery at Moli Nullah	Ls	1	24,000,000	–	–	Land provided to construct field office and hatchery
Civil works for hatchery **	Ls	1	41,000,000	–	–	Civil Works for hatchery
Equipment & material for hatchery	Ls	1	9,970,000	–	–	Equipment & material for hatchery
Supplemental equipment & accessories for hatchery	Ls	1	8,000,000	8,000,000	78,431	Supplemental equipment & material for hatchery
Construction of field offices (02)	No	2	1,500,000	3,000,000	29,412	4 rooms in each of 2 offices. 1 kitchen, bathrom and store included
Funiture & fixture	No	2	100,000	200,000	1,961	For the 2 field offices
Equipment and Materials						
First Aid box	No	2	5,000	10,000	98	Standard first aid box – 1 for each office
4 WD vehicle	No	1	3,500,000	3,500,000	34,314	Toyota Hilux Double Cabin standatd 4 x 4
Motor bikes	No	4	130,000	520,000	5,098	Honda CG 125 cc
Boat, Rafts, Gear, Life Jackets	No	2	125,000	250,000	2,451	Imported inflaTable boats and equipment
Night vision binoculars	No	2	20,000	40,000	392	Gen. 1 image–intensifier tube Powerful infrared spotlight 750–feet viewing range
Binoculors	No	24	4,000	96,000	941	Bushnill Bi Nocular 20 X 16

Activity	Units	Qty	Unit Cost PKR	Contribution by Mira Power		Budget Notes
				Total Cost PKR	Total in USD*	
GPS (Garmin eTrex 30)	No	1	30,000	30,000	294	2.2" 65K color, sunlight–readable display 3–axis compass and barometric altimeter Wireless capability to share waypoints.
Video camera (Sony HDR–CX280)	No	1	40,000	40,000	392	(Sony HDR–CX280) Full HD, wide–angle Carl Zeiss lens, Exmor R™ CMOS sensor, 50x extended zoom & Optical SteadyShot
Cameras	No	2	55,000	110,000	1,078	Nikon D5100– NIKKOR lens with 7x optical zoom.DSLR
Computer	No	2	50,000	100,000	980	Core I 3 computers , with 4GB Ram 80 GB HDD, Suprer Drive 6 MB Cache
Laptop	No	1	70,000	70,000	686	HP Core I 7 Laptop , with 6GB Ram 640 GB HDD, Suprer Drive 6 MB Cache
Printer	No	2	30,000	60,000	588	HP Laser jet Printer with coper scanner and Fax
Posters	No	2000	50	100,000	980	1500 copies of 22 " X 33" of four color poster
Brochures	No	2000	15	30,000	294	2000 copies of four color A4 brochure with 3 foldings
Signboards (Small)	No	36	8,000	288,000	2,824	36 number of road direction sign boards (1.0m X 0.7m) with 10ft Iron poll
Signboards (Large)	No	12	22,000	264,000	2,588	12 number of steel sign boards (104m X 2m) with 10ft Iron poll
Total Capital and One Time Expenses				**19,068,000**	**186,941**	

* 1 USD = 102 PKR

** The AJK Fisheries and Wildlife Department is planning to construct a hatchery for breeding Mahaseer and some other fish primarily for commercial purposes. Construction of a Mahaseer hatchery to meet the requirements of the Project would cost substantially less (an estimated 20,000,000 PKR for civil works and 8,000,000 for equipment and materials = 28,000,000 PKR (USD 274,510).

Table 11-8: Budget for Annual Operating Expenses for Implementation of the Biodiversity Action Plan

	Units	Qty	Unit Cost PKR	Contribution by Mira Power		Budget Notes
				Total Cost PKR	Total in USD*	
1. Staffing						
a. Watch and Ward						
Part time Project Manager	Months	12	80,000	960,000	9,412	Manager of Implementing Organization (IO)
Supervisor	Months	12	40,000	480,000	4,706	Supervisor of Watch and Ward
Mining Inspectors (2)	Months	12	20,000	480,000	4,706	1 upstream Kotli and 1 downstream Kotli
Watchers (12)	Months	12	12,000	1,728,000	16,941	For watch and ward of entire Poonch River
AJKFWD watchers (06)	Months	12	10,000	–		For watch and ward of entire Poonch River
Admin/Accounts assistant	Months	12	30,000	360,000	3,529	For support in field office/office of IO
Female social mobilizers (2)	Months	12	18,000	432,000	4,235	2 female for community outreach program
Vehicle driver (1)	Months	12	15,000	180,000	1,765	Vehicle driver for watch and ward and other activities such as staff training and community outreach
b. Hatchery						
Assistant Director Fisheries	Months	12	40,000	–	–	Manager of hatchery
Computer operator	Months	12	20,000	–	–	For hatchery office
Accounts clerk	Months	12	17,000	–	–	For hatchery office
Fisheries supervisor	Months	12	15,000	–	–	Supervize hatchery activities
Driver	Months	12	12,000	–	–	For hatchery office
Head watcher (2)	Months	12	13,000	–	–	For hatchery operation
Watcher (8)	Months	12	12,000	–	–	For hatchery operation
Plumber	Months	12	15,000	–	–	For maintenance of hatchery equipment
Electrician	Months	12	15,000	–	–	For maintenance of hatchery equipment
Chowkidar	Months	12	12,000	–	–	Guard for hatchery
Office Attendant	Months	12	12,000	–	–	For hatchery office
Sub Total for Staffing				**4,620,000**	**45,294**	

	Units	Qty	Unit Cost PKR	Contribution by Mira Power		Budget Notes
				Total Cost PKR	Total in USD*	
2. Operating Costs						
Fuel for vehicle (1)	Months	12	35,000	420,000	4,118	Fuel for1 4WD Toyota Hilux
Fuel for m/bikes (4)	Months	12	6,000	288,000	2,824	Fuel for 4 motorbikes
Running and maintenance vehicle (1)	Months	12	10,000	120,000	1,176	Oil change, repairs, service, tuning etc
Running and maintenance m/bikes (4)	Months	12	2,500	120,000	1,176	Oil change, repairs, service, tuning etc
Travelling boarding and lodging charges	Months	12	10,000	120,000	1,176	Visits by staff of Implementing Organization (IO) to Project site
Printing and stationary	Months	12	10,000	120,000	1,176	Field office requirements
Communication charges (24)	Months	12	500	144,000	1,412	Mobile phone charges for 24 staff of watch and ward including mining inspectors and supervisor and social mobilizers
Uniform (2 for each watcher)	No	44	6,000	–	–	2 Uniforms each for 22 staff of watch and ward
Field gear	No	22	15,000	–	–	Hat, torch, binoculars, life jacket, day bag, shoes, jacket, name badges etc.
Teacher training program	No	4	25,000	100,000	980	4 programs in a year for elementary school teachers of community
School activities and community outreach programs	No	8	10,000	80,000	784	Awareness programs. One every month in selected school (except 4 months of school holidays)
Office utilities	Months	12	10000	120,000	1,176	gas, electricity, water for field offices
Depreciation on vehicle and equipment	No	1	–	455,600	4,467	Depreciation on vehicles and motorbikes @10% of cost less salvage value @40%, and @20% for equipment
Sub Total for Operating Costs				**2,087,600**	**20,467**	
3. Management and Overheads	**15%**			**937,800**	**9,194**	
Total Annual Recurring Cost (Sum of Staffing Cost + Operating Cost + Management and Overheads)				**7,645,400**	**74,955**	

* 1 USD = 102 PKR

Appendix A: Physical Baseline

A.1 Seismicity

See following pages.

Seismic Hazard Study

General

The proposed Project site is located on the foothill of Himalayan range. It lies close to the Riasi thrust which is a branch of Main Boundary Thrust (MBT). Numerous large earthquakes with magnitude greater than VIII are believed to be associated with MBT in Himalayan range East of the Project site. As the Project site is located in active seismic region, evaluation of realistic seismic design parameters is therefore necessary to design the Project structures so that these can withstand the expected ground motions due to earthquakes.

Methodology

The methodology adopted for the seismic hazard evaluation of Gulpur Hydropower Project is as follows:

- Collection and review of the regional geology and tectonic setting in an area of 150 km radius from the site. For this, the data available with WAPDA, Geological Survey of Pakistan, Oil and Gas Development Corporation and various universities were collected and analyzed.
- Study of all available historical and instrumental earthquake data including data from regional network as well as Mangla local network and development of comprehensive earthquake catalogue.
- Study of existing faults of the area through satellite images and available geologic literature and maps.
- On the basis of synthesis of tectonic and siesmological data obtained from the above mentioned studies, development of a siesmotectonic map and evaluation of the active faults for their capability to generate earthquakes.
- Carry on seismic hazard analysis by using probabilistic and deterministic approaches. EZ-FRISK software was used for the probabilistic hazard analysis. For the deterministic analysis, several faults and attenuation relationship were used to calculate the maximum horizontal ground acceleration.
- Evaluation of OBE and MCE accelerations and selection of appropriate seismic design parameters for the design of the Project structures.

Tectonic Setting

Regional Tectonic Setting

The geodynamic of Pakistan is characterized by the collision and coalescence of Eurasian and Indian Continental Plates (**Figure 1**), which were once separated by oceanic domains. This process started in the late Eocene to early Oligocene with formation of the Himalayan ranges[1]. It is however, also

[1] Farah, A., De Jong, K.A; Geodynamics of Pakistan: An introduction; Geodynamics of Pakistan, Geological Survey of Pakistan (1979).

understood that the recent collision of Indo-Pakistan subcontinent has succeeded a similar collision immediately north of Pakistan[2] or throughout southern Asia[3] that took place in Paleozoic era.

The Himalayas are believed to form a sharp frontal thrust belt as the southern edge of a wide collision zone extending north to include Hindukush, Pamir, Tien Shan, Tibetan Plateau, and other collisional features of Central Asia.

Figure 1: Regional Plate Tectonic Setting

Relative to Eurasia, the Indian Plate is still moving northwards at a rate of about 3.7 cm/yr near 73 degree longitude east[4]. Indus suture line that coincides with upper Tsengpo river valley represents the original site of the continental collision along which linear and well-developed ophiolite suites are found. These ophiolites are interpreted as the remnants of the oceanic crust of the Tethys ocean trapped during the collision between Indian and Eurasian continental blocks. The major portion of this convergence was taken up by deformation along the northern collision boundary involving folding and thrusting of the upper crustal layers[5] in the shape of MKT (Main Karakorum Thrust), MMT (Main Mantle Thrust), MBT (Main Boundary Thrust) and SRT (Salt Range Thrust), as shown in **Figure 2.**

[2] Kravchenko, K.N.; Tectonic evolution of the Tien Shan, Pamia and Karakorum; Geodynamics of Pakistan, Geological Survey of Pakistan (1979)

[3] Talent, J.A.; Mawson, R.; Paleozoic – Mesozoic biostratigraphy of Pakistan in relation to biogeography and the coalescence of Asia; Geodynamics of Pakistan, Geological Survey of Pakistan (1979)

[4] Minster, J.B., et el..; Numerical modeling of instantaneous plate tectonics, Royal Astron. Soc. Geophys. Jour. Vol.36 (1974).

[5] Seeber, L., Jacob K.H.; Micro earthquake survey of northern Pakistan, Preliminary results and tectonic implications; Proc. Symp. on Himalayan Geology, CNRS, Paris (1976).

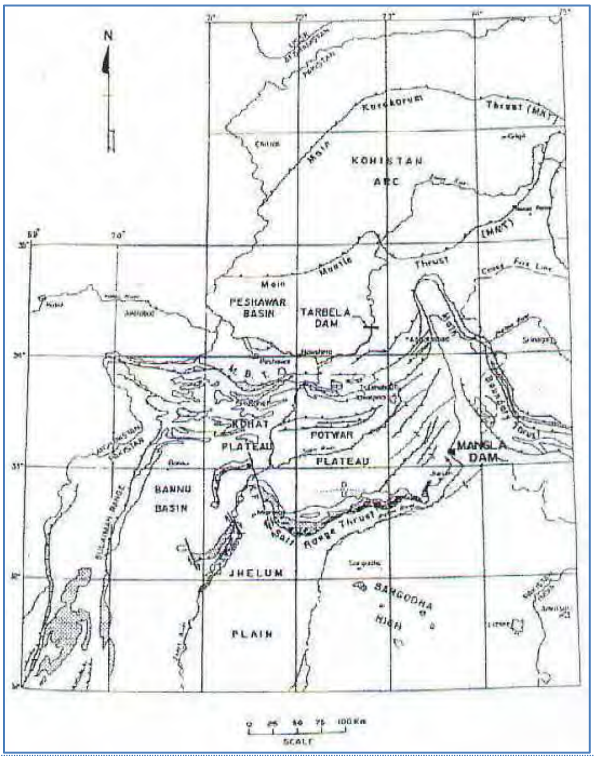


Figure 2: Generalized Tectonic Map Northern Pakistan

The MKT separates rocks of Asian landmass from Kohistan island arc complex. The Kohistan island arc is separated from the Indian plate by MMT. The MBT separates pre-collisional Paleozoic and Mesozoic sedimentary rocks of the Indian plate from the younger post-collisional Himalayan molasse sediments. A single detachment surface is believed to exist beneath the entire rocks south of MMT. This surface extends southwards till it emerges out in the shape of Salt Range Thrust[6].

Local Tectonic Setting

Project site is located close to Riasi thrust, which runs more than 200 km along the Himalayan range and is considered as a main branch of the MBT. Towards East it joins MBT and towards West it merges again into MBT at the axis of Hazara-Kashmir Syntaxial Bend, which is quite sharp near Muzaffarabad towards North and becomes less sharp towards South. On the East of the Hazara-Kashmir Syntaxial Axis, the geological features show predominantly northwest trend while their trend change to northeast towards the West of the axis. The main tectonic features West of Syntaxial Axis are Salt Range Thrust, Dil Jabba Thrust, Kahuta Fault and Riwat Fault (Fig-4.8). The Syntaxial Axis itself is believed to run along a north-south running strike-slip fault called Jhelum Fault. As many active tectonic features are present close to the Project site, therefore it is located within highly active geotectonic environment.

[6] Seeber L. et al; Seismicity and continental subduction in the Himalayan arc, in Zagros – Hindukush Himalayas; Geodynamics Evolution, A.G.U. Geodynamics Services, Vol.3 (1981).

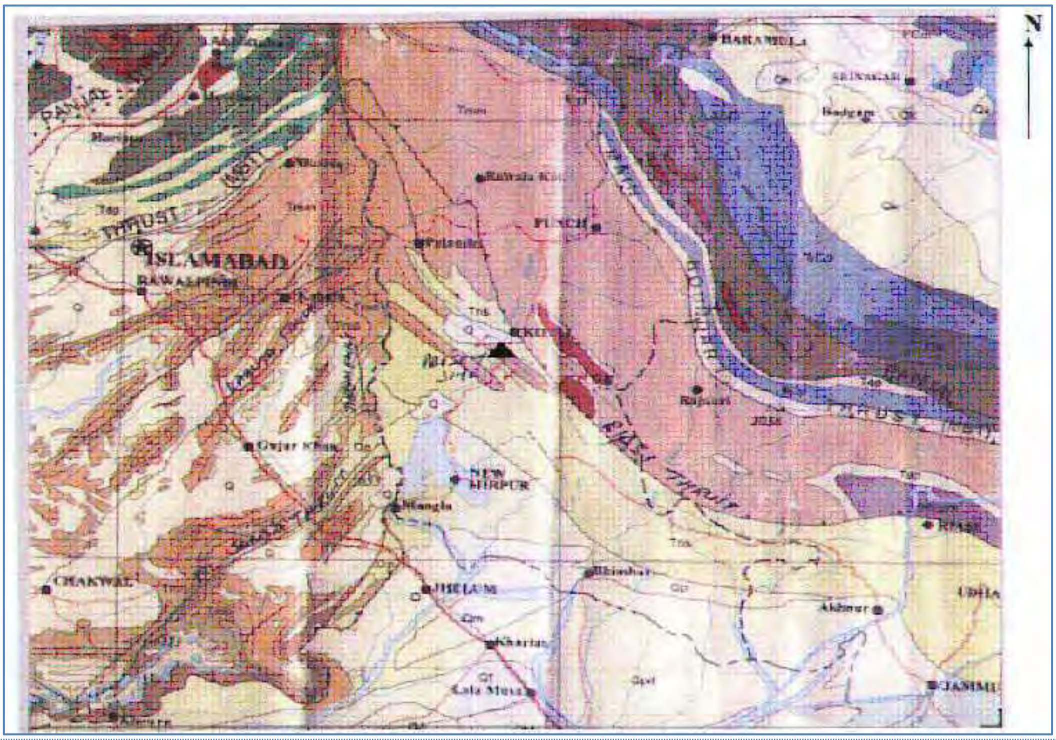


Figure 3: Regional Geological Map

Quittmeyer et al.[7] have classified whole of the area of Pakistan into fifteen seismotectonic provinces (**Figure 4**). Gulpur Hydropower project is located near the following four distinct provinces being discussed below:

a. Himalayas Province
b. Hazara Region Province
c. Salt Range Province and
d. Indus Basin Province

a) Himalayas Province

The Himalayas represent one of the primary compressional features that have resulted from the collision of the Indo-Pakistan Continental Plate with Eurasian Plate. This zone of deformation is the result of folding and thrusting associated with the development of large nappe structures and deep crustal shortening[8]. The Himalayas trends in a southeasterly direction just east of the Hazara-Kashmir syntaxis (Fig-4.7) where the project site is located.

Seismicity within this seismotectonic province is characterized as moderate to high level. Most events are associated with the frontal zone of deformation. They are located parallel to and northeast of the surface trace of the Main Frontal Thrust. One great earthquake, the 1905 Kangra event with Ms=8.0 occurred within this zone, probably rupturing a 300 km portion along the Main

[7] Quittmeyer, R.C., et al; Seismicity of Pakistan and its relation to surface faults; Geodynamics of Pakistan (1979).
[8] Ganser, A.; Geology of the Himalayas: New York, Inter Science Publications (1964).

Frontal Thrust[9]. Riasi thrust is a branch of MBT and runs almost parallel to MBT upto the syntaxial bend.

In the vicinity of the Hazara-Kashmir syntaxis, the mapped surface trace of the frontal thrust bends around from a southeast trend to a southwest orientation. The seismically defined fault zone, however, does not follow the mapped surface faults; it continues for an additional 100 km to the northwest of the Hazara-Kashmir syntaxis[10].

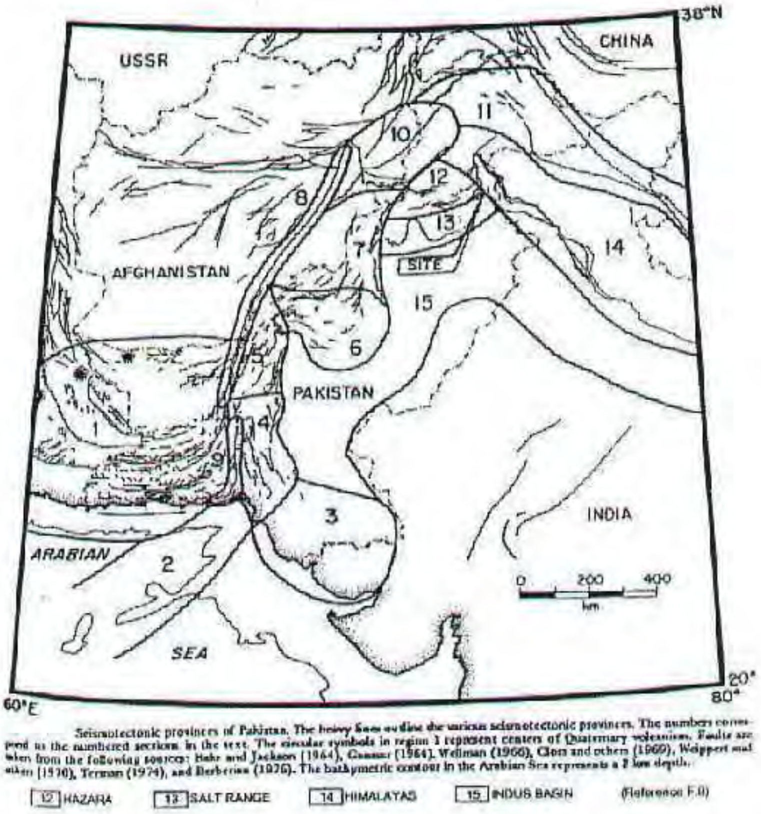


Figure 4: Seismotectonic Provinces of P[Pakistan

b) Hazara Region Province

The Hazara seismotectonic province encompasses mostly eastward trending folds and faults of the Hazara region in Northern Pakistan. The deformation within this zone is primarily the result of thrusting and a deep crustal decollement process associated with the collision between the Indian and Eurasian plates[11].

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[9] Quittmeyer, R.C., et al; Seismicity of Pakistan and its relation to surface faults; Geodynamics of Pakistan (1979).

[10] Armbruster, J., et al.; Tectonics of the lower Himalayas in north Pakistan based on micro earthquake observations, Jour. Geophys. Res., Vol.83 (1978).

[11] Ganser, A.; Geology of the Himalayas: New York, Inter Science Publications (1964).

Seismic activity within this province has occurred at a low level[12]. Historical data however do indicate moderate events causing significant damage in this region.

Shallow seismicity within the Hazara region occurs on perpendicular, steeply dipping faults characterized by reverse and strike-slip faulting. The microseismicity data suggest that the Hazara Thrust Fault may be related to a decollement surface identified at depth[13]. However, as the mapped faults are dominantly of thrust nature, a narrow alignment of epicenters along these faults is not to be expected. Furthermore, some activity is also associated with faults that are located below the decollement surface, which do not have any surface expression. The broad band of activity following the dominant structural trend, however, suggests that at least some of these earthquakes may be related to the major mapped structures[14].

c) Salt Range Province

The Salt Range is situated south of the Hazara seismotectonic province and extends from the Sulaiman Range on the West to the Himalayas in the East (Fig-4.9). General orientation of this range is east northeast, but prominent southeast trending transverse features offset parts of it (Fig-4.7). It is composed of folded and faulted thrust sheets and represents thin-skinned internal deformation within the Indian Plate resulting from its collision with Eurasia.

Although it is the frontal zone of deformation in this region, the Salt Range is characterized by a low level seismic activity, in contrast to other parts of the frontal zone in Pakistan. It has limited known history of moderate or large magnitude earthquake. Micro-earthquake studies, however, indicate that at low magnitude levels ($m<4$), the entire Salt Range is active, especially along transverse faults at points where it is offset. Cambrian salt deposits may provide an explanation for this aseismic character of the Salt range. Deformation may result from aseismic slip along a decollement surface mechanically detached by the salt[15]. The micro seismic activity may represent small readjustments within the decollement sheets.

d) Indus Basin Province

The Indus Basin is located within the Indo-Pakistan Plate South and Southwest of the Himalayas and Salt Range, and East of the predominantly northward trending mountain ranges of Pakistan (Fig-4.8). This feature is a foredeep basin. The seismicity occurring within this zone is generally of low level. Although infrequent, some events have caused considerable damage. Southwest of the Himalayas, the events occur along a discontinuous, but nevertheless, linear trend about 200 km from the Main Frontal Thrust[16]. This same trend parallels the Salt Range, but not at as great a distance. This activity

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12 Seeber, L., Jacob K.H.; Micro earthquake survey of northern Pakistan, Preliminary results and tectonic implications; Proc. Symp. on Himalayan Geology, CNRS, Paris (1976).

13 Seeber L. et al; Seismicity and continental subduction in the Himalayan arc, in Zagros – Hindukush Himalayas; Geodynamics Evolution, A.G.U. Geodynamics Services, Vol.3 (1981).

14 Quittmeyer, R.C., et al; Seismicity of Pakistan and its relation to surface faults; Geodynamics of Pakistan (1979).

15 Seeber, L., et al; Seismicity of the Hazara arc in northern Pakistan; Decollement vs. basement faulting; Geodynamics of Pakistan (1979).

16 Menke, W., and Jacob, K.H.; Seismicity Patterns in Pakistan and north western India associated with continental Collision: Seismol. Soc. America Bull; Vol.66 (1976).

within the Indus Basin may be related to bending of the lithosphere[17], active basement faults transverse to the fold and thrust belts[18], and/or development of a new frontal thrust[19]. A focal mechanism for one event near New Delhi showed normal faulting on one of two nodal planes parallel to the Himalayas[20].

Surface faults have not been mapped in the Indus Basin; the extensive alluvial cover has buried any structural evidence of faulting on the surface. Inferences based on gravity data, however, indicate basement faults may exist in some portions of the Indus Basin[21].

Seismicity

General

Earthquakes pose a multitude of hazard to dams, either by direct loading of the structures or by initiating a sequence of events that may lead to dam failure. For example, strong ground shaking or fault offset at the dam foundation is a direct load on the structure while an upstream failure, seiche or landslide into the reservoir are earthquake generated events that can lead to overtopping and failure. Effects of ground shaking by earthquakes are also documented in terms of loss of free board due to differential tectonic ground movements, slope failure, piping failure through cracks induced by ground shaking, failure of spillway and outlet works[22].

Earthquakes are generated by tectonic process in the upper part of the earth called lithosphere that is divided into several rigid parts called as “Plates”. Due to movements along these plates, stress build up takes place and results in the deformation of the crystal mass. This energy accumulation gives birth to seismic events. The contact zones between adjacent plates are, therefore, considered as most vulnerable parts from the seismic hazard point of view.

The project site is located near one of these contacts between Indian plate and Eurasian plate. This contact represented by the Himalayas has always been generating moderate to large earthquakes including Kangra (1905), Bihar-Nepal (1934) and Assam (1897) earthquakes that caused widespread destruction and huge loss of life.

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17 Molnar, P., et al; Fault plane solutions of shallow earthquakes and contemporary tectonics in Asia, Earth and Planetary Science Letters, Vol.19 (1973).

18 Valdiya, K.S.; Himalayan Transverse faults and folds and their parallelism with subsurface structures of north Indian plains, Tectonophysics, Vol.32 (1976).

19 Le Fort, P., Himalayas: The collided range. Present knowledge of the continental Arc: A.M. Jour Sci., Vol.275-A (1975).

20 Molnar, P., et al; Fault plane solutions of shallow earthquakes and contemporary tectonics in Asia, Earth and Planetary Science Letters, Vol.19 (1973).

21 Farah, A., et .el; Gravity field of the buried shield in the Punjab plain, Pakistan: Geol. Soc. America Bull., Vol.88 (1977).

22 Seed, H.B. “Earthquake resistant design of earth dams:, International Conference on Recent Advances in Geotechnical Earthquake, Engineering and Soil Dynamics, Missouri, (1981).

Historical Seismicity

The earthquakes originated before the advent of seismic recording instruments that have been mentioned in the literature and were located within the Project region give mainly information about the level of damage that this region has undergone historically. Though this information does not give a conclusive account of their epicentral location, these do give an understanding about the extent of structural damages and probable life loss in return. This non-instrumental data is solely dependent upon human observation. In order to perform a quantitative analysis of the effects of an earthquake, it is convenient to reduce the raw data to a more manageable form. For this purpose intensity scales have been established which categorize the effects experienced by human being into well defined level ranging from minimum sensations to catastrophic extremes. The historical / pre-instrumental earthquake data was collected from Oldham[23], Heuckroth et al.[24], Ambraseys et al.[25] and Quittmeyer et al.[26] catalogues as the same source of information has been used in the seismotectonic studies of other large projects in Pakistan (Tarbela dam, Mangla dam, etc.).

A brief description of the main historic events in the region under study is given below:

a) 4th Century B.C

The first known historical account of seismicity in this region was described in 4th Century B.C by Aristobulus of Cassanderia. He accompanied Alexander on his expedition to India and pointed out that the country above river Jhelum was subjected to earthquakes which caused the ground to open up so much that even the river bed was changed.

b) Year 25 A.D

Another historical record of a destructive earthquake is available of Taxila event. This event was located in the Hazara area and occurred in 25 A.D. Seismic intensity at Taxila was about X and felt throughout the country. The damage effects are still witnessed in the remains of Jandial, Sirkap and Dharmarajika around Taxila. After the earthquake, building methods had to be changed and height of the buildings was reduced. It was also started to ensure that foundations of the new buildings are more secure.

c) June 23, 1669

An earthquake with as much intensity as IX was felt at the city of Attock.

d) September 24, 1827

A destructive earthquake was felt in Lahore Region. The Fort Kolitaran near the city was destroyed. About 1000 lives were lost. A hill was shaken down which fell into the River Ravi. Its maximum intensity was estimated as VIII-IX.

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23 Oldham, T.; A catalogue of Indian earthquakes, Mem. Geol. Survey India, Vol. 19 (1893)

24 Heuckroth, L. and Karim, R.: Earthquake history, seismicity and tectonics of the regions of Afghanistan, Seism. Centre, Kabul University (1970).

25 Ambraseys A. Lensen G., and Monifer A.; The Pattan earthquake of 28 December 1974, UNESCO Publication (1975)

26 Quittmeyer R.C and Jacob K.H; Historical and modern seismicity of Pakistan, Afghanistan, northwestern India and southeastern Iran ; Bull. Siesm. Soc. Am. Vol. 69, No.3 (1979)

e) May 30, 1885

A destructive earthquake in Kashmir, which inflicted heavy destruction in Sopor, Gulmarg and Srinagar area, 3,000 people were killed. Radius of perceptibility was about 650 km. Many aftershocks were recorded. The maximum intensity in the epicentral region was VIII.

The intensities of the felt earthquakes recorded in this region are shown in **Figure 5**.

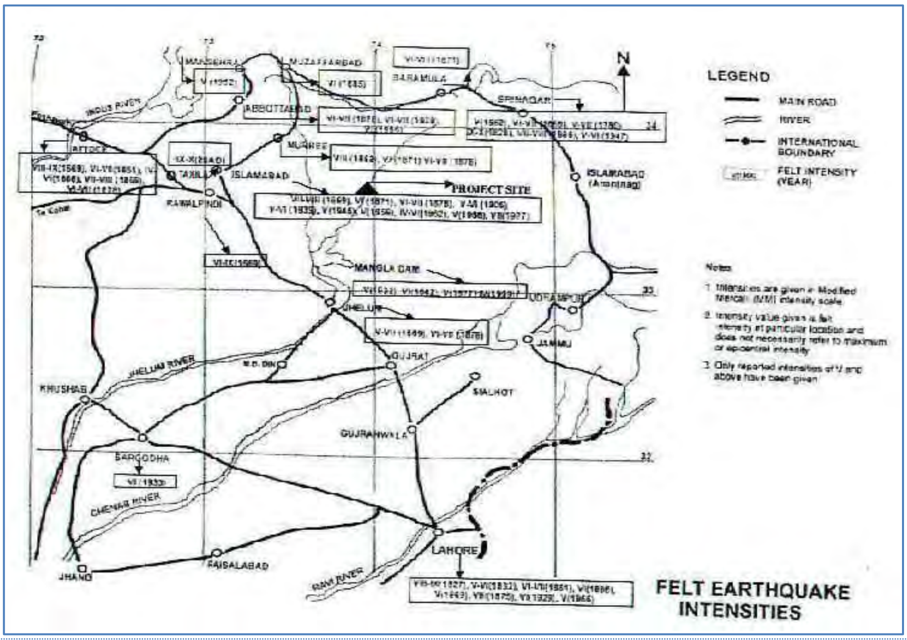


Figure 5: Felt Earthquake Intensities

A chronological list of available intensity data of the earthquakes occurred in the Project region before the present instrumental recordings started in 1904 is given in **Table 1**.

Table 1: Historical Earthquakes in the Project Region

Sr. No.	*Year*	*Date*	*Description*	*Estimated Intensity MM*	*Source*
1	4^{th} Century BC		Aristobulus of Cassandreia, who accompanied Alexander on his expedition to India, points out that the country above the river Hydaspes (Jhelum) is subjected to earthquakes which cause the ground to open up so that even the beds of river are changed.	IX-X	Ambraseys
2	25 AD		A destructive earthquake in north-western Pakistan laid Taxila in ruins and caused wide spread havoc throughout the country side. The effects of this earthquake can still be seen among the excavated remains at Jandial, Sirkap and Dharmarajika. As result of the earthquake new methods of buildings were introduced and the height of buildings was reduced from four to two storeys with special precautions to make the foundation secure.	IX-X	Q&J
3	1669	4-Jun	Strongly felt in Mandra	VI-X	Q&J

Sr. No.	Year	Date	Description	Estimated Intensity MM	Source
4	1669	23-Jun	An earthquake at Attock, a fissure 50 yards long was formed in the ground.	VIII-IX	Q&J
5	1827	24-Sep	Destructive in Lahore region. Fort Kolitaran near city destroyed, about 1000 perished in ruins. A hill shaken down, which fell into river Rowee (Ravi) produced an inundation of 100 coss of land.	VIII-IX	Q&J
6	1831		Peshawar & valley of Indus – Severe, extended from Peshawar to Dera Ghazi Khan, felt most at Dera bank (Darban); men and camels unable to stand, rocks fell in many places, water forced from crevices in the plains.	Daraban VIII-IX Peshawar & D.G. Khan IV-VI	Q&J
7	1832	22-Jan	Near Lahore-violent, people all rushed out of houses.	V-VI	
8	1832	21-Feb	Lahore, valley of Badakhshan, N.W. India huge masses of rock was thrown from the cliffs at many places chocking up valleys. Great part of population destroyed.	Lahore V-VI Mangla V	
9	1842	19-Feb	Kabul, Peshawar. At Kabul said to have lasted for 3 minutes, several shocks, rocked the fouth in a frightful manner. At Peshawar very destructive, "earth-trembled like aspen leaf" several killed. At Ferozpur severe. At Ludhiyana north south, the hot springs of South (temp. 140 deg-110 deg) become as cold as the ordinary wells, water diminished greatly and at times the springs were completely dry. These appearances continued for 25 days.	Kabul	Q&J
				VI-VII Peshawar VI Ferozpur VI	
10	1851	4-Feb	Lahore, appears to have extended all over Punjab.	Lahore V-VI	
11	1851	6-Feb	Lahore, appears to have extended all over Punjab.	Lahore V-VI	
12	1851	17-Feb	Strongly felt in Lahore, Multan	Lahore V-VI	
13	1853	Nov.	Strongly felt in Attock	VI	Q&J
14	1858	29-Aug	Lahore-sharp shocks	Lahore IV-V	
15	1865	22-Jan	Slight damage and great panic in Peshawar, long duration.	V-VII	
16	1865	4-Dec	Lahore – tow smart shocks	III-V	
17	1867	10-Nov	Damaging in Bannu	VII-VIII	Q&J
18	1868	11-Aug	Damaging in Peshawar, a portion of the fort was shaken down (official record).	VII-VIII	Q&J
19	1868	12-Nov	Violent shock felt in Lahore, Dera Ismail Khan and Attock, followed by many aftershocks which were felt throughout the Punjab.	Attock IV-VI & D.I. Khan IV-VI	Q&J
20	1869	24-Mar	Severe shock in the upper reaches of Jhelum	V-VII	Q&J
21	1869	25-Mar	A large earthquake in the Hindukush, strongly felt at Kohat, Lahore, Peshawar and at Khojend and Tashkent; shocking lasting 20 seconds.	Kohat, Lahore & Peshawar V	NESPAK

Sr. No.	Year	Date	Description	Estimated Intensity MM	Source
22	1869	April	Peshawar – Part of fort shaken down (official record).	VII-VIII	Q&J
23	1869	20-Dec	Rawalpindi – Shock said to have lasted for 1/2 a minute; cracked walls and caused all people to run out of houses. Attock – A series of shocks at intervals of about 20 sec. Lawrencepur – Ist shocks 15 sec others at 5 sec. interval. Campbellpur – For half an hour; building much damaged. Talagang – Not felt	VII-VIII	Q&J
24	1871	April	Severe at Rawalpindi and Murree; originating from Kashmir	Rawalpindi & Murree VI	Q&J
25	1875	12-Dec	Damaging in villages between Lahore and Peshawar where a number of people were killed.	VII-VIII	Q&J
26	1878	2-Mar	Damaging earthquake in the Punjab. At Kohat several houses, public buildings and portion of the wall of the fort fell. At Peshawar, it caused damage to houses and city walls. Damaging at Attock, Abbottabad, Rawalpindi, Jhelum, Murree. Strongly felt at Bannu, Nowshera, Mardan, Lahore and Simla. Many aftershocks.	Peshawar & Kohat VII-VIII, Attock VI-VII, Lahore VI	
27	1883	April	Damaging shock at Peshawar.	VI-VIII	Q&J
28	1885	30-May	Destructive shock in Kashmir, Sopor, Gulmarg and Srinagar about totally ruined and 3,000 people killed. Heavy damage at Gurias and Punch: Muzaffarabad heavily damaged. Felt in Peshawar, Lahore, Simla, Leh, Kanpalu, and Gilgit. Radius of perceptibility about 650 km. Many aftershocks.	Kashmir VIII, Muzaffarabad VI-VII, Peshawar IV	Q&J
29	1893	3-Nov	Slight damage at Peshawar, Nowshera, felt throughout the Punjab	VI-VII	Q&J
30	1905	4-Apr	Kangra earthquake, in Rawalpindi few lofty buildings cracked, some damage in Lahore.	Kangra VIII Rawalpindi V-VI	Q&J
31	1929	1-Feb	Destructive earthquake, perhaps shallower than calculated, ruin Skorzor and Drosh. Damage was equally heavy in the USSR at Kulyab. It caused substantial damage in Abbottabad, Peshawar, Cherat, Gurez, Chitral and Dushambe. It was felt within a radius area of 1,000 km.	Abbottabad & Peshawar VI-VII	NESPAK
32	1939	21-Nov	Destructive in the Badakhshan area, the damage extending to Srinagar, Rawalpindi and Kargil. Drosh was seriously damaged. Felt within a radius of 600 km.	Rawalpindi V-VI	NESPAK
33	1945	27-Jun	Felt in Peshawar	IV	NESPAK
34	1945	22-Jun	Destructive at Chamba and parts of Kahsmir. Strongly felt at Rawalpindi, Peshawar, Lahore and Simla.	Rawalpindi V	NESPAK
35	1953	1-Mar	Slight damage in Cambellpur	VI-VII	Q&J
36	1956	16-Sep	Destructive in the Ghazi district in Afghanistan where many villages were destroyed and animals lost. The damage was equally serious at Said Karem. Cause panic at Kohat. Strongly felt at Parachinar, Parwan, Loger, Ghaiz, Nazerajat, Beshud, Makur, Rawalpindi and Rawalpindi	Rawalpindi V	NESPAK

Sr. No.	Year	Date	Description	Estimated Intensity MM	Source
			Srinagar. Radius of perceptibility about 450 km.		
37	1962	2-Aug	Felt at Rawalpindi	IV-VI	Q&J
38	1966	11-Jan	Felt at Risalpur	IV	NESPAK
39	1966	2-Feb	Strongly felt around Abbottabad where it caused minor damage at Havelian. Felt at Rawalpindi, Islamabad, Abbottabad, Taxila. The shock was felt at Muzaffarabad and Gujar Khan.	Abbottabad VI Islamabad V Taxila VI	Q&J
40	1977	14-Feb	About 7 km northeast of Rawalpindi caused damage in 20 villages. In villages Kuri, Malot and Pindi Begwal around Nilour most of the “Katcha” houses either collapsed or damaged. A few houses built with dressed blocks of sandstone and sand-cement mortar also developed extensive cracks.	VII	NESPAK
41	1978	7-May	Felt widely at Punjab and NWFP Provinces. Some damage at Peshawar and Chitral.	Mangla IV Tarbela VI	WAPDA
42	1980	12-Feb	Felt widely in the areas of Punjab and NWFP.	Mangla IV Tarbela V	WAPDA
43	1983	31-Dec	Felt widely in the areas of Punjab and NWFP. Damages at Peshawar, Chitral and many northern areas. Some damage near Tarbela also. Felt in parts of Afghanistan also.	Chitral VII Peshawar VI Rawalpindi V Tarbela V Mangla III	WAPDA
44	1996	4-Apr	Felt widely in the areas of Punjab and NWFP. Some damages at Peshawar, Chitral and Northern Areas. Some damage near Tarbela also. Felt also in parts of Afghanistan.	Chitral VI Peshawar V Rawalpindi IV Mangla III Lahore & Jhelum III	WAPDA
45	1999	17-Feb	Epicenter near Mangla. Felt also in the adjoining areas.	Mangla IV	WAPDA

Instrumental Seismicity

The instrumental recording of earthquakes started in 1904 but the number of seismic stations remained small in South Asian Region until 1960 when the installation of high quality seismographs under World Wide Standard Seismograph Network (WWSSN) increased the quality of earthquake recording. In addition, local microseismic networks were also established at important dams and other projects in Pakistan. In the present seismic studies, two classes of instrumental earthquake data have been used. The first one is based upon earthquakes recorded by local seismic networks and the other is compiled from regional data catalogues.

Seismicity Recorded by Local Networks

Near the Project site, an independent telemetry microseismic network belonging to Mangla Dam Project is functioning. Initially, it comprised of three stand-alone stations since 1966. However, in 1993, it was replaced with a more modern microseismic network having thirteen field seismic stations out of which seven have been put to operation. The Central Recording Station (CRS) is installed near the left abutment of the main embankment of Mangla dam. The microseismicity recorded by Mangla Dam network is shown in **Figure 6**.

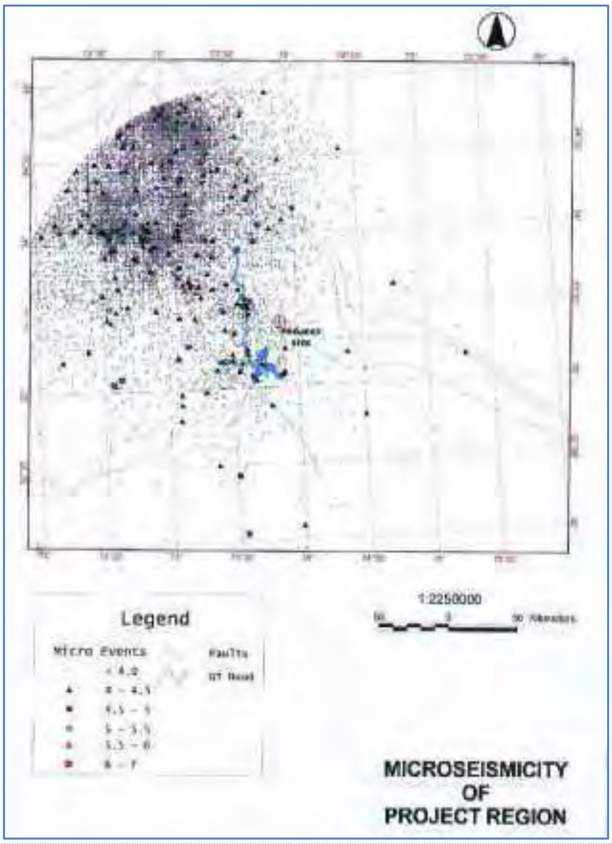


Figure 6: Microseismicity of the Project Region

Seismicity Recorded by Regional Networks

The regional seismic data catalogue being used in the study is compiled on the basis of seismic events listed since 1904 by various agencies like British Association for the Advancement of Science (BAAS), International Seismological Centre (ISC), International seismological summary (ISS), United States Geological Survey (USGS) and others. It consists of a list of 594 earthquakes among which 331 earthquakes have magnitude more than or equal to 4 within a radius of about 200 km from project site.

Composite Earthquake Catalogue

A composite list of earthquakes recorded within about 200 km of the Project site was prepared from the data collected from regional as well as microseismic networks mentioned above. This list contains all the earthquakes recorded in area between latitude 32.0o-35.0oN and longitude 72.0o-76.0oE. This list is presented in **Table 2**. The epicenters of these earthquakes are plotted in **Figure 7**.

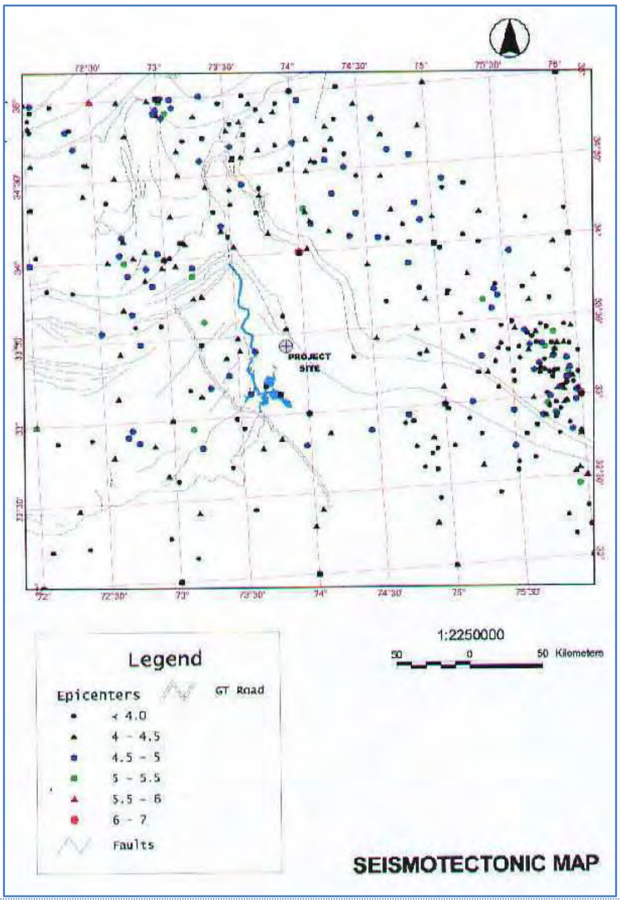


Figure 7: Seismotectonic Map of the Project Region

Table 2: Composite List of Recorded Earthquake Data

Sr No	*Date*			*Time*	*Latitude*	*Longitude*	*Depth*	*Magnitude*			*Source*
	Year	*Month*	*Day*	*GMT*	*N*	*E*	*Km*	*mb*	*MS*	*ML*	
1	1905	4	4	00:50:00.00	33.0000	76.0000	35	6.8	8.0		PAS
2	1928	11	14	04:33:09.00	35.0000	72.5000	110	5.6	6.0		PAS
3	1937	11	7	19:07:40.00	35.0000	73.0000	100	5.5	5.8		PAS
4	1945	6	22	18:00:57.00	32.5000	76.0000	60	5.9	6.5		PAS
5	1964	2	13	05:10:47.20	34.9900	72.7000	68	4.5			ISC
6	1964	7	3	14:10:27.80	34.1500	74.9100	33	4.9			ISC
7	1964	12	31	08:21:11.00	34.9000	73.0000	131	4.4			ISC
8	1965	10	9	04:34:22.00	32.3000	74.0000	79	4.5			USCGS
9	1965	11	8	21:23:09.40	34.6000	73.3000	65	4.6			USCGS
10	1966	2	2	09:20:09.30	33.8900	73.2000	37	5.1			ISC
11	1966	3	16	00:08:17.30	33.2300	75.9100	33	4.7			ISC
12	1966	4	6	01:51:53.20	34.9100	73.0600	54	5.1			ISC
13	1967	2	10	05:46:29.00	33.2800	75.2900	21	4.8			ISC
14	1967	2	20	14:23:48.70	33.6900	75.4200	38	4.8			ISC
15	1967	2	20	15:18:39.00	33.6300	75.3300	20	5.5			ISC
16	1967	2	20	15:39:54.40	33.4800	74.8300	96	4.0			ISC
17	1967	2	21	12:37:43.00	33.6500	75.4400	20	4.9			ISC
18	1967	2	24	00:17:38.80	33.5700	75.3900	32	4.6			ISC
19	1967	7	2	08:32:39.70	33.2100	75.7100	42	4.8			ISC
20	1968	3	3	09:31:21.60	34.7100	72.3600	43	5.0			ISC
21	1968	7	3	19:46:55.00	34.8000	74.6000	88	4.6			ISC
22	1969	1	23	20:01:21.00	32.1900	76.0000	64	3.9			ISC
23	1970	1	2	20:01:02.00	32.5000	76.0000	96	4.1			ISC
24	1970	4	28	14:12:32.00	32.8000	74.9000	116	4.5			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
25	1970	4	28	15:11:47.70	32.9000	74.7000	126	3.5			ISC
26	1970	4	30	03:24:54.30	33.2600	73.4300	33	4.8			ISC
27	1970	6	11	10:30:39.90	33.1100	75.0000	72	4.5			ISC
28	1970	9	7	21:19:09.00	33.0000	75.2000	54	4.6			ISC
29	1970	12	5	17:51:54.00	33.9000	74.5000	75	4.3			ISC
30	1971	4	28	15:12:42.62	34.4449	73.5973	43	4.8			ISC
31	1971	12	27	20:59:39.26	34.9776	73.0234	55	5.2			ISC
32	1972	1	8	01:30:35.00	34.7000	74.1000	96	4.0			ISC
33	1972	3	10	14:36:16.95	33.9073	72.7158	40	4.9			ISC
34	1972	4	17	02:24:50.14	33.9487	72.8622	52	4.8			ISC
35	1972	9	27	02:03:39.00	33.9910	72.6996	41	5.1			ISC
36	1973	1	16	21:31:25.86	33.2922	75.8320	39	5.1			ISC
37	1973	4	10	00:10:02.88	33.1703	75.7460	61	4.4			ISC
38	1973	7	13	22:03:38.06	33.1732	75.6747	48	4.8			ISC
39	1973	7	13	22:54:27.85	33.1819	75.7057	55	4.4			ISC
40	1973	10	24	05:23:51.34	33.1479	75.9166	37	5.3			ISC
41	1973	10	24	19:57:17.09	33.1167	75.9269	48	4.9			ISC
42	1973	12	16	19:09:46.94	34.2686	74.0466	40	5.1			ISC
43	1974	3	25	13:44:05.79	33.7003	72.6774	39	4.4			ISC
44	1974	3	26	04:45:54.73	33.8805	72.8457	72	4.1			ISC
45	1974	4	12	10:32:48.23	33.5311	73.8677	50	4.4			ISC
46	1974	5	20	17:39:19.59	34.5632	74.2327	49	4.8			ISC
47	1974	8	1	19:54:11.76	33.4410	74.5294	0	4.5			ISC
48	1974	8	11	17:21:00.02	34.8828	73.2713	33	4.1			ISC
49	1974	12	28	22:38:53.24	34.9946	73.1013	68	4.8			ISC
50	1975	1	20	09:28:00.68	34.9363	73.1054	63	4.6			ISC
51	1975	4	7	06:41:02.95	34.9085	72.9663	53	5.0			ISC
52	1975	10	17	10:46:09.30	34.2535	74.0640	77	4.1			ISC
53	1975	10	30	14:20:54.36	32.8923	75.7092	75	4.7			ISC
54	1975	10	30	14:36:44.40	32.9700	75.9583	45	4.8			ISC
55	1975	12	10	05:03:47.30	32.7871	75.9180	76	4.7			ISC
56	1976	1	9	23:50:16.49	32.7799	75.9813	96	4.5			ISC
57	1976	2	25	07:45:23.79	33.3444	74.8921	51	4.5			ISC
58	1976	5	22	18:32:53.58	33.0491	75.8290	71	4.4			ISC
59	1977	1	21	14:57:46.38	32.7601	75.9826	51	4.5			ISC
60	1977	2	14	00:22:37.80	33.5967	73.2669	27	5.2			ISC
61	1978	4	12	02:10:16.20	33.7184	75.4263	33	3.8			ISC
62	1978	4	27	18:12:24.79	35.0022	73.0280	58	4.9			ISC
63	1978	5	7	10:32:25.57	33.3964	73.6306	25	5.0	4.4		ISC
64	1978	5	16	06:31:57.14	33.1817	75.3309	96	4.1			ISC
65	1978	5	17	08:39:15.29	32.8934	75.7301	96	4.0			ISC
66	1978	11	18	01:35:00.00	32.8740	72.7513	39	4.6			ISC
67	1979	3	4	02:51:47.95	33.9436	73.1959	42	4.7			ISC
68	1979	7	2	16:27:04.29	34.7364	74.9361	74	4.4			ISC
69	1979	7	2	16:30:47.22	34.5062	74.3684	89	4.6			ISC
70	1979	12	4	04:05:42.07	34.1725	74.0963	33	4.7			ISC
71	1979	12	22	22:28:44.99	33.1078	75.8963	18	4.8	4.1		ISC
72	1980	2	5	20:17:56.85	33.2496	75.8083	33	4.2			ISC
73	1980	2	9	18:23:01.17	32.7900	72.5576	27	4.1			ISC
74	1980	3	29	02:02:53.68	32.7961	73.9736	18	4.7			ISC
75	1980	3	29	07:12:56.39	33.1427	73.2231	30	4.5			ISC
76	1980	5	1	05:43:10.65	33.0264	75.9745	18	4.9	3.8		ISC
77	1980	7	27	11:24:00.24	34.6240	72.0444	53	4.0			ISC
78	1980	8	23	21:36:49.04	32.9637	75.7509	3	5.2	4.9		ISC
79	1980	8	23	21:50:01.20	32.9023	75.7974	13	5.2	4.9		ISC
80	1980	10	5	10:47:18.67	34.6882	74.2892	33	4.1			ISC
81	1981	2	6	09:54:01.40	34.3459	72.0258	263	3.8			ISC
82	1981	6	23	19:54:02.10	34.2608	74.8815	33	4.8			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
83	1981	7	4	03:49:25.77	34.3555	75.2542	209	3.7			ISC
84	1981	8	17	09:11:15.75	33.4165	75.6202	6	4.9	3.8		ISC
85	1981	9	27	11:10:42.48	33.2954	75.6352	33	4.5			ISC
86	1981	11	9	19:31:02.47	33.3267	75.8524	33	4.5			ISC
87	1981	12	14	18:25:39.23	33.1881	75.7226	21	4.5			ISC
88	1982	1	17	12:17:37.86	34.5236	73.9030	33	3.9			ISC
89	1982	4	3	22:39:21.98	33.3664	73.4204	3	4.1			ISC
90	1982	9	8	17:53:18.54	32.9277	75.4959	33	4.8			ISC
91	1982	10	25	08:16:27.39	34.0589	73.5200	83	4.3			ISC
92	1983	1	18	13:45:30.03	34.3461	74.2660	33	4.8			ISC
93	1983	5	30	08:39:49.37	32.7136	75.4850	41	4.6			ISC
94	1983	10	12	02:44:42.23	33.7596	75.7209	33	4.5			ISC
95	1984	2	18	07:08:56.67	34.3491	72.0208	33	4.1			ISC
96	1984	4	21	20:34:20.58	34.9902	73.6360	10	3.8			ISC
97	1984	5	23	03:14:17.66	33.1703	75.9302	14	4.8			ISC
98	1984	6	4	05:03:50.16	34.8752	73.0254	52	4.6			ISC
99	1984	8	15	05:31:04.62	34.9020	74.4680	53	4.5			ISC
100	1984	12	20	07:32:07.23	32.9495	72.6961	37	4.6			ISC
101	1984	12	27	20:22:05.91	32.9062	72.6691	22	4.6			ISC
102	1984	12	28	16:28:01.63	34.6108	73.6090	47	4.5			ISC
103	1985	2	25	18:56:07.72	34.2191	74.4430	44	4.6			ISC
104	1985	4	23	12:23:56.07	32.8225	73.2092	64	4.6			ISC
105	1985	8	10	12:56:13.90	33.8905	74.8008	41	4.6			ISC
106	1986	4	25	06:30:50.46	34.8207	73.5379	33	3.9			ISC
107	1986	5	16	05:16:13.70	34.0000	72.5800	15	4.3		4.0	ISC
108	1986	7	10	07:56:12.00	34.1500	72.6900	2	4.7		4.5	ISC
109	1986	7	30	04:03:27.18	33.0499	75.8544	61	4.6			ISC
110	1986	9	19	11:15:38.56	34.2749	73.0635	64	4.4			ISC
111	1987	3	16	06:09:36.61	34.8302	72.3380	212	3.7			ISC
112	1987	7	12	12:19:18.59	33.4897	73.5054	22	4.4	3.3		ISC
113	1988	1	9	01:16:12.48	34.4401	73.3257	95	4.4			ISC
114	1988	1	20	11:48:33.40	34.6956	74.6575	33	4.3			ISC
115	1988	1	21	10:26:48.69	34.7349	73.1783	33	3.4			ISC
116	1988	11	25	00:07:07.45	32.8931	75.8088	80	4.8			ISC
117	1988	12	7	21:13:54.99	33.9486	72.9770	50	4.4			ISC
118	1989	4	7	05:43:24.49	33.7463	73.2029	43	4.3			ISC
119	1989	5	7	10:19:33.68	32.2303	72.3548	33	3.9			ISC
120	1989	5	10	20:05:28.01	33.3402	75.6956	33	3.9			ISC
121	1989	5	10	20:19:21.56	33.3270	75.6545	37	4.7	4.0		ISC
122	1989	9	7	07:42:36.94	34.7668	74.2484	147	4.4			ISC
123	1989	12	5	02:46:11.18	34.8303	73.7770	33	4.2			ISC
124	1990	3	3	05:53:37.96	32.8660	74.1490	10	4.3			ISC
125	1990	3	6	14:43:08.50	33.2381	75.3939	10	3.8			ISC
126	1990	3	15	17:33:27.92	34.5038	74.0883	33	4.5			ISC
127	1990	4	26	15:39:18.31	34.5983	73.5383	33	4.2			ISC
128	1990	9	7	01:57:55.58	34.1017	73.1395	33	4.0			ISC
129	1990	10	9	21:56:38.54	34.0921	73.1564	33	4.4			ISC
130	1990	11	12	15:45:19.76	33.2544	75.8220	67	4.8			ISC
131	1990	12	20	05:46:48.57	34.4392	74.6409	33	4.3			ISC
132	1990	12	25	03:56:46.06	33.3059	75.7558	51	5.3	4.5		ISC
133	1991	1	10	01:33:22.37	34.0152	74.8202	33	3.9			ISC
134	1991	3	16	03:57:42.41	34.5221	72.6623	33	4.5			ISC
135	1991	5	17	17:04:30.87	34.9251	73.8863	33	3.9			ISC
136	1991	5	24	15:38:03.11	34.9778	72.2006	210	3.4			ISC
137	1991	12	18	14:17:21.95	32.8030	73.6496	42	4.2			ISC
138	1992	1	6	19:07:13.99	34.0237	74.0587	34	4.3			ISC
139	1992	2	6	18:47:03.05	34.7764	72.7539	33	4.0			ISC
140	1992	3	24	21:01:47.77	33.8365	72.9023	14	4.9	4.4		ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
141	1992	4	17	12:42:58.71	34.1295	72.7016	13	4.2			ISC
142	1992	6	19	23:02:35.62	32.2247	72.0831	33	3.8			ISC
143	1993	2	17	16:06:07.62	33.5623	72.5114	26	4.9	4.3		ISC
144	1993	5	15	07:27:12.14	34.8269	72.0362	33	3.8			ISC
145	1993	5	15	08:14:04.96	34.9046	72.0295	33	3.8			ISC
146	1993	6	8	14:30:37.83	33.6669	72.7367	32	4.8			ISC
147	1993	7	2	21:03:59.63	34.1576	73.4272	19	4.3			ISC
148	1993	7	12	01:27:51.90	33.3303	75.9049	33	4.0			ISC
149	1993	9	15	15:08:14.79	33.3314	75.7436	44	5.0	4.3		ISC
150	1993	11	13	00:01:40.54	34.3166	73.5060	33	3.9			ISC
151	1994	4	15	09:44:21.37	34.5578	74.1278	58	4.5			ISC
152	1994	5	13	09:19:52.17	32.5496	75.9544	33	4.3			ISC
153	1994	8	4	22:43:10.32	33.8449	72.1197	28	3.8			ISC
154	1994	12	19	03:22:18.05	34.0508	72.0483	33	3.9			ISC
155	1995	9	26	20:31:54.64	32.2679	74.8940	0	4.2			ISC
156	1995	12	8	21:00:25.17	33.4263	72.6422	10	4.1			ISC
157	1995	12	30	23:40:16.95	34.8482	72.0314	33	3.8			ISC
158	1996	2	14	01:52:22.94	34.9863	73.0220	30	3.9			ISC
159	1996	2	20	02:55:52.66	34.0396	72.6740	46	4.7	4.2		ISC
160	1996	3	25	06:31:20.76	33.1437	73.5821	16	4.6	3.5		ISC
161	1996	4	21	01:09:48.70	34.7841	73.5142	34	4.0			ISC
162	1996	5	5	10:21:23.30	33.5900	72.7600	0	3.7			EIDC
163	1996	5	15	15:02:06.43	33.1462	75.8056	58	3.5			ISC
164	1996	5	24	16:23:44.70	34.4198	72.4188	55	4.1			ISC
165	1996	8	8	14:58:19.85	34.0425	72.9533	21	4.8	4.2		ISC
166	1996	8	17	15:48:02.76	33.4550	75.4542	78	3.2			ISC
167	1996	8	25	05:13:25.20	34.1200	75.6900	0	3.8			EIDC
168	1996	9	8	10:47:15.70	33.8220	72.3103	33	3.6			ISC
169	1996	9	23	11:13:11.52	33.3954	75.6388	33	3.5			ISC
170	1996	11	28	22:56:33.30	32.2700	72.9400	85	3.6			EIDC
171	1996	12	14	09:48:39.36	34.2335	74.7044	33	4.0			ISC
172	1996	12	16	17:59:35.16	33.1416	75.9892	46	3.4			ISC
173	1997	1	19	13:59:24.10	33.6811	75.0662	33	3.6			ISC
174	1997	4	12	05:35:24.18	33.4529	75.7405	33	3.4			ISC
175	1997	5	19	22:21:49.17	34.6110	72.4376	16	3.8			ISC
176	1997	5	31	19:20:21.03	34.8346	73.6131	57	4.4	3.9		ISC
177	1997	7	2	12:01:58.75	34.4141	73.7255	33	3.8			ISC
178	1997	7	21	17:24:49.30	32.9030	72.3950	0	3.8			EIDC
179	1997	7	29	09:43:35.67	32.8482	73.7897	7	4.0	3.1		ISC
180	1997	8	28	01:15:41.20	33.7600	73.2600	15	4.5		4.3	BJI
181	1997	9	5	15:41:52.39	33.9647	73.0764	24	4.0			ISC
182	1997	10	25	12:20:34.30	34.2825	73.3834	0	3.6			EIDC
183	1997	12	7	18:59:50.80	32.9700	75.0200	33	3.2		2.7	NDI
184	1997	12	23	04:15:04.96	33.8045	75.2336	33	4.0			ISC
185	1997	12	27	12:38:20.70	33.9600	75.8800	26	4.1		3.8	BJI
186	1998	3	18	13:35:22.56	35.0082	74.3500	102	3.7			ISC
187	1998	3	24	04:25:43.89	32.3976	74.0587	54	4.0	3.6		ISC
188	1998	5	10	09:42:23.20	34.3737	72.5867	0	3.8			EIDC
189	1998	5	18	12:29:31.78	33.1574	75.8387	65	3.5			ISC
190	1998	5	24	13:22:28.84	34.5864	74.3820	33	3.6			ISC
191	1998	5	29	19:11:05.14	34.1016	73.1230	33	3.9			ISC
192	1998	6	7	08:20:35.68	34.0109	73.0408	33	3.5			ISC
193	1998	6	8	12:22:07.70	34.5535	74.1551	0	3.6	3.3		EIDC
194	1998	7	6	22:50:49.32	33.0806	75.9018	23	3.7			ISC
195	1998	7	6	10:24:06.24	32.9384	75.7640	59	3.8			ISC
196	1998	7	12	05:45:02.41	34.0217	72.7723	66	4.5			ISC
197	1998	8	17	17:55:01.86	33.1524	75.7102	33	3.5			ISC
198	1998	8	21	01:58:36.26	34.3694	73.7272	64	4.0			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
199	1998	9	28	15:28:01.46	34.1280	74.7807	33	3.7			ISC
200	1998	9	28	18:10:55.53	34.0470	74.6599	33	3.5			ISC
201	1998	11	9	17:52:55.24	34.9465	72.0533	122	3.6			NDI
202	1999	1	5	03:06:05.90	33.1180	75.7970	10	2.7			NDI
203	1999	1	11	00:35:08.90	32.3080	75.9890	5	1.7			NDI
204	1999	1	13	15:01:36.90	34.6720	73.8730	272	3.4			NDI
205	1999	2	12	16:30:49.90	32.9333	73.5163	0	3.6			NDI
206	1999	2	17	03:02:13.22	33.1290	73.7990	3	4.0			ISC
207	1999	2	21	15:14:56.50	32.8330	75.8980	10	2.1			NDI
208	1999	2	23	06:56:13.89	34.0570	74.5920	25	4.8	3.9		ISC
209	1999	2	24	09:59:18.50	33.9850	75.3320	33	2.9			NDI
210	1999	2	28	00:38:02.90	32.6860	73.4220	10	2.7			NDI
211	1999	2	28	10:53:26.30	32.9550	75.8090	10	2.2			NDI
212	1999	2	28	23:28:09.60	32.8690	75.7980	10	2.1			NDI
213	1999	3	1	01:00:06.93	33.5470	75.1620	10	3.9			ISC
214	1999	4	2	10:48:07.90	33.1760	73.6940	81	3.0			NDI
215	1999	4	7	00:43:50.00	32.9220	75.8390	0	2.9			NDI
216	1999	4	9	17:59:22.40	33.1690	75.5170	5	2.7			NDI
217	1999	4	12	04:11:30.40	33.0150	75.7520	6	2.0			NDI
218	1999	4	21	06:32:17.50	32.8310	75.6600	15	3.8		3.4	NDI
219	1999	4	22	05:22:04.80	32.9960	75.7680	7	4.9			NDI
220	1999	4	22	07:19:30.40	33.1750	75.2610	6	3.7		3.3	NDI
221	1999	4	24	04:38:33.80	32.4710	72.2880	1	4.3			NDI
222	1999	4	28	13:00:43.80	33.4810	72.7930	15	5.0		5.2	NDI
223	1999	4	28	13:00:47.25	33.1900	73.2910	17	4.9	3.6		ISC
224	1999	5	8	20:59:17.40	33.4420	75.9120	15	2.7			NDI
225	1999	5	14	09:05:56.70	34.6520	73.7420	2	4.1			NDI
226	1999	5	14	09:06:00.60	33.1750	73.1360	33	3.7			ISC
227	1999	5	17	17:45:40.30	32.5590	75.5030	33	2.0			NDI
228	1999	7	12	17:43:53.30	34.4450	74.4590	33	3.0			NDI
229	1999	7	12	21:45:50.80	33.6120	75.6740	18	4.1		3.8	NDI
230	1999	7	12	21:45:58.71	33.1560	75.8170	66	3.7			ISC
231	1999	7	13	03:17:29.40	32.7760	75.5810	33	3.7			NDI
232	1999	7	15	04:29:33.45	32.6610	72.9510	36	4.2	3.5		ISC
233	1999	7	15	04:29:35.50	32.8460	72.8610	33	4.5		4.1	NDI
234	1999	7	30	19:55:08.90	33.1120	75.5240	38	2.0			NDI
235	1999	8	24	05:39:18.00	32.4200	73.5670	17	3.1			NDI
236	1999	9	18	16:30:02.50	32.9630	75.8670	9	4.1		3.8	NDI
237	1999	10	25	18:12:17.60	32.4340	75.3610	15	2.9			NDI
238	1999	10	29	01:23:03.60	33.4770	75.5290	10	3.1			NDI
239	1999	10	29	23:31:37.10	34.1880	74.0940	15	4.2		3.9	NDI
240	1999	10	31	19:03:05.90	34.9870	72.9250	33	4.2		3.8	NDI
241	1999	11	29	14:31:19.48	33.0040	75.6470	33	4.2			ISC
242	2000	1	16	12:00:57.95	33.2650	75.8240	39	4.0			ISC
243	2000	2	22	17:53:43.31	33.4280	75.7760	15	3.5			ISC
244	2000	2	25	22:23:37.70	33.2340	75.7450	33	2.2			NDI
245	2000	3	17	07:41:42.20	33.3520	75.4380	5	2.5			NDI
246	2000	4	8	12:47:00.30	33.7010	75.0800	6	2.9			NDI
247	2000	4	26	12:15:21.26	34.0390	75.2200	43	3.5			ISC
248	2000	5	28	14:52:01.31	33.7340	74.8650	58	3.7			ISC
249	2000	7	8	14:22:41.60	34.4050	73.5070	33	3.0			NDI
250	2000	7	10	23:32:27.40	33.3340	74.3460	15	2.7			NDI
251	2000	7	12	07:51:40.40	33.0640	75.8710	5	2.3			NDI
252	2000	7	15	00:45:12.20	33.3180	75.5730	20	2.8			NDI
253	2000	7	17	05:26:11.45	34.9320	72.9900	52	4.8	3.8		ISC
254	2000	7	23	23:13:40.50	32.7990	75.2530	33	2.5			NDI
255	2000	7	24	12:53:30.20	32.1380	75.8910	18	2.4			NDI
256	2000	7	27	01:47:06.70	33.6090	73.8450	0	2.8			NDI

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
257	2000	8	11	03:46:44.40	32.6050	75.5110	48	2.9		2.3	NDI
258	2000	8	14	14:46:11.80	33.0770	75.4000	14	2.7			NDI
259	2000	8	23	14:32:44.70	34.0750	74.3830	33	4.7			NDI
260	2000	8	24	01:29:08.60	33.3190	75.4200	33	3.0			NDI
261	2000	8	28	00:32:11.20	33.4440	75.2430	7	2.7			NDI
262	2000	8	31	22:46:36.70	34.1240	73.4810	33	3.2			NDI
263	2000	9	5	14:04:28.90	33.9730	75.0360	33	2.9			NDI
264	2000	9	6	02:53:03.49	34.3400	75.0920	33	3.7			ISC
265	2000	9	7	21:58:41.80	33.3240	74.8350	26	3.4			NDI
266	2000	9	26	19:39:24.95	33.4090	75.6960	9	4.4			ISC
267	2000	10	2	05:41:54.00	35.0000	76.0000	0	5.1			NDI
268	2000	10	28	16:47:01.90	32.6010	74.9060	35	2.4			NAO
269	2000	10	28	23:53:13.10	32.9040	75.1710	33	2.6			NAO
270	2000	12	22	16:55:58.20	33.3190	75.9430	5	2.9			NAO
271	2000	12	27	00:40:16.40	33.2670	75.9950	0	2.7			NAO
272	2001	1	2	04:49:27.00	32.0000	75.0000		3.7			NAO
273	2001	1	3	21:35:23.00	32.0000	75.0000		4.1			NAO
274	2001	1	5	21:35:23.00	34.0000	76.0000		4.0			NAO
275	2001	1	8	09:01:51.60	33.6910	75.6250	33	3.9		3.5	NAO
276	2001	1	8	09:01:53.85	33.4260	75.9610	38	4.0			ISC
277	2001	1	8	09:06:19.40	33.2470	75.5730	15	2.9			NDI
278	2001	1	9	03:12:27.80	33.7670	75.9670	33	2.8			NDI
279	2001	1	9	07:19:37.00	32.0000	75.0000		3.8			NAO
280	2001	1	14	04:19:20.00	33.0000	76.0000		4.3			NAO
281	2001	1	16	10:36:58.00	33.0000	75.0000		4.3			NAO
282	2001	1	20	01:15:36.00	34.0000	72.0000		3.7			NAO
283	2001	1	21	01:24:50.00	33.0000	75.0000		4.0			NAO
284	2001	1	21	08:13:25.14	34.9500	73.4590	33	3.7			ISC
285	2001	1	23	12:01:07.00	33.0000	73.0000		4.2			NAO
286	2001	1	24	12:23:53.30	32.6310	75.6330	5	2.7			NDI
287	2001	1	24	19:49:44.50	32.7720	75.8240	33	2.7			NDI
288	2001	1	25	19:23:58.00	33.0000	74.0000		3.5			NAO
289	2001	1	31	04:18:05.00	34.0000	74.0000		2.7			NAO
290	2001	2	2	21:22:59.00	32.0000	72.0000		4.0			NAO
291	2001	2	4	10:14:08.44	33.2860	75.8310	19	4.3	3.6		NAO
292	2001	2	9	03:00:56.80	34.5520	73.9600	45	3.8			ISC
293	2001	2	9	18:17:51.00	33.0000	72.0000		3.9			NAO
294	2001	2	10	01:27:06.00	34.0000	76.0000		3.9			NAO
295	2001	2	10	03:46:16.00	32.0000	75.0000		4.5			NAO
296	2001	2	10	18:57:34.00	32.0000	75.0000		3.7			NAO
297	2001	2	12	10:20:37.00	32.0000	72.0000		4.5			NAO
298	2001	2	15	21:17:09.00	33.0000	72.0000		3.7			NAO
299	2001	2	18	07:42:25.00	32.0000	72.0000		3.8			NAO
300	2001	2	18	19:35:56.00	33.0000	74.0000		4.1			NAO
301	2001	2	20	17:33:33.50	33.1240	75.9510	40	4.5	3.8		ISC
302	2001	3	1	20:56:55.00	32.0000	72.0000		3.8			NAO
303	2001	3	1	21:29:52.10	32.4150	74.9170	33	2.6			NDI
304	2001	3	6	04:24:12.00	34.0000	72.0000		4.7			NAO
305	2001	3	6	17:59:39.60	32.9070	74.7640	28	2.8			NDI
306	2001	3	11	03:19:32.00	33.0000	75.0000		3.6			NAO
307	2001	3	11	19:09:52.00	32.0000	73.0000		3.5			NAO
308	2001	3	11	20:19:06.00	32.0000	74.0000		4.4			NAO
309	2001	3	12	09:35:22.00	32.0000	75.0000		3.8			NAO
310	2001	3	17	18:34:54.00	34.0000	75.0000		3.9			NAO
311	2001	3	17	19:37:03.00	35.0000	75.0000		3.6			NAO
312	2001	3	19	00:35:10.00	33.0000	73.0000		4.5			NAO
313	2001	3	22	04:03:28.00	33.0000	76.0000		3.8			NAO
314	2001	3	24	14:39:10.48	33.3790	75.6720	33	3.8			ISC

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
315	2001	3	28	12:33:32.00	35.0000	74.0000		4.6			NAO
316	2001	4	2	19:08:50.00	32.0000	76.0000		3.5			NAO
317	2001	4	8	18:33:54.00	34.0000	73.0000		3.9			NAO
318	2001	4	9	15:00:37.74	32.6205	73.0157	0	3.8			IDC
319	2001	4	9	15:19:07.00	35.0000	74.0000		4.3			NAO
320	2001	4	13	03:25:27.10	32.7360	75.0530	76	2.5			NDI
321	2001	4	18	23:32:26.50	32.6200	74.8150	33	2.6			NDI
322	2001	4	19	22:06:50.00	32.0000	72.0000		3.8			NAO
323	2001	4	22	20:29:28.00	32.0000	75.0000		3.7			NAO
324	2001	4	22	22:47:10.00	32.0000	75.0000		3.6			NAO
325	2001	4	29	13:52:46.00	34.0000	76.0000		3.6			NAO
326	2001	4	30	00:32:15.00	33.0000	75.0000		3.8			NAO
327	2001	4	30	15:37:12.20	33.1510	75.7770	8	2.6			NDI
328	2001	5	4	06:26:42.50	34.6210	74.2410	33	3.9			ISC
329	2001	5	7	22:08:00.00	35.0000	73.0000		3.6			NAO
330	2001	5	9	03:47:52.00	33.0000	75.0000		4.3			NAO
331	2001	5	11	14:59:21.00	32.0000	73.0000		4.3			NAO
332	2001	5	18	03:06:16.00	34.0000	72.0000		3.7			NAO
333	2001	5	21	22:16:00.00	34.0000	76.0000		4.5			NAO
334	2001	5	23	18:06:39.30	32.7290	74.9190	38	2.5			NDI
335	2001	6	2	04:39:00.70	34.1203	74.2258	200	4.3			DMN
336	2001	6	3	19:47:28.00	35.0000	72.0000		3.5			NAO
337	2001	6	5	22:50:34.00	32.0000	75.0000		3.8			NAO
338	2001	6	7	04:48:12.00	32.0000	72.0000		4.0			NAO
339	2001	6	8	22:10:31.90	34.9961	73.3194	10	4.8			DMN
340	2001	6	11	14:36:12.20	34.6762	73.5251	10	4.9			DMN
341	2001	6	13	07:33:45.00	32.0000	75.0000		4.1			NAO
342	2001	6	13	19:43:28.20	33.3090	75.4900	5	3.1			NDI
343	2001	6	13	19:49:18.80	32.6960	74.8840	11	2.5			NAO
344	2001	6	15	03:56:30.00	33.0000	75.0000		3.6			NDI
345	2001	6	15	11:13:13.60	32.8870	72.1500	33	3.6			NAO
346	2001	6	16	07:43:38.00	34.0000	73.0000		4.6			NAO
347	2001	6	17	17:18:43.00	34.0000	76.0000		3.8			NAO
348	2001	6	18	14:04:50.00	35.0000	73.0000		4.0			NAO
349	2001	6	20	04:36:56.00	34.0000	73.0000		3.8			LDG
350	2001	6	23	07:49:16.00	32.0000	73.0000		3.7			NDI
351	2001	6	27	03:50:32.00	35.0000	76.0000		3.5			NDI
352	2001	6	28	23:25:09.00	32.7520	74.7670	10	3.1			NAO
353	2001	7	1	00:12:51.00	33.0000	75.0000		3.5			IDC
354	2001	7	2	20:33:05.75	34.7376	73.3292	0	3.8			NAO
355	2001	7	4	05:35:45.00	35.0000	76.0000		4.3			NAO
356	2001	7	6	15:52:38.00	33.0000	75.0000		5.1			NAO
357	2001	7	7	21:24:36.00	33.0000	76.0000		4.6			NAO
358	2001	7	11	23:52:04.00	34.0000	72.0000		4.3			NAO
359	2001	7	14	01:54:56.00	32.0000	76.0000		3.8			NAO
360	2001	7	15	05:01:38.00	32.0000	73.0000		4.0			NAO
361	2001	7	16	16:07:16.20	32.9420	73.1480	33	5.2			MOS
362	2001	7	17	02:55:32.00	33.0000	75.0000		4.0			NAO
363	2001	7	17	14:10:33.00	32.0000	72.0000		3.9			NAO
364	2001	7	18	12:22:11.60	33.4074	75.1596	345	4.5			NAO
365	2001	7	20	05:21:24.00	33.0000	73.0000		4.3			NAO
366	2001	7	20	13:27:28.00	33.0000	75.0000		4.0			NAO
367	2001	7	21	00:17:17.00	33.0000	75.0000		4.7			NAO
368	2001	7	25	21:47:09.00	35.0000	73.0000		3.5			NAO
369	2001	8	7	08:31:39.00	34.0000	75.0000		3.9			NAO
370	2001	8	9	01:30:01.00	32.0000	74.0000		3.8			NAO
371	2001	8	9	19:32:32.80	33.4444	75.5545	336	4.2			DMN
372	2001	8	15	00:45:06.00	33.0000	72.0000		3.7			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
373	2001	8	24	18:57:02.00	33.0000	73.0000		4.0			NAO
374	2001	8	25	19:54:09.00	33.0000	75.0000		4.6			NAO
375	2001	8	26	17:05:28.00	33.0000	75.0000		4.2			NAO
376	2001	8	26	17:52:17.00	32.0000	75.0000		3.7			NAO
377	2001	8	27	01:57:26.20	33.6622	74.9070	200	4.1			DMN
378	2001	8	27	03:42:48.00	33.0000	75.0000		4.8			NAO
379	2001	8	28	11:33:44.00	33.0000	74.0000		4.7			NAO
380	2001	8	30	09:02:14.00	35.0000	76.0000		4.7			NAO
381	2001	8	31	15:36:21.00	35.0000	73.0000		2.8			NAO
382	2001	9	1	05:59:51.00	33.0000	72.0000		4.3			NAO
383	2001	9	6	00:40:49.00	33.0000	75.0000		4.8			NAO
384	2001	9	8	15:48:53.00	33.0000	75.0000		4.5			NAO
385	2001	9	9	01:04:37.00	33.0000	72.0000		3.7			NAO
386	2001	9	9	01:06:26.00	32.5326	75.9245	324	4.5			DMN
387	2001	9	9	23:39:35.50	34.5198	73.1259	133	4.4			DMN
388	2001	9	14	15:18:19.00	35.0000	73.0000		4.7			NAO
389	2001	9	14	15:39:10.80	34.5967	74.6998	300	4.7			DMN
390	2001	9	14	16:28:24.00	33.0000	73.0000		3.9			NAO
391	2001	9	14	18:29:53.00	33.0000	75.0000		3.7			NAO
392	2001	9	20	20:22:53.00	34.0000	76.0000		3.8			NAO
393	2001	9	24	05:30:53.00	34.0000	73.0000		3.6			NAO
394	2001	9	24	20:15:35.00	32.0000	76.0000		3.7			NAO
395	2001	9	26	15:29:57.00	33.0000	75.0000		3.8			NAO
396	2001	9	28	04:37:57.50	33.4010	75.8300	33	5.1			MOS
397	2001	9	30	00:54:15.90	34.6835	74.0036	133	4.7			DMN
398	2001	9	30	11:29:15.00	32.0000	74.0000		4.5			NAO
399	2001	9	30	11:31:02.80	34.5649	74.8615	320	4.8			DMN
400	2001	10	5	02:36:56.00	33.0000	75.0000		4.8			NAO
401	2001	10	6	19:21:07.30	34.1863	73.4330	10	4.9			IDC
402	2001	10	7	13:57:05.00	34.0000	74.0000		3.6			NAO
403	2001	10	11	06:01:41.72	34.6092	72.4553	0	4.0			IDC
404	2001	10	14	10:35:51.00	33.0000	73.0000		3.7			NAO
405	2001	10	15	20:18:09.00	33.0000	72.0000		3.8			NAO
406	2001	10	18	17:54:26.00	35.0000	76.0000		4.3			NAO
407	2001	10	18	17:55:59.00	34.3970	75.0860	268	5.0			DMN
408	2001	10	21	13:23:29.00	34.0000	76.0000		4.2			NAO
409	2001	10	21	14:29:12.00	34.0000	72.0000		3.7			NAO
410	2001	10	21	20:17:15.10	34.9918	72.0489	10	4.7			DMN
411	2001	10	27	03:53:51.00	32.0000	75.0000		3.9			NAO
412	2001	10	28	23:16:24.00	32.0000	72.0000		3.8			NAO
413	2001	11	3	04:50:45.71	33.1522	72.6066	0	4.2			IDC
414	2001	11	6	02:19:36.00	32.0000	72.0000		3.8			NAO
415	2001	11	6	10:50:06.00	32.0000	73.0000		4.1			NAO
416	2001	11	7	05:13:08.00	33.0000	76.0000		3.9			NAO
417	2001	11	12	22:21:40.00	32.0000	73.0000		4.2			NAO
418	2001	11	13	16:35:04.00	32.0000	72.0000		4.9			NAO
419	2001	11	13	19:29:13.00	33.0000	75.0000		3.9			NAO
420	2001	11	16	12:34:21.00	32.0000	75.0000		4.1			NAO
421	2001	11	19	17:58:08.00	32.0000	72.0000		3.8			NAO
422	2001	11	23	20:42:29.00	34.0000	74.0000		6.7			NAO
423	2001	11	24	14:43:57.00	33.0000	74.0000		3.7			NAO
424	2001	12	9	12:08:57.00	33.0000	75.0000		4.0			NAO
425	2001	12	9	16:01:32.00	35.0000	73.0000		4.0			NAO
426	2001	12	16	05:32:32.00	33.0000	75.0000		3.5			NAO
427	2001	12	16	05:34:02.50	34.1263	73.7819	147	4.3			DMN
428	2001	12	21	20:06:41.00	33.0000	75.0000		4.2			NAO
429	2001	12	21	21:56:41.50	32.8733	74.4470	33	5.0			DMN
430	2001	12	22	03:39:13.00	34.0000	75.0000		5.0			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
431	2001	12	22	11:26:25.90	34.8174	72.3052	10	4.8			DMN
432	2001	12	22	12:06:59.10	34.6710	73.1330	33	4.3			MOS
433	2001	12	24	09:42:50.40	32.6147	75.2520	305	4.0			NAO
434	2001	12	28	20:58:48.75	34.6099	73.5547	0	3.8		3.1	IDC
435	2001	12	30	18:39:14.00	33.0000	75.0000		4.2			NAO
436	2001	12	31	22:20:24.00	33.0000	75.0000		5.1			NAO
437	2002	1	6	14:34:22.00	33.0000	74.0000		3.8			NAO
438	2002	1	7	13:04:18.24	33.6575	74.6155	61	3.6			IDC
439	2002	1	7	20:32:47.00	33.0000	74.0000		4.4			NAO
440	2002	1	11	01:24:49.00	34.0000	76.0000		4.4			NAO
441	2002	1	13	12:08:10.60	32.4450	75.9370	33	5.1			NAO
442	2002	1	13	12:08:35.19	34.9422	74.0524	33	4.6			MDD
443	2002	1	13	13:39:30.82	33.9197	75.5453	33	4.6			MDD
444	2002	1	19	04:38:04.00	33.0000	75.0000		3.8			NAO
445	2002	1	24	15:34:32.00	35.0000	72.0000		4.3			NAO
446	2002	2	5	05:35:56.00	32.0000	73.0000		5.1			NAO
447	2002	2	7	03:29:20.00	34.0000	72.0000		4.2			NAO
448	2002	2	8	04:02:14.00	32.0000	76.0000		3.8			NAO
449	2002	2	9	18:10:03.00	33.0000	76.0000		3.8			NAO
450	2002	2	12	23:13:56.00	33.0819	75.9476	0	3.4		2.9	IDC
451	2002	2	12	23:14:22.36	33.6144	75.8236	0	3.9		3.7	IDC
452	2002	2	14	23:44:02.00	32.0000	72.0000		4.6			NAO
453	2002	2	17	05:22:59.70	33.0400	75.8800	31	4.3		4.1	BJI
454	2002	2	18	22:33:31.00	32.0000	74.0000		4.4			NAO
455	2002	2	19	07:22:47.00	33.0000	72.0000		4.1			NAO
456	2002	2	20	01:37:50.00	35.0000	74.0000		4.0			NAO
457	2002	2	22	10:01:31.00	33.0000	75.0000		4.5			NAO
458	2002	2	22	17:27:02.00	33.0000	73.0000		4.0			NAO
459	2002	2	26	14:04:26.00	34.0000	76.0000		4.6			NAO
460	2002	3	3	12:07:11.00	32.0000	74.0000		4.7			NAO
461	2002	3	3	13:04:48.00	33.0000	75.0000		5.0			NAO
462	2002	3	3	16:31:37.00	32.0000	73.0000		3.9			NAO
463	2002	3	3	21:03:38.00	32.0000	75.0000		4.3			NAO
464	2002	3	5	14:15:03.00	33.0000	74.0000		4.0			NAO
465	2002	3	6	19:56:13.00	33.0000	75.0000		4.7			NAO
466	2002	3	7	16:59:46.00	33.0000	73.0000		3.9			NAO
467	2002	3	9	20:58:43.00	32.0000	75.0000		3.9			NAO
468	2002	3	14	10:45:36.00	33.0000	75.0000		3.8			NAO
469	2002	3	14	18:44:03.80	34.1600	75.9800	48	3.9		3.8	BJI
470	2002	3	18	04:29:14.40	32.9700	75.8900	57	4.1		4.5	NAO
471	2002	3	21	21:57:31.00	33.0000	72.0000		4.9			NAO
472	2002	3	24	10:18:09.70	32.2564	75.8423	0	3.7		3.8	IDC
473	2002	3	29	01:58:18.00	33.0000	73.0000		4.2			NAO
474	2002	3	30	21:13:21.00	32.0000	74.0000		3.8			NAO
475	2002	3	31	17:09:17.00	33.0000	75.0000		3.5			NAO
476	2002	4	3	02:23:09.00	34.0000	72.0000		4.6			NAO
477	2002	4	5	20:30:42.00	33.0000	74.0000		4.7			NAO
478	2002	4	11	16:05:58.00	33.0000	75.0000		3.9			NAO
479	2002	4	13	23:13:57.00	32.0000	75.0000		3.8			NAO
480	2002	4	14	14:48:20.00	33.0000	75.0000		3.5			NAO
481	2002	4	16	08:14:07.00	32.0000	75.0000		3.5			NAO
482	2002	4	16	23:45:39.00	33.0000	73.0000		4.3			NAO
483	2002	4	17	06:32:53.00	32.0000	75.0000		3.5			NAO
484	2002	4	18	22:12:41.90	32.9470	74.7260	33	4.8			BER
485	2002	4	21	10:41:16.00	35.0000	76.0000		4.0			MDD
486	2002	4	30	23:01:19.00	33.0000	73.0000		4.0			NAO
487	2002	5	6	09:32:10.10	34.2600	73.7000	70	3.9			BJI
488	2002	5	6	16:27:25.00	33.0000	74.0000	0	3.6			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
489	2002	5	8	06:30:40.00	35.0000	73.0000		4.1			NAO
490	2002	5	9	08:11:38.00	32.0000	73.0000		3.6			NAO
491	2002	5	10	06:00:49.27	33.0359	75.9810	0	3.8		3.7	IDC
492	2002	5	13	18:41:11.00	32.0000	73.0000		4.0			NAO
493	2002	5	15	15:32:54.00	35.0000	74.0000		3.8			NAO
494	2002	5	18	22:47:22.30	32.1414	73.1310	0	3.8	4.2	3.2	IDC
495	2002	5	18	22:47:44.00	35.0000	74.0000		3.5			NAO
496	2002	5	19	03:56:51.81	34.1667	74.9971	0	4.0		3.1	IDC
497	2002	5	19	08:39:52.00	35.0000	76.0000		4.1			NAO
498	2002	5	21	05:48:26.00	34.0000	74.0000		3.8			NAO
499	2002	5	23	09:19:48.00	34.0000	72.0000		3.1			NAO
500	2002	5	27	00:05:01.00	32.0000	72.0000		3.8			NAO
501	2002	6	2	05:15:16.00	33.0000	75.0000		3.6			NAO
502	2002	6	4	00:12:04.00	33.0000	72.0000		4.0			NAO
503	2002	6	6	00:32:15.00	35.0000	73.0000		3.5			NAO
504	2002	6	9	02:51:14.00	33.0000	72.0000		3.5			NAO
505	2002	6	10	23:19:47.00	33.0000	72.0000		2.8			NAO
506	2002	6	10	23:26:00.00	32.0000	75.0000		4.1			NAO
507	2002	6	16	19:47:09.48	33.5874	72.9457	0	3.8		3.2	IDC
508	2002	6	24	20:41:39.00	34.0000	72.0000		3.8			NAO
509	2002	6	25	03:21:42.00	33.0000	75.0000		3.7			NAO
510	2002	7	1	07:35:09.00	33.0000	75.0000		3.9			NAO
511	2002	7	2	05:36:33.99	33.0653	75.8859	0	3.8		3.6	IDC
512	2002	7	2	07:01:11.00	32.0000	74.0000		3.8			NAO
513	2002	7	9	02:56:47.32	32.9866	73.4734	0	3.8		2.9	IDC
514	2002	7	11	03:32:11.00	33.0000	76.0000		4.5			NAO
515	2002	7	14	21:03:28.00	34.0000	73.0000		3.6			NAO
516	2002	7	18	20:29:19.00	34.0000	72.0000		4.1			NAO
517	2002	7	22	07:55:59.00	32.0000	73.0000		3.0			NAO
518	2002	7	22	09:57:23.00	32.0000	72.0000		3.8			NAO
519	2002	8	3	15:26:12.80	33.8840	72.8450	33	4.4			MOS
520	2002	8	4	05:02:28.00	35.0000	74.0000		3.5			NAO
521	2002	8	8	20:50:27.00	33.0000	75.0000		4.2			NAO
522	2002	8	8	22:45:11.00	33.0000	72.0000		4.0			NAO
523	2002	8	14	12:06:34.00	35.0000	73.0000		3.9			NAO
524	2002	8	14	16:15:17.00	33.0000	75.0000		3.8			NAO
525	2002	8	16	01:33:08.00	35.0000	74.0000		4.0			NAO
526	2002	8	17	23:23:28.00	33.0000	72.0000		3.6			NAO
527	2002	8	18	00:32:06.60	34.0550	72.8600	33	4.5			MOS
528	2002	8	20	14:53:38.00	34.0000	73.0000		4.1			NAO
529	2002	8	20	22:51:26.00	34.0000	76.0000		3.4			NAO
530	2002	9	3	17:26:14.00	33.0000	72.0000		5.5			NAO
531	2002	9	3	21:01:06.00	33.0000	76.0000		3.9			NAO
532	2002	9	4	11:37:46.00	33.0000	76.0000		4.4			NAO
533	2002	9	9	23:46:49.00	35.0000	74.0000		3.9			NAO
534	2002	9	11	06:39:20.00	33.0000	75.0000		3.8			NAO
535	2002	9	13	04:27:22.00	32.0000	74.0000		3.7			NAO
536	2002	9	13	18:20:12.00	33.0000	72.0000		4.0			NAO
537	2002	9	16	06:09:40.00	32.0000	73.0000		4.0			NAO
538	2002	9	18	04:46:38.00	32.0000	72.0000		3.9			NAO
539	2002	9	22	19:57:07.00	33.0000	74.0000		4.3			NAO
540	2002	10	1	02:50:51.00	33.0000	72.0000		5.3			NAO
541	2002	10	2	23:28:30.00	35.0000	75.0000		4.3			NAO
542	2002	10	4	14:59:54.00	33.0000	73.0000		3.9			NAO
543	2002	10	5	11:47:16.00	35.0000	73.0000		4.2			NAO
544	2002	10	10	15:27:00.00	32.0000	76.0000		4.6			NAO
545	2002	10	10	17:25:05.00	33.0000	73.0000		3.8			NAO
546	2002	10	17	04:29:45.00	32.0000	73.0000		4.4			NAO

Sr No	Date			Time	Latitude	Longitude	Depth	Magnitude			Source
	Year	Month	Day	GMT	N	E	Km	mb	MS	ML	
547	2002	10	17	14:24:03.00	34.0000	72.0000		4.6			NAO
548	2002	10	21	13:49:10.00	33.0000	72.0000		3.7			NAO
549	2002	10	29	11:00:58.00	34.0000	76.0000		5.1			NAO
550	2002	10	30	03:12:30.00	35.0000	76.0000		3.6			NAO
551	2002	11	1	22:55:05.00	33.0000	76.0000		3.9			NAO
552	2002	11	1	22:55:18.56	34.7529	73.6430	0	3.8		2.9	IDC
553	2002	11	1	22:57:44.73	34.9448	73.6945	0	4.1		2.9	IDC
554	2002	11	2	04:55:07.00	35.0000	76.0000		4.0			NAO
555	2002	11	2	15:23:17.00	33.0000	76.0000		4.6			NAO
556	2002	11	3	04:47:17.00	33.0000	76.0000		4.0			NAO
557	2002	11	3	06:11:11.00	34.0000	76.0000		4.1			NAO
558	2002	11	3	14:48:07.00	33.0000	75.0000		3.8			NAO
559	2002	11	3	18:53:05.00	32.0000	72.0000		3.8			NAO
560	2002	11	4	05:18:47.00	35.0000	76.0000		4.1			NAO
561	2002	11	4	22:03:36.00	34.0000	76.0000		3.9			NAO
562	2002	11	5	11:59:20.00	33.0000	76.0000		4.2			NAO
563	2002	11	8	02:22:05.00	33.0000	76.0000		4.2			NAO
564	2002	11	8	02:51:22.00	33.0000	76.0000		3.7			NAO
565	2002	11	11	09:17:04.06	34.1842	75.3474	0	4.0			IDC
566	2002	11	13	18:40:45.00	35.0000	72.0000		3.4			NAO
567	2002	11	13	21:17:12.00	33.0000	72.0000		3.7			NAO
568	2002	11	16	14:18:36.00	35.0000	72.0000		3.9			NAO
569	2002	11	19	04:30:09.00	34.0000	76.0000		3.8			NAO
570	2002	11	20	19:22:26.00	32.0000	75.0000		3.9			NAO
571	2002	11	20	22:28:31.80	34.8068	74.3212	0	3.9		2.9	IDC
572	2002	11	20	22:50:17.00	34.0000	74.0000		4.0			NAO
573	2002	11	21	00:02:01.00	34.0000	76.0000		4.1			NAO
574	2002	11	21	03:10:22.00	34.0000	75.0000		3.8			NAO
575	2002	11	22	07:10:30.00	34.0000	76.0000		4.3			NAO
576	2002	11	22	09:12:12.60	33.4080	73.5240	33	4.5			MOS
577	2002	11	24	09:35:25.34	32.4224	73.1631	0	4.0		2.9	IDC
578	2002	11	24	12:56:47.00	34.0000	76.0000		4.5			NAO
579	2002	11	24	14:57:52.20	34.9015	73.7414	0	3.8		3.0	IDC
580	2002	11	25	11:06:18.00	33.0000	76.0000		4.2			NAO
581	2002	11	28	14:07:19.00	33.0000	72.0000		4.7			NAO
582	2002	11	30	19:19:49.00	35.0000	75.0000		3.9			NAO
583	2002	12	2	00:56:51.00	33.0000	72.0000		4.2			NAO
584	2002	12	4	10:29:35.00	33.0000	75.0000		4.3			NAO
585	2002	12	11	04:54:33.00	35.0000	75.0000		4.1			NAO
586	2002	12	17	10:28:08.00	33.3288	75.8066	46	3.6	3.0	3.2	IDC
587	2002	12	19	15:22:50.00	32.0000	75.0000		4.0			NAO
588	2002	12	19	16:13:32.21	33.4550	73.2430	0	3.9		3.5	IDC
589	2002	12	20	18:57:33.00	33.0000	75.0000		4.0			NAO
590	2002	12	23	00:12:41.00	33.0000	72.0000		5.2			NAO
591	2002	12	23	02:19:32.00	32.0000	73.0000		4.2			NAO
592	2002	12	29	07:29:17.00	33.0000	76.0000		3.7			NAO
593	2002	12	29	20:15:48.57	34.8821	73.8705	0	4.0		2.6	IDC
594	2002	12	31	01:07:45.00	33.0000	75.0000		3.7			NAO

Seismicity Pattern

The microseismic data of the region indicate that the region is very active on a microseismic level with frequent earthquakes of magnitude greater than 4.

The largest earthquake recorded by regional network is the Kangra earthquake of magnitude Ms=8.0 occurred on 4th April 1905 about 200 km southeast of the project. Two earthquakes of magnitude greater than 6 have also been recorded in this area.

Figure 8 shows distribution of seismicity with depth in the region as recorded by Mangla microseismic network. Major concentration of earthquakes is within upper 20 km. It is important to note that all the events having magnitude 5 or greater are originated within shallow depth (< 20 km). This aspect of seismicity depicts that seismic forces are active at shallow depth, which increases earthquake hazard within this region. Majority of the events falls within focal depths less than 30 km. Though, events with magnitude greater than 5 do not seem to occur beyond 30 km depth, nevertheless, events with magnitude 4 to 5 do occur at depths upto as much as 60 km. There is only one earthquake that was located at focal depth of 79.3 km.

From the spatial point of view, number of earthquakes is quite less south of latitude 32.5o. This low level of seismicity may be true as no prominent causative seismotectonic feature is recognized in the plain areas of Punjab due to thick alluvial cover. However, another factor for this reduced level could be the fact that no local seismic network properly covers this area. Generally the spread of earthquake epicentres seems to be random for magnitudes less than 4. However, for the events having magnitudes more than 4, most of these show association with local tectonic features except in Potwar and Punjab plain (**Figure 8**). The concentration of events in zone near latitude 34.0o and longitude 72.75o may be associated with Tarbela reservoir induced effect. The concentration of events west of Abbotabad appears to be partially associated with HLSZ (Hazara Lower Seismic Zone) as suggested by Seeber et al.[27] extending northwest-southeast from Hazara thrust system of faults except the event of February 25, 1996 of magnitude 5.2 with focal depth of five kilometers located only four kilometers downstream of Tarbela dam, which was an induced event. Lot of seismicity is associated with MBT and other faults of the Hazara thrust system, which indicates that these faults are active. In Salt Range, a lot of seismicity appears to be associated with Kahuta fault and Dil Jabba thrust, therefore indicating these faults as seismically active. A concentration of seismic activity is seen along river Jhelum north of Mangla. This could probably be associated with the mapped portion of the Jhelum fault, which is also considered as a possible extension of Dil Jabba thrust along the axis of the syntaxial bend, as suggested by the study of fault plane solutions of a few earthquakes in this area. This association of seismicity suggests that this portion of Jhelum fault upto Kahuta may be considered as active tectonic feature. Another concentration of epicenters is seen northeast of Mangla, which could be associated with Riasi fault and a possible associated fault closer to Mangla. Further towards northeast, lot of seismicity is associated with Riasi thrust, MBT and other tectonic features of the Himalayan range.

[27] Seeber, L., et al; Seismicity of the Hazara arc in northern Pakistan; Decollement vs. basement faulting; Geodynamics of Pakistan (1979).

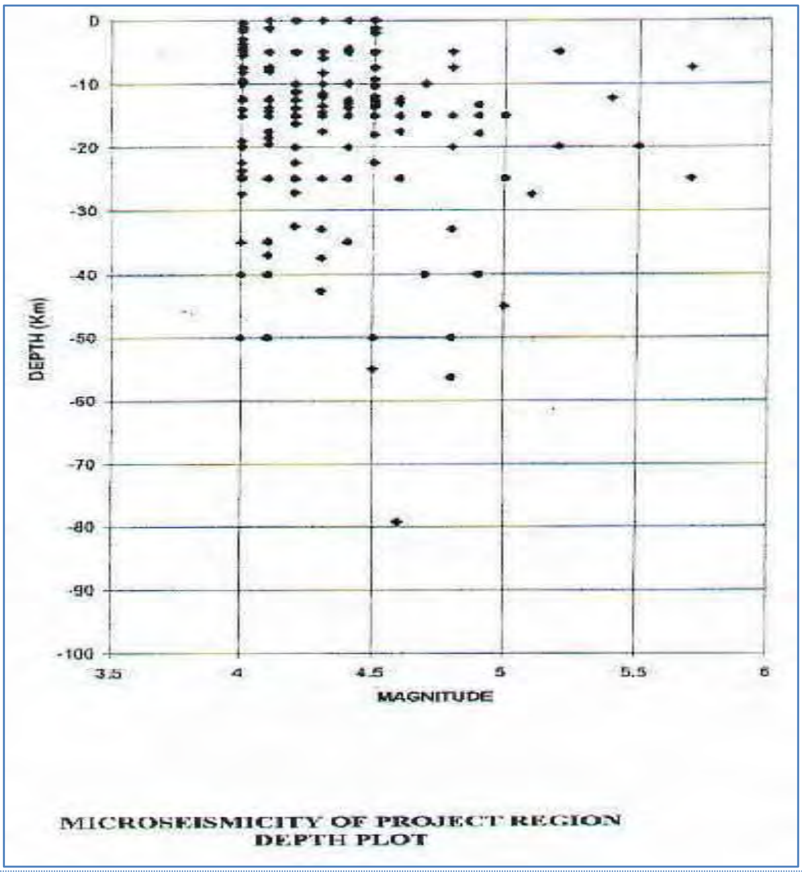


Figure 8: Microseismicity of the Project Region Depth plot

Seismotectonic Setting

Seismotectonic Model

Based on the synthesis of geological and seismicity data described above, a seismotectonic model of the project region is presented below which provides the basis for seismic hazard analysis for the Project.

The Project site is located near the base of Himalayan range where major tectonic features of this gigantic range are present. The other prominent tectonic feature is the presence of Hazara-Kashmir syntaxial bend which is very sharp near Muzaffarabad and gradually dies out southwards. All geological features show NW-SE trend towards east of the syntaxial bend while these have NE-SW trend on the western side of the syntaxial bend.

The seismotectonic features that have been considered critical for the seismic hazard to the Project include:

i. Himalayan Frontal Thrusts i.e. Main Boundary Thrust (MBT) and Riasi Thrust and associated parallel faults, having NW-SE trend and located east of the syntaxial axis;
ii. Jhelum Fault, trending N-S, and running along the axis of the syntaxial bend; and
iii. Dil Jabba thrust, Kahuta Fault and Salt Range Frontal Thrust, all have NE-SW trend and located west of the axis of the syntaxis.

The entire region is dominated mainly by thrust type of faults that do have some strike- slip component at places also. These faults are considered active because of association of observed seismicity with these faults (**Figure 7**). The faults critical to the project are discussed below:

Project Area Faults

The main tectonic features controlling the seismic hazard for the Project are as follows:

a) Main Boundary Thrust

Main Boundary thrust is the main frontal thrust of the Himalayan range which runs along the Himalayan arc for about 2500 km from Assam in the east to Kashmir in the west. Near the Project site, it takes a northwest trend due to the syntaxial bend. Near it surface trace, it dips towards northeast at steep angle but becomes sub-horizontal in the subsurface away from the surface trace. Seeber et al.[28] have shown that the series of large earthquakes which occurred along the Himalayan range are probably related to slip along this sub-horizontal surface, termed as detachment. The MBT is seismically active and have seismic potential to generate large earthquakes. The closest distance of MBT from project site is 40 km towards northeast.

b) Riasi Thrust

Another important fault of the Himalayan front is the Riasi Thrust which is a branch of the MBT and runs almost parallel to MBT for a distance of about 220 km. Lot of observed seismicity can be associated with this fault. This fault passes at a distance of only 8 km northeast of the Project site. Near the site, it has a trend of NW-SE, dipping towards northeast away from the site. Because of its close association with the MBT and recorded seismicity, this fault is considered as an active tectonic feature.

c) Jhelum Fault

This is a north-south trending left lateral strike-slip fault with steep dip towards east. Kazmi[29] has shown that this fault may extend from north of Muzaffarabad to near Jhelum towards south along the axis of the syntaxial bend. The mapped length of this fault is, however, limited to about 20 km only between Mangla and Kahuta (**Figure 4**). The alignment of observed seismicity along this fault suggests that this fault may extend towards south up to the northeastern termination of Dil Jabba thrust. A 50 km length of this fault is taken as active with nearest trace at 30 km west of the project site.

d) Dil Jabba Thrust:

Dil Jabba Thrust is a north east trending fault present near the eastern side of Salt Range with a surface trace 86 km long. This thrust dips towards northwest and terminates on the western side of River Jhelum. Some disturbance of Quaternary deposits has been reported near the surface trace of this fault and epicenters of many earthquakes can be associated with this fault, therefore indicating

[28] Seeber L. et al; Seismicity and continental subduction in the Himalayan arc, in Zagros – Hindukush Himalayas; Geodynamics Evolution, A.G.U. Geodynamics Services, Vol.3 (1981).

[29] Farah, A., De Jong, K.A; Geodynamics of Pakistan: An introduction; Geodynamics of Pakistan, Geological Survey of Pakistan (1979).

that this fault is seismically active. Its eastern termination is at a distance of about 35 km from the Project site.

e) Kahuta Fault:

This fault is present north of Dil Jabba Thrust and runs parallel to it. This fault starts northwest of GT Road and terminates near the axis of the syntaxis. It length is about 50 km. Because of its similarity with Dil Jabba Thrust and observed seismicity of the area, this fault is also taken as active.

Seismic Hazard Evaluation

Both probabilistic as well as deterministic hazard evaluation procedures were employed for seismic hazard analysis of the project in accordance with the ICOLD guidelines[30].

Probabilistic Approach

Methodology

In probabilistic hazard evaluation method, the seismic activity of seismic source (line or area) is specified by a recurrence relationship, defing the cumulative number of events per year versus the magnitude. Distribution of earthquake is assumed to be uniform within the source zone and independent of time[31].

The principle of the analysis is to evaluate at the site of interest the probability of exceedence of a ground motion parameter (e.g. acceleration) due to the occurrence of a strong event, at a certain distance from the site. This approach combines the probability of exceedence of the earthquake size (recurrence relationship), and probability on the distance from the epicenter to the site.

Each source zone is split into elementary zones at a constant distance from the site. Integration is carried out within each zone by summing the effects of the various elementary zones taking into account the attenuation effect with distance. Total hazard is obtained by adding the influence of various sources. The results are expressed in terms of a ground motion parameter associated to the total number of expected events per year (i.e. the inverse of the return period), or in terms of annual hazard.

A seismic hazard model is developed based on findings of the seismotectonic synthesis. The seismic hazard model relies upon the concept of seismotectonic zones. Each zone is defined as a zone with homogenous seismic and tectonic features, inferred from geological, tectonic and seismic data. These zones are first defined, then a maximum earthquake and an earthquake recurrence equation is elaborated for each of these source zones.

The seismic parameters attached to the various seismic zones are a recurrence relationship relating the number of events for a specific period of time to the magnitude, the maximum earthquake giving an upper bound of potential magnitude in the zone, and an attenuation relationship representing the decrease of acceleration with distance.

[30] International Commission on Large Dams (ICOLD); Guidelines for selecting seismic parameters for large dams, Paris (1989).
[31] Cornell, C.A.; Engineering seismic risk analysis, Bull. Seism. Soc .Am., Vol.58, No.5 (1968).

Seismic Source Modeling

For the definition of seismic sources, either line (i.e. fault) or area sources can be used for modeling. Because of uncertainty in the epicentral locations, it is difficult to relate the recorded earthquakes to the faults present in the area and to develop recurrence relationship for each fault. The area around the site was therefore divided into six seismic zones (area sources) based on their homogeneous tectonic and seismic characteristics. These zones are MBT, Riasi, Hazara, Potwar, Salt Range and Punjab seismic zones (**Figure 9**).

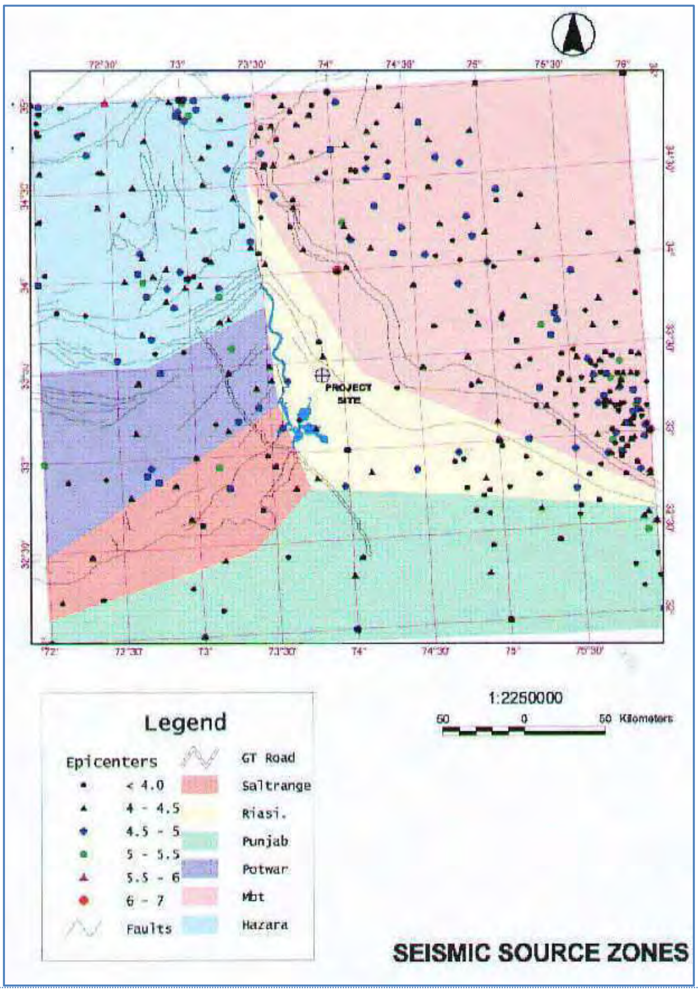


Figure 9: Seismic Source Zones

Each of these areas was assigned a maximum magnitude potential. As the shallow earthquakes are of more concern to seismic hazard, the minimum depth of the earthquakes is taken as 5 km for all sources except Punjab seismic zone where the minimum depth of earthquakes is taken as 30 km. The source parameters used in probabilistic hazard analysis are given in **Table 3**.

Table 3: Source Parameters for Probabilistic Analysis

Source Zone	*Minimum Magnitude M0*	*No. of Earthquakes of Mb >= M0*	*Activity Rate No. /Year*	*b-value*	*Maximum Potential Magnitude Mb*
Main Boundary Thrust (MBT)	4.0	146	1.5052	0.81	8.3

Source Zone	Minimum Magnitude M0	No. of Earthquakes of Mb >= M0	Activity Rate No. /Year	b-value	Maximum Potential Magnitude Mb
Riasi	4.0	40	0.4124	1.03	7.5
Hazara	4.2	55	0.5670	1.28	7.0
Potwar	4.0	33	0.3402	0.93	7.0
Salt Range	4.2	7	0.0722	0.82	7.0
Punjab	4.0	35	0.3608	0.85	6.0

Magnitude–Frequency Relationship

A general equation that described earthquake recurrence may be expressed as follows:

$$N(m) = f(m, t) \quad (1)$$

Where N (m) is the number of earthquakes with magnitude equal to or greater than m, and t is time period

The simplest form of equation (1) that has been used in most engineering applications is the well known Richter's law which states that the cumulated number of earthquakes occurred in a given period of time can be approximated by the relationship

$$\log N(m) = a - b\,m \quad (2)$$

Equation (2) assumes spatial and temporal independence of all earthquakes, i.e. it has the properties of a Poisson model. Coefficient a is related to the total number of events occurred in the source zone and depends on its area, while coefficient b represents the coefficient of proportionality between log N(m) and the magnitude. Coefficients a and b can be derived from seismic data relative to the source of interest.

The composite list of earthquakes given in **Table 2** for the window 32.0oN to 35.0oN and 72.0oE to 76.0oE covering an area within about 200 km radius of the project provided the necessary data base for the computation of b-value for each seismic source zone.

The seismic data from 1904-2002 contain magnitude values in the form of surface wave, body wave or local magnitude scales. Since attenuation relationships are based on magnitudes of given type, a single scale must be selected. All the magnitudes above 4 were therefore converted to body wave (mb) by using the following equations as suggested by Ambraseys and Bommer[32]:

$$0.87\,(mb) - 0.50\,(Ms) = 1.91$$
$$0.82\,(Ml) - 0.58\,(Ms) = 1.20$$

Where mb is body–wave magnitude, Ms is surface-wave magnitude and Ml is local magnitude.

The converted body wave magnitudes values are given is **Table 2**. Separate list of earthquakes occurring within each seismic zone was extracted from the composite list through GIS software. Magnitude-frequency plot was then drawn and b-values were calculated for each zone through

32 Ambraseys N.N. & Bommer J.J.; Uniform magnitude re-evaluation for the strong motion database of Europe and adjacent areas, European Earthquake Engineering, Vol.4 No.2 (1990).

regression analysis of data. The b–values and activity rate for the six seismic zones used in the probabilistic analysis are shown in **Table 3**.

Attenuation Relationships

Because of lack of sufficient strong–motion data covering a larger range of magnitudes and distances, attenuation relationships for the South Asian region could not be developed. For probabilistic hazard analysis, the attenuation equations of Boore et al.[33], Idriss[34], Sadigh[35] and Abrahamson-Silva[36] have been used. As the Project is founded on rock, the average shear wave velocity up to 30 meters depth was taken as 800 m/sec, which was observed at proposed Kalabagh damsite for similar rock formations.

Results of Peak Ground Acceleration (PGA)

The probabilistic hazard analysis was carried out by using EZ-FRISK software developed by Risk Engineering Inc. of Colorado, USA. The parameters for all the six seismic zones (area sources) given in **Table 3** were fed to the software. The results of the hazard analysis are presented in **Figure 10** in the form of total hazard at the Project site in terms of annual frequency of exceedence of peak horizontal ground acceleration.

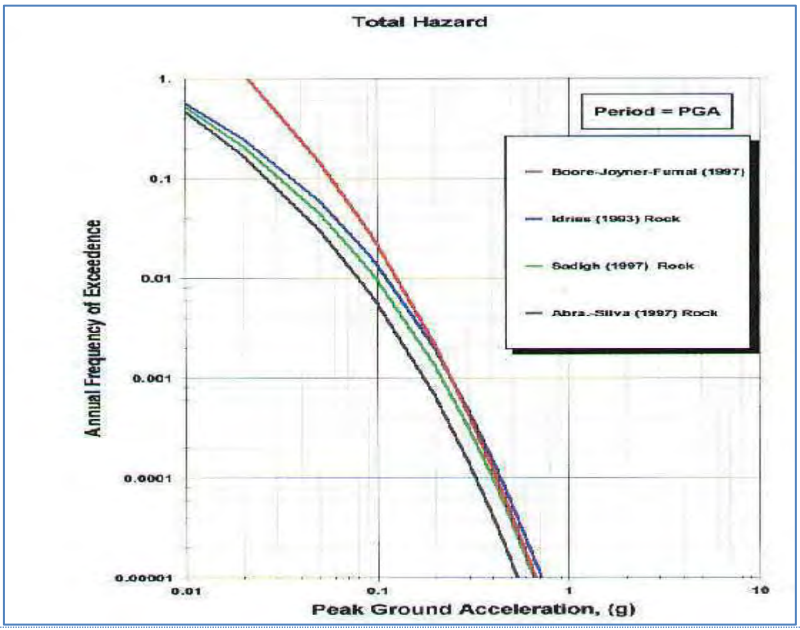


Figure 10: Total Hazard Plot

Deterministic Approach

33 Boore et al.; Equations for estimating horizontal response spectra and peak acceleration from western north American earthquakes: A summary of recent work, Seism. Res. Letters, Vol. 68 (1997).

34 Idriss, I. M.; Procedure for selecting earthquakes ground motions at rock sites, National Institute of Standards and Technology, NIST GCR 93-625 (1993).

35 Sadigh K. et al.; Attenuation relationships for shallow crustal earthquakes based on California strong motion data, Seism. Res. Letters, Vol. 68 (1997).

36 Abrahamson, N.A. and Silva W.J.; Empirical response spectral attenuation relations for shallow crustal earthquakes, Seism. Res. Letters, Vol. 68 (1997).

Methodology

In the deterministic procedure, critical seismogenic sources, like capable fault, representing a threat to the Project are identified and a maximum magnitude assigned to each of these faults. The capability of the faults is ascertained through observation of historical and instrumental seismic data and geological criteria such as the rupture length – magnitude relationship or fault movement - magnitude relationship. The maximum seismic design parameter is obtained by considering the most severe combination of maximum magnitude and minimum distance to the Project site, independently of the return period.

Maximum Earthquake Potential

Table 4 gives the various active faults present around the Project site and their lengths. The maximum rupture length of the faults has generally been taken as 50% of the total length. The Main Boundary Thrust (MBT) is a long active feature extending all along the Himalayan front from Assam to Kashmir, its maximum rupture length has been taken same as that observed in Kangra earthquake of 1905.

The maximum potential magnitude of each of these faults (**Table 4**) was calculated on the basis of fault rupture length and rupture area using various available relationships[37] and a maximum magnitude was selected accordingly for each of these active tectonic features as shown in **Table 4**.

Table 4: Maximum Potential Magnitudes of Critical Faults

Tectonic Feature	*Fault Length (Km)*	*Fault Rupture Length (Km)*	*Rupture Length Basis*				*Rupture Area Basis*				*Selected Max. Mag.*
			Slemmons 1982	*Patwardhan et al. 1975*	*Tocher, Seed & Housner*	*Wells Coppersmith 1994*	*Rupture Area Lgt. (Km)*	*Rupture Area Wdt. (Km)*	*Wells & Coppersmith 1994*	*Wyss 1979*	
Main Boundary Thrust (MBT)	1200	300	8.0	8.0	8.1	8.2	300	150	8.6	8.8	8.3
Riasi Thrust	220	110	7.4	7.4	7.3	7.5	100	40	7.6	7.7	7.5
Jhelum Fault	50	25	6.6	6.6	6.7	6.6	25	15	6.6	6.7	6.6
Dil Jabba Thrust	86	43	7.0	7.0	7.0	7.0	43	15	6.8	7.0	7.0
Kahuta Fault	50	25	6.6	6.6	6.7	6.6	25	15	6.6	6.7	6.6

Results of PGA

Horizontal Peak Ground Acceleration (PGA) at the project site induced by each seismic source was computed considering that maximum earthquake can occur at the closest distance from the site. The computed accelerations using several attenuation relationships of common use in engineering

[37] Slemmons, D.B., Bodin, P., and Zhang Xiaoyi ; Determination of earthquake size from surface faulting events, Proc . Seminar on Seismic Zonation, Guangzhou, China, State Seismological Bureau (Beijing) (1987).

practice are summarized in **Table 5**. This table shows that the maximum accelerations at the site are caused by Riasi thrust being at a closest distance of 8 km from the site.

Table 5: Peak Horizontal Accelerations

Tectonic Feature	*Max. Magnitude*	*Closest Distance to Fault (Km.)*	*Computed Accelerations (g) Median (50-percentile)*					
			Boore, Joyner & Fumel 1997	*Ambraseys et al. 1996*	*Idriss 1993*	*Sadigh et al. 1997*	*Ambraseys & Bommer 1991*	*Campbell & Bozorgnia 1993*
Main Boundary Thrust (MBT)	8.3	40	0.21	0.24	0.27	0.26	0.18	0.24
Riasi Thrust	7.5	8	0.41	0.59	0.53	0.57	0.49	0.43
Jhelum Fault	6.6	30	0.09	0.11	0.12	0.11	0.10	0.13
Dil Jabba Thrust	7.0	35	0.12	0.12	0.16	0.12	0.10	0.14
Kahuta Fault	6.6	40	0.08	0.08	0.11	0.09	0.07	0.09

Seismic Design Parameters

Design seismic parameters are selected herein on the basis of the results provided by probabilistic and deterministic approaches, and in compliance with the recommendations of ICOLD[38].

OBE Acceleration

According to ICOLD guidelines, "Operating Basis Earthquake (OBE) represents the level of ground motion at the dam site at which only minor damage is acceptable. The dam, appurtenant structures and equipment should remain functional and damage easily repairable from the occurrence of earthquake shaking not exceeding the OBE". Because of its definition, the OBE is best determined by using probabilistic procedures, for instance, such as specifying a 50% probability of not being exceeded in 100 years, the corresponding return period is equal to 144 years. In any case the OBE accelerations are significantly lower than those for MCE.

Figure 10 shows the results of probabilistic analysis for Gulpur Hydropower project obtained through EZ-FRISK software as total hazard in terms of annual frequency of proximity exceedence of peak ground accelerations. The source contribution analysis shows that maximum contribution to total hazard is from Riasi source zone. Keeping in view the proximity of the most critical tectonic feature, the recommended OBE acceleration for the project structures is 0.24g with a return period of 1000 years.

MCE Acceleration

According to ICOLD guidelines, "the MCE is the largest reasonable conceivable earthquake that appears possible along a recognized fault or within a geographically defined tectonic province, under the presently known or presumed tectonic framework". This definition is inspired by that of Seed[39]: "the largest rationally conceivable event that could occur in the tectonics environment in which the project is located". The MCE can be evaluated through a deterministic or a probabilistic procedure. If the probabilistic seismic hazard evaluation is used, the MCE is linked to a very long return period for this event.

[38] International Commission on Large Dams (ICOLD); Guidelines for selecting seismic parameters for large dams, Paris (1989).

[39] Seed, H. B.; The selection of design earthquake for critical structures. Bull. Seis. Soc. Am., Vol.72 (1982)

For Gulpur Hydropower Project, the most critical tectonic feature controlling the MCE is the Riasi thrust which is causing maximum accelerations at the project site (**Table 5**). Various attenuation relationships give peak horizontal accelerations ranging from 0.41g to 0.59g. For the peak horizontal acceleration associated with MCE, an average value of 0.50g is selected. This value is conservative but selected in view of the proximity of the most critical tectonic structure from the project.

Conclusions and Recommendations

The seismic hazard evaluation for Gulpur Hydropower Project was carried out on the basis of understanding of local tectonic environment, desk studies of faults in the vicinity of the Project and synthesis of available seismological and tectonic data to evaluate the capability of active tectonic features and assigning ground motion associated with them. The main conclusions based on the present study are as follows:

- The project site is located close to the Riasi Thrust which is a branch of MBT, the main source of destructive earthquakes in the Himalayan region.
- The critical surface tectonic features around the Project site are MBT and Riasi thrusts towards east and Dil Jabba Thrust, Kahuta Fault and Jhelum Fault towards west of the Project.
- Historical record shows that earthquakes in this region have caused maximum intensity of VIII-IX several times in the past. The instrumentally recorded seismicity shows that faults in this area are seismically active. Several epicenters of recorded earthquakes can be associated with the known faults of the area.
- Seismic hazard evaluation was carried out in accordance with the ICOLD guidelines for selecting seismic design parameters using both probabilistic as well as deterministic approaches.
- The probabilistic approach was used to select the Operating Basis Earthquake (OBE) using the instrumentally recorded earthquake data for the last century. For the project life of 100 years, recommended OBE acceleration is 0.24g.
- Based upon the deterministic evaluation, peak horizontal ground acceleration of 0.50g associated with Maximum Credible Earthquake (MCE) is recommended for the Project.

A.2 Ambient Air Quality

- Client Sustainable Solutions Pvt. Ltd.
- Sampling Point Proposed Power House Site
- Date of Intervention August 26–27, 2013

Parameter	***Unit***	***Duration***	***LDL***	***Average Obtained Concentration***
Carbon Monoxide (CO)	mg/m3	24 Hours	0.01	0.85
Nitrogen Dioxide(NO2)	ug/m3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO2)	ug/m3	24 Hours	5.0	<5.0
Particulate Matter (PM10)	ug/m3	24 Hours	2.00	97.14

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

A.3 Ambient Air Quality

- Client Sustainable Solutions Pvt. Ltd.
- Sampling Point Proposed Camp Area
- Date of Intervention August 27–28, 2013

Parameter	***Unit***	***Duration***	***LDL***	***Average Obtained Concentration***
Carbon Monoxide (CO)	mg/m^3	24 Hours	0.01	0.82
Nitrogen Dioxide(NO_2)	ug/m^3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO_2)	ug/m^3	24 Hours	5.0	<5.0
Particulate Matter (PM_{10})	ug/m^3	24 Hours	2.00	87.90

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

A.4 Ambient Air Quality

- Client Sustainable Solutions Pvt. Ltd.
- Sampling Point Proposed Batching Plant
- Date of Intervention August 29–30, 2013

Parameter	Unit	Duration	LDL	Average Obtained Concentration
Carbon Monoxide (CO)	mg/m^3	24 Hours	0.01	0.93
Nitrogen Dioxide(NO2)	ug/m^3	24 Hours	5.0	<5.0
Sulfur Dioxide (SO2)	ug/m^3	24 Hours	5.0	<5.0
Particulate Matter (PM10)	ug/m^3	24 Hours	2.00	66.77

ug/m^3: micrograms per cubic meter
mg/m^3: milligram per cubic meter
LDL: Lowest Detection Limit

A.5 Standards

A.5.1 National Environmental Quality Standards (NEQS) for Ambient Air Concentration in Ambient Air

Pollutants	Time– Weighted Average	Effective from 1st July 2010	Effective from 1st January 2013	Method of measurement
SO_2	Annual Average*	80 ug/m^3	80 ug/m^3	–Ultraviolet Fluorescence Method
	24 hrs**	120 ug/m^3	120 ug/m^3	
NO	Annual Average*	40 ug/m^3	40 ug/m^3	Gas Phase Chemiluminescence
	24 hrs**	40 ug/m^3	40 ug/m^3	
NO_2	Annual Average*	40 ug/m^3	40 ug/m^3	Gas Phase Chemiluminescence
	24 hrs**	80 ug/m^3	80 ug/m^3	
O_3	1 hr	180 ug/m^3	130 ug/m^3	Non Dispersive UV Absorption Method
Suspended Particulate Matter (SPM)	Annual Average*	400 ug/m^3	360 ug/m^3	High Volume Sampling (average flow rate not less than 1.1 m3/minute)
	24 hrs**	550 ug/m^3	500 ug/m^3	
Respirable Particulate Matter (PM_{10})	Annual Average*	200 ug/m^3	120 ug/m^3	–β Ray Absorption Method
	24 hrs**	250 ug/m^3	150 ug/m^3	
Respirable Particulate Matter ($PM_{2.5}$)	Annual Average*	25 ug/m^3	15 ug/m^3	–β Ray Absorption Method
	24 hrs**	40 ug/m^3	35 ug/m^3	
	1 hr	25 ug/m^3	15 ug/m^3	
Lead (Pb)	Annual Average*	1.5 ug/m^3	1 ug/m^3	ASS Method after sampling using EPM 2060 or equivalent Filter paper
	24 hrs**	2 ug/m^3	1.5 ug/m^3	
Carbon Monoxide (CO)	8hrs**	5 ug/m^3	5 ug/m^3	Non Dispersive Infra Red (NDIR) Method
	1 hr	10 ug/m^3	10 ug/m^3	

* Annual arithmetic mean of minimum 104 measurements in a year, taken twice a week 24 hourly at uniform interval.

** 24 hourly/ 8 hourly values should be met 98% of the in a year 2% of the time. It may exceed but not on two consecutive days.

A.6 Water Analysis Report

See following pages

Environmental Monitoring & Analysis

Hagler Bailly Pakistan

Sample ID	WGHPAI
Lab. ID	E 04156
Sample Collected By	Hussain Ali
Sampling Date	12/25/2013
Time of Sampling (hours)	10:05
Sample Received Date	12/25/2013
Sample	Water - Surface sample
Nature of Sample	Grab
Sample Collected from	River Water
Site/Location	Upstream of Kotli Town
Northings	N33.611747
Eastings	E73.946000

Parameter	*Analytical Method*	*Unit*	*LOR*	*Analysis Results*
Temperature	US EPA 170.1	°C	1.000	9.70
pH	US EPA 150.1		0.100	7.82
BOD5	US EPA 405.1	mg/l	5.000	ND
COD	US EPA 410.2	mg/l	4.000	ND
TSS	US EPA 160.2	mg/l	4.000	4.00
TDS	US EPA 160.1	mg/l	10.000	104.00
Nitrate	US EPA 300.1	mg/l	0.001	1.710
Phosphate	US EPA 300.1	mg/l	0.001	ND
Aluminium	US EPA 200.8	mg/l	0.001	0.103
Antimony	US EPA 200.8	mg/l	0.001	ND
Arsenic	US EPA 200.8	mg/l	0.001	0.070
Barium	US EPA 200.8	mg/l	0.001	0.046
Boron	US EPA 200.8	mg/l	0.001	0.006
Cadmium	US EPA 200.8	mg/l	0.001	ND
Chromium	US EPA 200.8	mg/l	0.001	ND
Copper	US EPA 200.8	mg/l	0.001	0.007
Iron	US EPA 200.8	mg/l	0.001	0.394
Lead	US EPA 200.8	mg/l	0.001	ND

Analyst

Saeed Nawaz

Checked By

Asif Mahmood
Manager, EMA Services

Environmental Monitoring & Analysis
Hagler Bailly Pakistan

Parameter	*Analytical Method*	*Unit*	*LOR*	*Analysis Results*
Mercury	US EPA 200.8	mg/l	0.001	ND
Manganese	US EPA 200.8	mg/l	0.001	0.574
Nickel	US EPA 200.8	mg/l	0.001	0.177
Selenium	US EPA 200.8	mg/l	0.001	ND
Silver	US EPA 200.8	mg/l	0.001	ND
Zinc	US EPA 200.8	mg/l	0.001	0.001

USEPA: United States Environmental Protection Agency

BOD: Biochemical Oxygen Demand

COD: Chemical Oxygen Demand

TSS: Total Suspended Solids

TDS: Total Dissolved Solids

LOR: Level of Reporting

mg/l: Milligram Per Liter

ND: Not Detected

Analyst

Saeed Nawaz

Checked By

Asif Mahmood
Manager, EMA Services

Environmental Monitoring & Analysis

Hagler Bailly Pakistan

Sample ID	WGHPA2
Lab. ID	E 04157
Sample Collected By	Hussain Ali
Sampling Date	12/25/2013
Time of Sampling (hours)	11:30
Sample Received Date	12/25/2013
Sample	Water - Surface sample
Nature of Sample	Grab
Sample Collected from	River Water
Site/Location	Downstream of Kotli Town
Northings	N33.455640
Eastings	E73.865800

Parameter	*Analytical Method*	*Unit*	*LOR*	*Analysis Results*
Temperature	US EPA 170.1	°C	1.000	10.30
pH	US EPA 150.1		0.100	8.12
BOD5	US EPA 405.1	mg/l	5.000	ND
COD	US EPA 410.2	mg/l	4.000	4.99
TSS	US EPA 160.2	mg/l	4.000	4.00
TDS	US EPA 160.1	mg/l	10.000	108.00
Nitrate	US EPA 300.1	mg/l	0.001	4.050
Phosphate	US EPA 300.1	mg/l	0.001	ND
Aluminium	US EPA 200.8	mg/l	0.001	0.084
Antimony	US EPA 200.8	mg/l	0.001	ND
Arsenic	US EPA 200.8	mg/l	0.001	0.079
Barium	US EPA 200.8	mg/l	0.001	0.041
Boron	US EPA 200.8	mg/l	0.001	0.010
Cadmium	US EPA 200.8	mg/l	0.001	ND
Chromium	US EPA 200.8	mg/l	0.001	ND
Copper	US EPA 200.8	mg/l	0.001	0.005
Iron	US EPA 200.8	mg/l	0.001	0.425
Lead	US EPA 200.8	mg/l	0.001	ND

Analyst

Saeed Nawaz

Checked By

Asif Mahmood
Manager, EMA Services

Environmental Monitoring & Analysis
HaglerBailly Pakistan

Parameter	Analytical Method	Unit	LOR	Analysis Results
Mercury	US EPA 200.8	mg/l	0.001	ND
Manganese	US EPA 200.8	mg/l	0.001	0.629
Nickel	US EPA 200.8	mg/l	0.001	0.189
Selenium	US EPA 200.8	mg/l	0.001	ND
Silver	US EPA 200.8	mg/l	0.001	ND
Zinc	US EPA 200.8	mg/l	0.001	0.008

USEPA: United States Environmental Protection Agency
BOD: Biochemical Oxygen Demand
COD: Chemical Oxygen Demand
TSS: Total Suspended Solids
TDS: Total Dissolved Solids
LOR: Level of Reporting
mg/l: Milligram Per Liter
ND: Not Detected

Analyst

Saeed Nawaz

Checked By

Asif Mahmood
Manager, EMA Services

Appendix B: Biodiversity Baseline

Hagler Bailly Pakistan

Biodiversity Baseline

Gulpur Hydropower Project

Final Report

HBP Ref.: R4E04GHP

October 12, 2014

Mira Power Limited

Islamabad

Contents

Exhibits

1. Introduction

Mira Power Limited (the "MPL" or the "Company") is an Independent Power Producer (the "IPP") which is planning to develop Gulpur Hydropower Project (the "Project") in the Azad Jammu & Kashmir (the 'AJK'). The Project will utilize the flow of Poonch River, the full length of which within AJK has been notified as a national park by the AJK Wildlife and Fisheries Department. MPL engaged Hagler Bailly Pakistan to conduct an assessment of potential impacts on biodiversity from the Project and to identify mitigation and management measures to address potential impacts from the Project.

The objective of this study is to establish ecological baseline information on the flora and fauna in the Study Area.

1.1 Project Setting

The Gulpur Hydropower Project with design capacity of 100 MW will use the water resources of the Poonch River for power generation. The Project site is located in Kotli District, Azad Jammu and Kashmir at latitude 33°27' and longitude 73°51', about 9 km South of Kotli Town (**Exhibit 1.1**).

Exhibit 1.2 illustrates the principle features of the Project. The Project's major components include weir, intake structure and power house. All the project structures will be located near Barali on the Poonch River at about 11 km downstream of Kotli Town and about 6 km downstream of the confluence of Ban Nullah with the river. The intake structure and intake portal of the power tunnel will be located on west bank of the Poonch River, 150 meter upstream of weir structure on the eastern face of a ridge. The power house and outlet will be located on right bank Poonch River about 800 m downstream of the Weir structure. A low flow section of a length of about 700m will be created downstream of the weir to the outlet of the powerhouse. The Normal Operating Level (NOL) of the Project shall be at an elevation of 532 m from the sea level

Exhibit 1.1: Project Setting

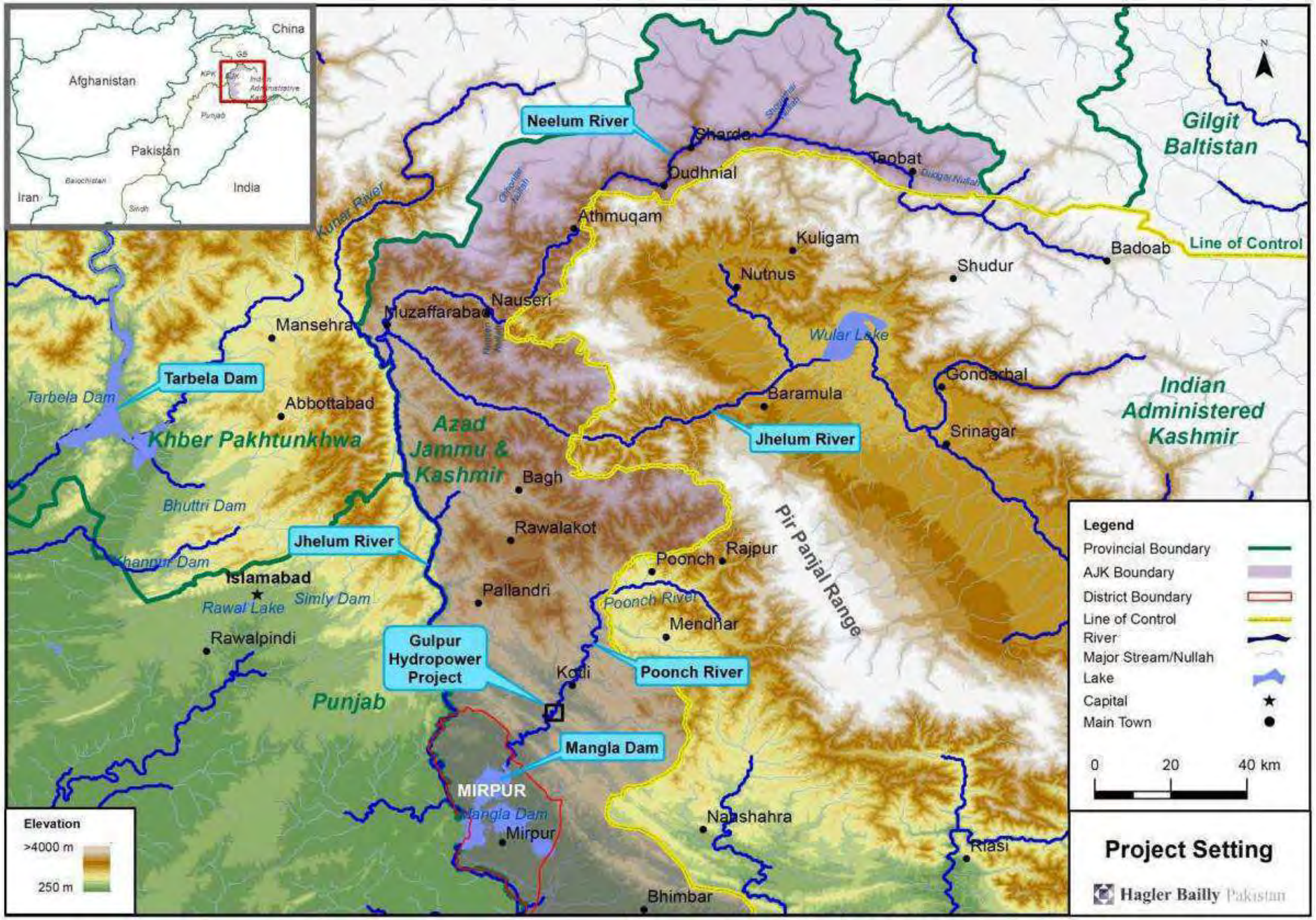
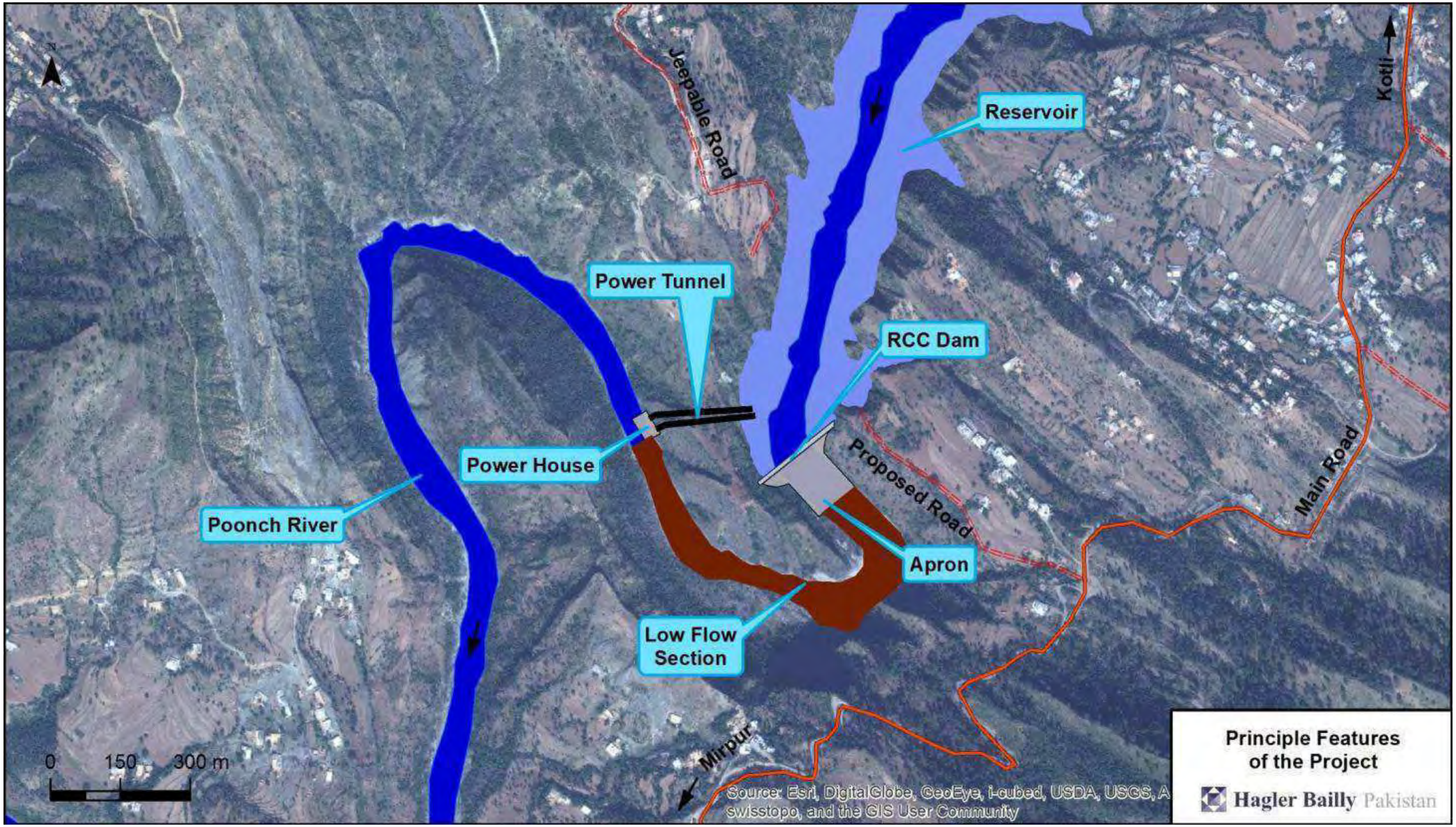


Exhibit 1.2: Principle Features of the Project



1.2 Scope

The specific tasks covered under this ecological baseline study included:

- A review of the available literature on the biodiversity of the Study Area.
- Field surveys including:
  - Qualitative and quantitative assessment of flora, mammals, reptiles, birds and invertebrates
  - Identification of key species, their population and their conservation status in the country and worldwide.
  - Reports of wildlife sightings in the Study Area by the resident communities.
- Analysis of ecological interaction of selected species with the environment using information collected during surveys. .
- Analysis was also carried out to further develop the basis for evaluating the potential impacts of Project related activities on the biodiversity, specifically seeking any potential critical habitat and ecosystem services in the Study Area.

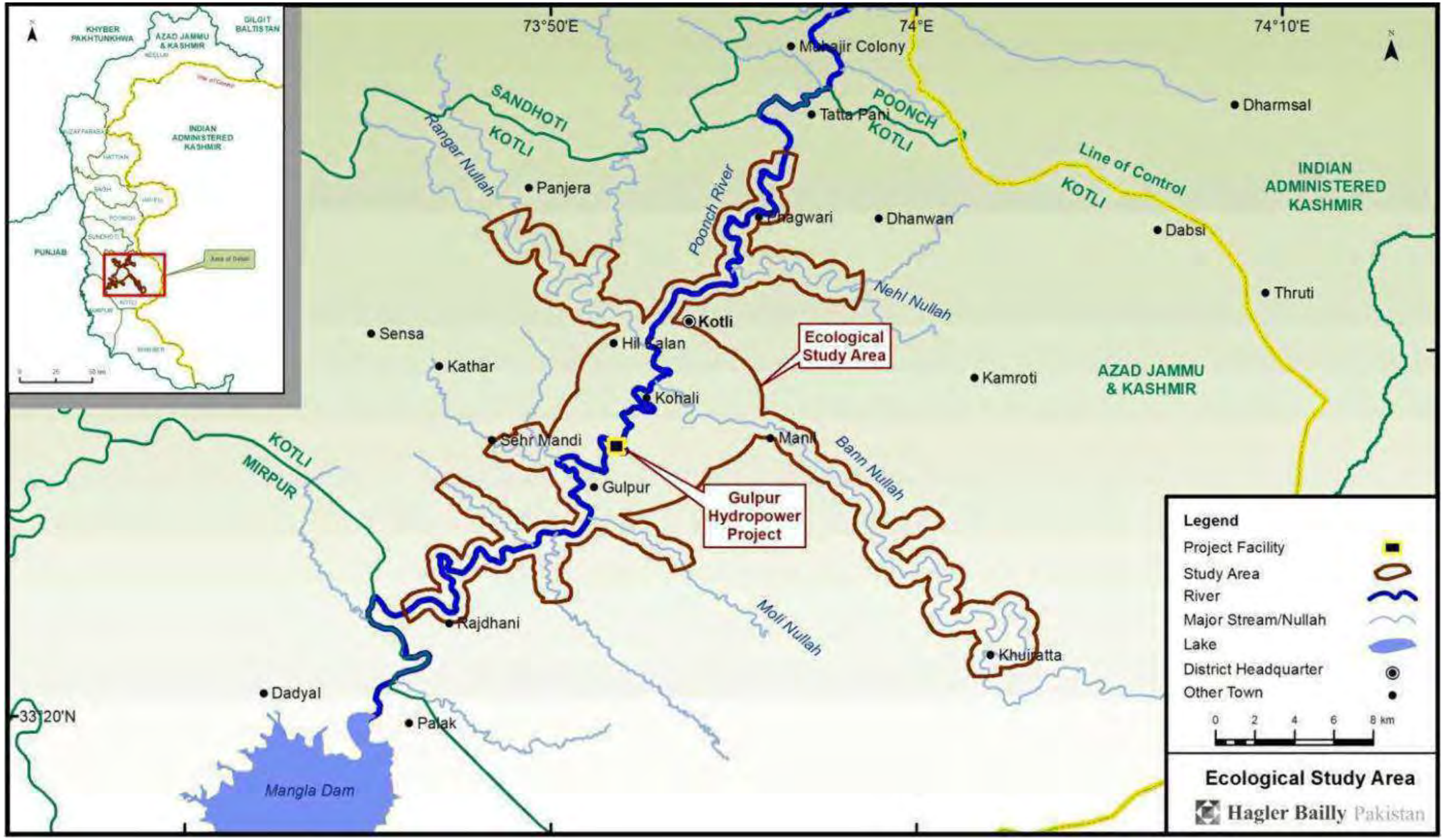
1.3 Study Area

The study area for sampling the aquatic resources consists of the stretch of Poonch River from Kallar Bridge to just downstream Rajhdani, as well as the main tributaries of the Poonch River including Ban Nullah, Rangar Nullah and Nehl Nullah. The river banks and areas within 500 m on either side of the river have been included in this Aquatic Study Area and sampling for vegetation, mammals, herpeto-fauna and birds has been conducted in these riparian habitats.

The terrestrial study area was demarcated when Option 1 for the location and layout of the Project was under consideration. Option 1 consisted of a dam located just downstream of the confluence of Bann Nallah and Poonch River, and a 3.1 km diversion tunnel located in Bann Nallah. The study area for sampling the terrestrial ecological resources, therefore, consists of the Project facilities (as proposed for Option 1) such as power house, weir, camping sites etc. as well as a 3 km potential impact zone around each facility to account for an area in which the ecological resources may be impacted by Project related activities such as habitat loss, sound, vibrations etc..

The term ‘Ecological Study Area’ or simply ‘Study Area’ is used to jointly refer to both the Aquatic and Terrestrial Study Areas and is shown on a map in **Exhibit 1.3**.

Exhibit 1.3: Study Area



1.4 Concerns Expressed by the Stakeholders

Consultations were undertaken with communities and institutions that may have interest in the proposed project or may be affected by it. A basin wide study approach was used and 11 rural communities were consulted along the Poonch River in February 2014. In addition to the potentially affected communities, local government and local NGO officials were also consulted. Consultations with the Project stakeholders were undertaken during the third and fourth week of February 2014. Separate meetings with institutional stakeholders were arranged in Kotli, Islamabad and Muzaffarabad. Concerns raised by the stakeholders related to biological resources are summarized below (**Exhibit 1.4**)

Exhibit 1.4: Concerns Expressed by Stakeholders

Concerns Expressed	*Response Given*
Reduced flow downstream of the dam may result in lesser habitat available for the aquatic flora and fauna particularly the fish of conservation and economic importance.	A minimum environmental flow will be determined and released downstream of the dam at all times of the year
Reduced flow downstream may increase the concentration of contaminants in river water.	A minimum environmental flow will be determined and released downstream of the dam at all times of the year
The Project construction and operation may negatively impact the terrestrial ecological resources in the Project site and vicinity particularly the vegetation.	Mitigation measures to minimize Project impacts on the terrestrial ecological resources will be included in the ESIA.

1.5 Organization of the Report

This report describes the ecological conditions in the Study Area focusing on Methodology (**Section 2**), Ecological Setting (**Section 3**), Fish Fauna (**Section 4**), Macro-invertebrates (**Section 5**), Floral Diversity and Habitats (**Section 6**), Mammals (**Section 7**), Herpeto-fauna (**Section 8),** Birds **(Section 9**), and **Section 10** presents the main Conclusions of the Draft Biodiversity Baseline of Gulpur Hydropower Project.

2. Methodology

The methodology for the field survey was compiled to obtain objective data, and to determine the baseline conditions for assessment of the resulting impacts of the Project for the data collected.

During the October 2013 survey, sampling was conducted at eight locations for fish and macro-invertebrates and eighteen locations for vegetation, mammals, herpeto-fauna and birds.

During the December 2013 survey, sampling for Otter sightings and signs was conducted at six locations, sampling for fish was conducted at 4 locations while sampling for vegetation, mammals and birds was conducted at three (3) sampling locations (the terrestrial habitat that will be occupied by Project infrastructure under Option 3). Since the herpeto-fauna hibernate in the winter months, reptile and amphibian sampling was not conducted during the December 2013 survey.

During the May 2014 survey, fish sampling was carried out at nine sampling locations, five sites that were sampled in the October 2013 survey and four additional sites – sites under consideration for planned hydropower projects in the Poonch River. Sampling for vegetation in the May 2014 survey was repeated at the same sampling locations as the December 2014 survey.

The timing, location, and scope of the surveys are summarized in **Exhibit 2.1**.

Exhibit 2.1: Timing, Location, and Scope of Surveys in the Study Area

Survey Period	*Area Studied*	*Scope*	*Comments*
October 2013	River, tributaries, and terrestrial habitats in the Aquatic and Terrestrial Ecological Study Area	Aquatic/River dependent: fish, macroinvertebrates, macrophytes, marginal vegetation, mammals, birds,and herpeto–fauna.	A total of eight sampling locations were selected for aquatic sampling in the river and its tributaries. The river biotopes at each sampling location were identified and sampling for fish and macro–invertebartes was conducted ensuring sampling in each biotope. Sampling of vegetation, mammals, reptiles and birds was conducted on the riparian habitats within 500 m on either side of the river.
		Terrestrial: vegetation, mammals, birds and herpeto–fauna	A total of eighteen sampling locations were selected for terrestrial sampling of vegetation, mammals, herpeto–fauna and birds. A grid of 2x2 km was drawn on a map of the Terrestrial Study Area and the sampling points were marked. The points were then adjusted to ensure habitat representation, accessibility, with a focus on the areas to be impacted. Seven trapping sites for small mammals were selected.

Survey Period	Area Studied	Scope	Comments
December 2013	River, and terrestrial habitats at the proposed Project location.	Aquatic/River dependent: fish, Otter Terrestrial: vegetation, mammals and birds	A total of 4 sampling locations were selected for aquatic sampling of fishes . A total of six sampling locations were selected for observing Otter sightings and signs. A total of three sampling locations were selected for terrestrial sampling of vegetation, mammals, herpeto–fauna and birds at the proposed Project location. One trapping site for small mammals was selected.
May 2014	River, and terrestrial habitats at the proposed Project location	Aquatic/River dependent: fish Terrestrial: vegetation	A total of 9 sampling locations were selected for aquatic sampling of fishes . A total of three sampling locations were selected for terrestrial sampling of vegetation at the proposed Project location.

The aquatic and terrestrial sampling locations are shown on a map in **Exhibit 2.2** and **Exhibit 2.3. Exhibit 2.4** shows the locations for fish sampling during May 2014 survey.

The location of sampling points, habitat types, dates of surveys, and coordinates of sampling locations and field data collected during various surveys are included in **Appendix A**. A list of the species recorded from the Study Area during the survey is provided in **Appendix B**.

Details on survey techniques and data collection are provided below.

2.1 Aquatic Ecological Resources Survey

2.1.1 Fish

The fish fauna were collected from the selected sampling points using cast with mesh sizes 2 x 2 cm, having a circumference of 4m. Twenty nets were cast on a line of 200 m along the bank of the river. Fish species collected were identified in the field and the number of specimens of each species was noted at the spot. Most of the specimens were released after identification, while voucher specimens were kept for record and preserved in 10% formaldehyde. Different micro-habitats of the river such as pools, riffles and back water were sampled to understand habitat preferences of different species. The abundance and diversity of the fish at each sampling point was calculated particularly for fish species chosen as biological indicators for the impact assessment.

In addition to cast net, gill net was also used during December 2013 survey. The gill net consisted of net attached between the head rope and the foot rope. Two gill nets of different mesh sizes were used during the survey. One gill net was 30 mx5 m with the mesh size of 4.5 cm and the other was 30mx5m with a mesh size of 6 cm.

2.1.2 Macro-invertebrate

Macro-invertebrates were sampled by adopting the standardized rapid biological assessment sampling techniques (using multi-habitat approach) developed by Barbour et al 1999[1]. A Surber Sampler or D frame kick net was used for sampling. Twenty efforts were taken at each sampling station based on percent availability of each biotope. For example if a sampling station comprised of 80% riffle and 20% pool habitat, then 16 efforts of the Surber Sampler were conducted in the riffles and 4 efforts in pool (ratio of 80% to 20%).

At each sampling location, the collected material was rinsed using running clean stream water through the net two to three times. The material was transferred into a large (white) tray or a bucket. The sample was then transferred to a container and covered with 10% formalin.

In the laboratory, each sample was put into a sieve of 500 μm mesh size and rinsed with running water (to remove traces of formalin). Macro-invertebrates were then sorted from the samples and identified using a Kyowa Stereozoom Microscope and the identification keys given in Edmondson, 1959[2]; Ali 1967[3], Ali 1970[4], Bouchard 2004[5].

The abundance of macro-invertebrates per square meter was calculated and the pollution tolerance of the identified taxa was taken from HKH bios scoring list (Hindukush Himalayan Score Bio-assessment) (Hartmann et a1., Deliverable 10[6]).

2.2 Terrestrial Ecological Resources Survey

2.2.1 Floral Diversity (Vegetation) and Habitats

The usual means of sampling vegetation for floristic composition is the quadrat. The vegetation in the marginal zone, flood plain and terrestrial habitats in the Study Area was sampled by the quadrat method, taking 3 quadrats of 5m x 5m at each sampling site. The first quadrat was taken at the beginning of the transect, the second at 250 meters and the third at 500 m. All sampling points were sampled to include representative habitats, topographic and physiographic conditions of the Study Area. Plants from each quadrat were noted and collected for the identification of the plant species if required. Additional plant species in the area adjacent to the quadrat were also noted down and collected to record the occurrence of the species. Cover, relative cover, density, relative density,

---

1 Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

2 Fresh-Water Biology Fresh-Water Biology, Second Edition. By hb Ward and gc Whipple (wt Edmondson, Editor). John Wiley and Sons, New York. 1959.

3 Ali, S.R. 1967. The Mayflies (Order: Ephemeroptera) of Rawalpindi District. Pak. J. Sci. 19 (3): 73-86.

4 Ali, S.R. 1970. Certain Mayflies of West Pakistan. Pak. J. Sci. 22 (3 & 4): 118-124.

5 Bouchard, R.W. Jr. 2004. Guide to Aquatic Macroinvertebrates of Upper Midwest. Water Resources Center, University of Minnesota, St. Paul, Minnesota. 208pp.

6 Hartmann, A., O. Moog, T. Ofenböck, T. Korte, S. Sharma and D. Hering. Deliverable No. 10. ASSESS-HKH Methodology Manual describing fundamentals a application of three approaches to evaluate river quality based on benthic macroinvertebrates: HKH screening, HKH score bioassessment & HKH multimatric bioassessment. 80pp. www.assess-hkh.at

frequency, relative frequency percentages and Importance Value Index (IVI) for each species from the study were calculated by using the following formulae:

The Cover and Relative Cover of species were calculated using the following formula:

$$\text{Cover} = \frac{\text{Total cover (cm) of a specie}}{\text{Number of plants of a species}}$$

$$\text{Relative Cover} = \frac{\text{Total cover (sq cm) of all plants of a species x 100}}{\text{Total cover (sq cm) of plants of all species}}$$

The Density and Relative Density of the species in the area were calculated using the following formulae:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrats taken}}{\text{Total number of quadrats taken}}$$

$$\text{Relative Density} = \frac{\text{Total number of individuals of a species in all quadrats x 100}}{\text{Total number of individual of all species in all quadrats}}$$

The Frequency and Relative Frequency percentages of the species were determined using the following formulae:

$$\text{Frequency} = \frac{\text{Number of quadrats of occurrence of a species x 100}}{\text{Total number of quadrats lay out}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of a species x 100}}{\text{Total Frequency of all species}}$$

Importance Value Index (IVI) of all the recorded species was calculated using the following formulae:

$$\text{IVI} = \frac{\text{Relative cover + Relative frequency + Relative density}}{3}$$

Plants collected were identified following the nomenclature from Flora of Pakistan (Nasir and Ali 1972-1994[7], Ali and Qaiser, 1995-to date[8]).

7 S. I. and Nasir. 1972-1994. Flora of Pakistan Fascicles. Islamabad

Local people were consulted to gather information about local names, uses, value and cultural values of the plants of the area.

2.2.2 Mammals

The mammal surveys were categorized into a) large mammals, b) small mammals, c) Otter survey.

Large Mammals

Line transects (500 m by 20 m) were placed at each sampling location to record all animals or their signs detected. All the animals sighted, or their signs (foot marks, droppings, dens) were recorded. GPS coordinates of the location and habitat type will also be documented. Samples of feces and photographs of tracks were taken and conserved for potential subsequent confirmatory analysis. Transects were started as early as possible in the day and will cover all possible habitat types in order to avoid bias of stratification.

In addition, incidental sightings of all mammals were recorded; number of individuals, location and habitat type were recorded for each sighting. Anecdotal information regarding specific mammals was collected from the local people and relevant literature was also consulted.

Otter

There methods used for Otter survey are given below:

Survey of Dens/ Caves/ Crevices

The river banks along the deep and long pools were surveyed to see the dens of the Otters. This technique clearly has value in rivers where Otters can make dens along the river bank.

Tracks:

As Otter foot prints are very distinct, they are used as evidence of otters during surveys Otter signs indicate only presence or absence, rather than the abundance of Otters.

Spraints (droppings of otter)

The most frequently used technique for detecting the presence of Otters, and in some cases estimating their abundance or relative abundance is to search for spraints. Otters frequently deposit spraint (droppings of the Otter) under or near bridges, where footprints are also frequently found. By virtue of its wide use, it has become the ‘standard method’ and was recognized as a major review of surveying methods carried out by Reuther et a1. (2000). The sites suitable for surveying are mainly selected for ease of access and are usually adjacent to bridges.

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[8] Ali, S. I. and Qaiser, M. 1995 to date. Flora of Pakistan Fascicles. Karachi

Complete searches of long lengths

Long lengths of river banks (1-2 km) were surveyed to determine habitat use by Otters. In this method, abundance of spraint was used as an indicator of Otter activity or habitat.

Interviews with the local people

Local people specially the fishermen and boatmen, sand miners were interviewed for presence of the Otter in the areas.

Live Trapping for Small Mammals

Live trapping for small mammals was carried out at various sampling sites. Trapped animals were identified and released alive after taking measurements.

Bait

A mixture of different food grains mixed with fragrant seeds was used as bait to attract the small mammals. Wheat and rice were used as food grains while peanut butter, coriander, oats, and onion were used for fragrance. Freshly prepared bait was used on every trapping day. Only a small amount of bait was put on the rear side of the traps. Care was taken while putting the bait on the rear side of the trap to make sure that it was placed properly on the trap platform.

Traps and Trapping Procedure

Sherman traps were used for the present study to collect live specimens. Thirty to forty traps were set at a specific area in two lines approximately 10 m apart. A colorful ribbon to locate traps the next day was used to mark each trap. The traps were set in the evening and checked early the next morning, ensuring that the trapped animals are not killed by heat.

Data Collection

The traps were checked the following morning as early as possible. The trapped animals were carefully transferred one after the other into an already weighed transparent polythene bag. Utmost care was taken to avoid direct handling and harassing the specimens. The species of the trapped animals were noted. The polythene bag along with the specimen were weighed and the net weight of the animal were noted down in a note book. The sex of the specimens was also observed and documented carefully. The important relevant data, such as the date of trap setting, date of data collection, habitat, location, elevation, and weather conditions, was recorded on the spot on a data sheet.

2.2.3 Birds

The line transects (500 m by 50 m) were placed at each sampling location to record all birds observed. Transects were started as early as possible in the morning and in late afternoon and will cover all possible habitats. The start time and coordinates of the starting point were recorded. The birds were identified using the most recent keys available in literature (Grimmett 2008)[9]. Density and diversity of birds were calculated. Multiple surveys were conducted to record seasonal variations and migratory birds.

2.2.4 Herpeto-fauna

Line transects 500 m long and 20 m wide were placed systematically at each sampling site in the Study Area.

An effective way to survey reptiles is by active searching, particularly during the daytime. This method is equally applicable to both nocturnal and diurnal species. The sampling sites were actively searched for all types of reptiles and amphibians along the line transects. Active searching was also carried out in sampling areas with a focus on suitable microhabitats. Nocturnal sampling was carried out at one sampling location. The species collected or observed during the survey were photographed with a digital camera and necessary field data was recorded. The coordinates and elevations were recorded using GPS, and other features of interest like habitat type were documented.

The presence of signs such as an impression of body, tail or footprints, fecal pellets, tracks, dens or egg laying excavations were recorded.

Samples were collected and preserved for identification purposes where the species could not be identified in the field for any reason. Hand picking (using bare hands or with the help of long forceps or a snake clutch) is the most efficient way of collecting different species of reptiles. However, for larger noose traps or other appropriate techniques were used. For handling snakes, especially poisonous ones, snake clutches/sticks were used.

Preservatives such as 10% formalin solution or 50-70% alcohol or methylated spirits solution in water were added to just cover the specimens, and the container were covered and left until the specimens are set. In the case of larger specimens, a slit was made in the belly and preservative were injected to preserve the internal organs.

The specimens were stored in the same preservative in a watertight jar. A waterproof label was added to the jar, giving details of habitat, date and collector's name. A label was tied to the specimen written with permanent Indian ink or simple carbon pencil.

The specimens were identified with the help of the most recent keys available in literature (Khan, 2006)[10]. Density and diversity of herpeto-fauna at each sampling location was calculated.

2.3 Basis for Determination of Conservation Status of Species and Performance Standard for Preparation of the Baseline

The basis for determination of the conservation status of the species and the standard followed for preparation of this baseline are outlined below.

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9 Grimmett, R., Roberts, T., and Inskipp, T. 2008. Birds of Pakistan, Yale University Press.

10 Muhammad Sharif Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Malabar, Florida, pp. 311.

Pakistan Mammals National Red List: This National list is based on country-wide surveys conducted by IUCN in 2005 to assess the conservation status of mammals in Pakistan. The list was officially published in 2006.

IUCN Red List of Threatened Species: The IUCN Red List of Threatened Species™[11] (IUCN Red List 2013) is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species. The location of the sightings of the species appearing in the IUCN Red List has been provided in the report.

CITES: The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international convention of governments to insure that international trade in specimens of wild animals and plants does not threaten their survival. CITES works by regulating international trade in specimens of selected species. All import and export species covered by the Convention have to be authorized through a licensing system. Species are assigned to one of three Appendices[12] depending upon the degree of protection deemed necessary with Appendix I being the most restricted use. The CITES lists available online were consulted for this study in October 2013. The location of the sightings of the species listed under CITES have been provided in the report. It may be noted that the focus of the CITES is to regulate the movement of the species with the ultimate aim of safeguarding the resources for the future, the species may not be endangered. In terms of environmental management related to a project, designs and activities that can facilitate utilization of a species (particularly regarding across the border) is of concern.

Equator Principles and IFC Performance Standard 6: This ecological baseline document was developed to address the requirements of the Equator Principles[13] and International Finance Corporation (IFC) Performance Standards[14].

The Equator Principles were created to determine, assess, and manage social and environmental risk in project financing. The principles provide a framework for each

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[11] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 26 October 2013.

[12] **Appendix I** shall include all species threatened with extinction which are or may be affected by trade. Trade in specimens of these species must be subject to particularly strict regulation in order not to endanger further their survival and must only be authorized in exceptional circumstances.

Appendix II shall include:
(a) all species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival; and
(b) other species which must be subject to regulation in order that trade in specimens of certain species referred to in sub-paragraph (a) of this paragraph may be brought under effective control.

Appendix III shall include all species which any Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and as needing the co-operation of other Parties in the control of trade.

[13] The Equator Principle. June 2006. Adopted by The Equator Principles Financial Institutions, www.equator-principles.com, Accessed 11 October, 2011.

[14] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

Equator Principle Financial Institution (lenders) to develop its own procedures and standards. In general they require, in the initial stages: review and categorization of the proposed project, social and environmental assessment, and the application of applicable social and environmental standards. There are other steps in the Equator Principles, and while they all apply to any proposed project, for the purpose of this baseline, it is the particulars of IFC Performance Standard 6 that are considered.

The IFC Performance Standards were developed from the broad principles of the Equator Principles and specifically address components of the assessment of projects (and any alternatives) applying for international funding. The baseline report (its information) becomes the foundation of the analysis of the potential impacts, as well as the management of those impacts for the proposed Project.

To address the IFC Performance Standard 6, each ecological baseline report should address the biodiversity of the Study Area, which includes habitats (both abiotic factors such as topography, soils and water, and biotic factors, which includes flora) and fauna (which includes all life, from invertebrates to megafauna). If the Project will have a potentially significant impact, greater care is required in the analysis.

Habitat descriptions should include critical habitat, both modified and natural habitats, particularly those with high biodiversity value for the survival of threatened (threatened with or in danger of extinction) species, if any are determined. Those habitats having special significance for endemic or restricted range species, or having importance for migratory species or congregatory species, or unique assemblages of species with key evolutionary processes, or provide key ecosystem services, or lastly, areas that have biodiversity of significance to social, economic or cultural importance to local communities should also be delineated. This document should describe the accuracy, reliability and sources of the data. In addition, the baseline further must describe methods used to collect and analyze data and should be relevant to project location (and any alternatives), design, operation and potential mitigation measures (to be determine from the baseline).

2.4 Limitations of the Study

Carnivores: Large carnivore species (e.g. Common Red Fox Vulpes vulpes Asiatic Jackal Canis aureus, cats Felis sp., etc) are highly elusive and predominantly nocturnal, which make their detection difficult. These species also have large home ranges and exist in sparse populations (or primarily individually), which further reduce chances of encountering them or their signs. Intensive sign surveys (as described in **Section 2.1.2**) were conducted and local informants were consulted to evaluate survey findings. However, it is recognized that sign surveys have limitations; for example, tracks are especially difficult to determine on hard substrates making it confusing to differentiate between signs of related species.

Exhibit 2.2: Aquatic Ecological Sampling Locations

Exhibit 2.3: Terrestrial Ecological Sampling Locations

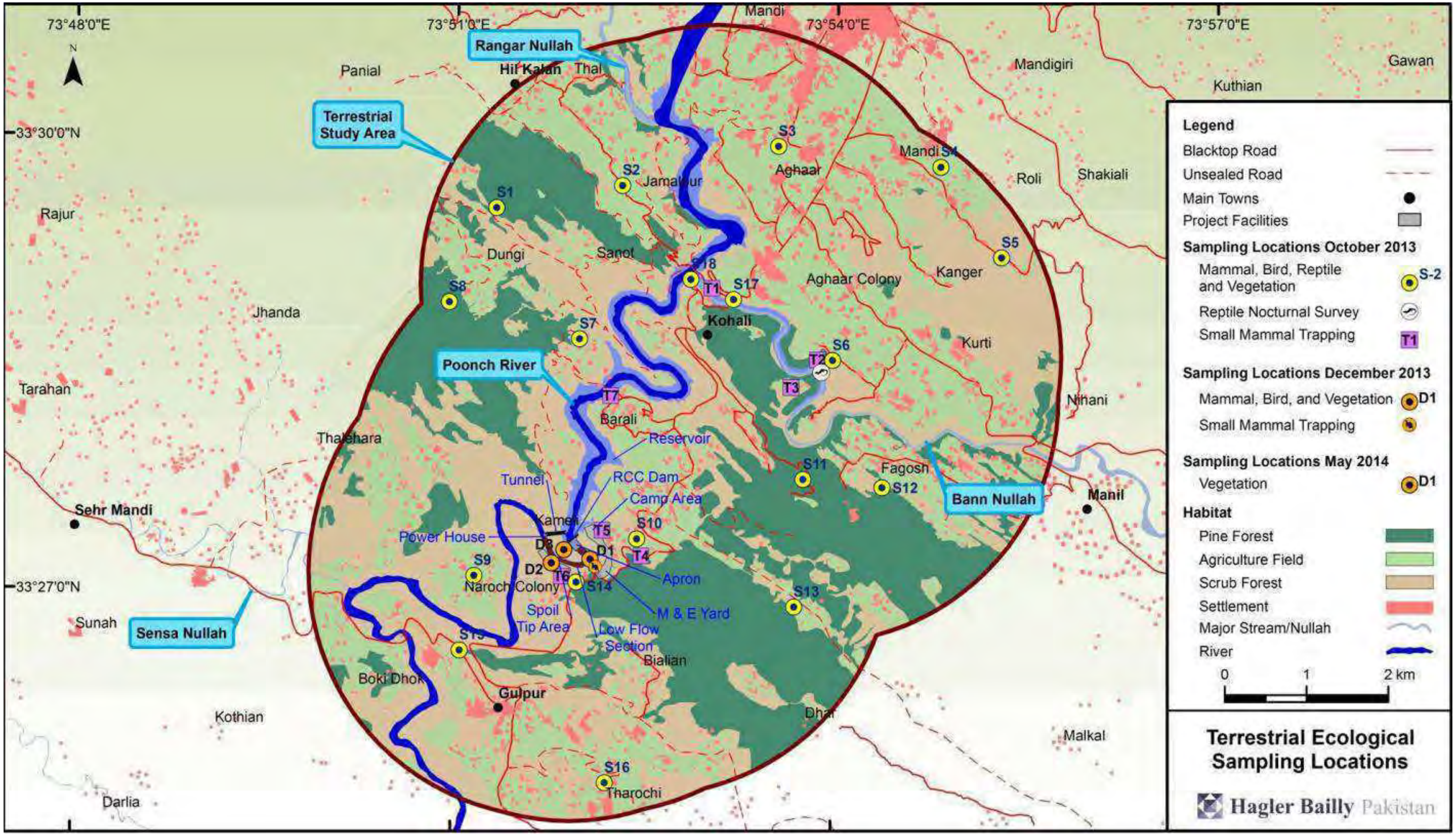
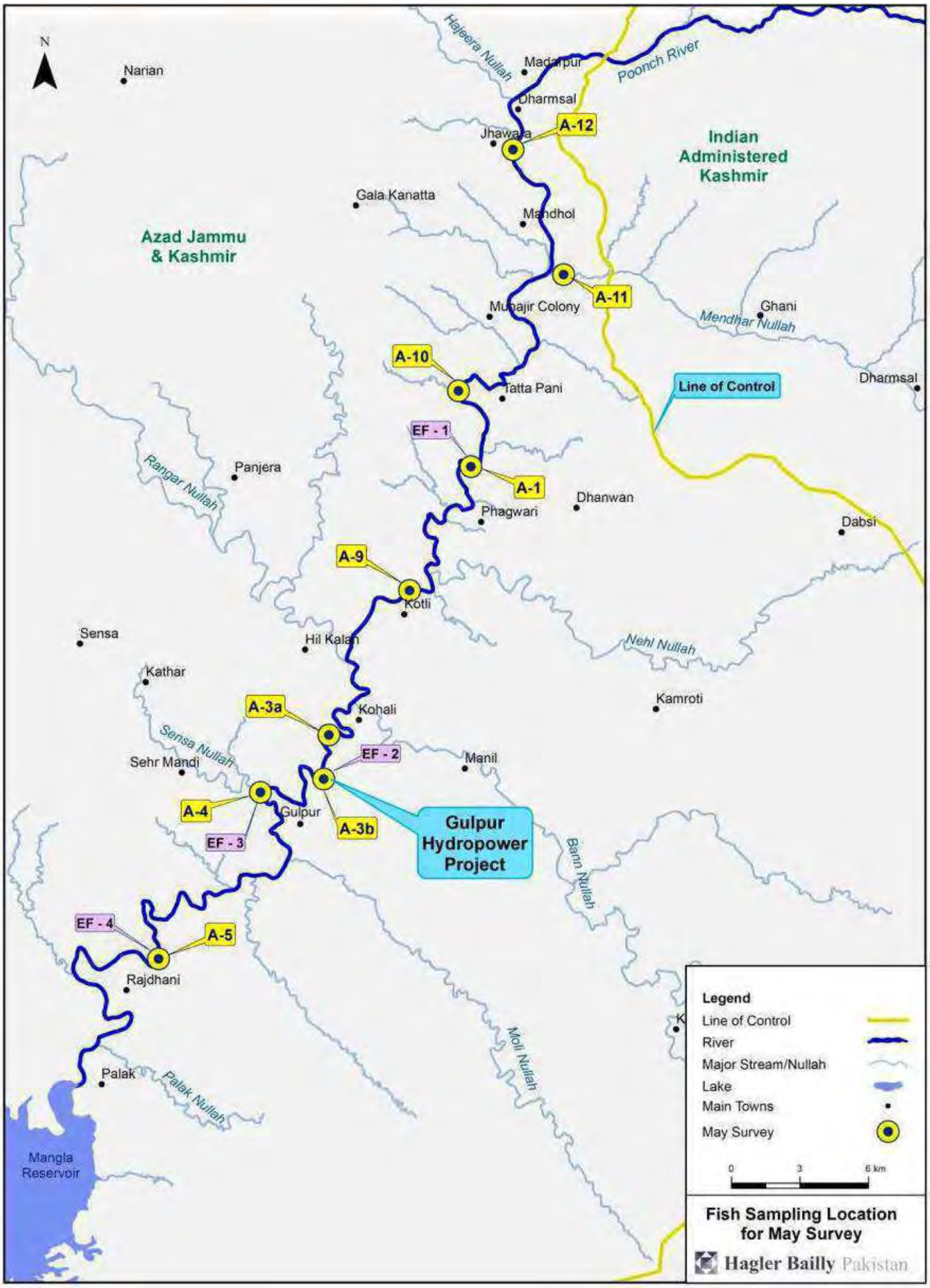


Exhibit 2.4: Fish Sampling Locations for May 2014 survey



3. Ecological Setting

This section outlines the ecological setting of the Project and the importance of the Poonch River in terms of its biological resources. Information for this section is derived from literature review of relevant scientific journals, EIA reports, books, websites and biodiversity assessment reports compiled by NGOs and government organizations.

3.1 Regional Overview

The Area of Azad Jammu and Kashmir is drained by three main rivers viz., Neelum, Jhelum and Poonch, all draining into Mangla Reservoir. The Mangla Dam is the twelfth largest dam in the world. It was constructed in 1967 across the Jhelum River in Mirpur district of Azad Kashmir (**Exhibit 1.1**).

Mangla Dam, which became operational in 1967, was a major intervention, which has altered the river ecology downstream as well as upstream of the reservoir. The rivers draining into Mangla Reservoir have different characteristics as they originate from areas having different geographical and physical features. The Poonch River originates in the western foothills of Pir Panjal Range. The steep slopes of the Pir Panjal form the upper catchment of this river. It is a small gurgling water channel in this tract and descends along a very steep gradient until it reaches in the foothill areas. The river widens as more and more tributaries from both sides enter into the main river. The valley too opens up, Poonch River begins to flow with a more gentle current in its middle, and lower reaches. The upper catchment is covered by dense forests while the vegetation of the middle and lower region is under intense biotic pressure. Poonch River from the line of control to Kotli town has steep slope (6.9-8.3 m/km) and the valley is narrow. Below Kotli, the river gradient is relatively mild (3.7m/km). The river ultimately joins the Mangla Lake near Chomukh in Mirpur district of Azad Jammu and Kashmir.

The Poonch River is a warm water river and the water temperature approaches almost 30^{o} C during the summer months. Water in the Jhelum River has the intermediate temperature reaching 25^{o} C during the summer months. These variable temperature regimes give the Mangla reservoir a unique physic-chemical characteristic having different temperature regimes, both, on horizontal as well as on vertical scales. Different pockets in the Mangla reservoir have different temperature regimes. The depth of the dam gives temperature stratification throughout its depth. The Jhelum River is deep with fast water flows all along the river. It flows through a "V" shaped valley. On the other hand, the Poonch River is shallow, open, flat and the water flows with a moderate speed. The fish fauna in these water bodies is therefore distributed according to their requirements of temperature and other physic-chemical and factors. The vast lake environment of Mangla reservoir has facilitated large commercial fishes to be established in the dam area while the typical river fish fauna is distributed in the two rivers according to their requirements of the physic-chemical factors.[15]

The Jhelum River, Poonch River and Mangla Reservoir show variations in diversity of fish fauna. The Mangla Reservoir and Jhelum River differ from each other and the Poonch River falls in between these two water bodies (**Exhibit 1.1**). The physic-chemical factors and the fish fauna studied previously also revealed similar results. Poonch River is in between the Jhelum River and Mangla Reservoir in terms of water temperature, nature of habitat, physical conditions of the breeding grounds, water speed, water volume, relative length of the river and topography of the area of three water bodies (Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012).

Cluster Analysis also showed that the three water bodies can be divided into three distinct groups on the basis of their fish fauna at 65% similarity level. The Poonch and Jhelum Rivers are somewhat similar due to the flowing water conditions in both of the water bodies and having similar impact of the Mangla Reservoir at least in their lower reaches. Moreover, most of the fish fauna found in the Mangla Reservoir, specially the commercially important fish fauna, are distributed in the downstream areas of the lake in the rivers of Punjab. Construction of the dam has changed the ecosystem from a flowing one to that of a large stagnant water body. The fish fauna of the Indus plain are distributed throughout the whole stretch of the Poonch in AJK while it is distributed in the River Jhelum to variable extant due to comparatively cold water of the river (Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012).

The River Poonch also shares a number of fish fauna with the Jhelum River. All the cool water fish fauna found in the river Poonch are also represented in the River Jhelum. A total of 15 species are common between the two rivers. The River Poonch, therefore, shares its 52% fish fauna with the river Jhelum. The River Jhelum on the other hand shares 47% of its fish fauna with the Poonch River. The fish fauna of River Jhelum common with the Poonch River is distributed in the lower reaches of the River Jhelum which mainly migrates from Mangla Reservoir upstream in the River Jhelum during the summer season. Out of 62 species found in the Mangla Reservoir and 32 in the Jhelum River, only twenty species are common in both these water bodies. Poonch River is the main breeding area for the fish in the Mangla Reservoir, which is an important area for commercial fishery in the AJ&K, and is a source of revenue for the government[16].

3.2 Ecological and Socio-economic Significance of Poonch River

The Poonch River is a warm water river and the water temperature approaches almost 30^{o} C during the summer months. A total of 37 fish species have been recorded from the

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15 Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

16 Rafique, M., Qureshi, M. Y. (1997). A contribution to the fish and fisheries of Azad Kashmir. In: S. A. Mufti, C. A. Woods and S. A. Hasan, (eds.), Biodiversity of Pakistan. Pak. Mus. Nat. Hist. Islamabad and Fl. Mus. Nat. Hist. USA, p 335-343.

Poonch River[17 18]. The diversity is higher in the area where the River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer. The reason is the topography and water temperature of the River Poonch. The Poonch flows gently in a vast and flat valley, which provides numerous breeding grounds for the reproduction of fish. High temperature and gravely, rocky and the sandy river bed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival. The completion of Mangla dam in 1967 created a barrier in the Jhelum River and isolated the Poonch River from the segment of Jhelum downstream of the dam. Mangla dam also created a barrier to movement of riffle dwelling smaller fishes such as the Kashmir Catfish Glyptothorax kashmirensis and the Twin–Banded Loach Botia rostrata between the Jhelum and Poonch rivers.

The fish species Mahaseer Tor putitora is an important food and sport fish found in the Poonch River. The largest and most stable population of this fish in the country is found in this River that also forms a breeding ground for this fish. Keeping in view its declining population and threats to survival, the Mahaseer Tor putitora has been declared Endangered in the IUCN Red List 2013.

The entire stretch of the Poonch River and its tributaries inside AJK have been declared as a national park. The main reason for this notification is the high fish diversity and importance of supporting fish of both conservation and economic importance particularly the Endangered fish (in IUCN Red List 2013) Mahaseer Tor putitora that is important both from the conservation and commercial viewpoint.

The ecological importance of the Poonch River has been summarized in the Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012. These are listed below.

1. **Last Refuge for Mahsheer Fish:** Mahaseer Tor putitora has been a widely distributed fish in Pakistan during sixties and seventies. It was flourishing in the five rivers of Punjab and breeding in the Himalayan foothill areas. Due to damming of the water bodies, ecological fragmentation of the water bodies, pollution, water diversion, habitat destruction and indiscriminate hunting, its population has been continuously declining in its natural habitat. Its distribution range in the country, therefore, continued squeezing and presently it is almost non-existent in the rivers of Punjab. Recently (2010), IUCN has declared it as an "Endangered species". The Poonch River, however, is still having a reasonably good population of Mahasher. It is still successfully breeding in its upper and middle reaches. The main centers of Mahasher breeding are the Ban Nullah, Rangar Nullah, Nail Nullah, Hajeera Nullah, Meander Nullah and the Titri Note

[17] Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

[18] HBP, November 2013, Draft Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

area where river is wide to its maximum extant. It is the Poonch River where anglers still can catch a fish of 100 cm weighing 10 Kgs.

2. **Habitat for Critically Endangered Kashmir Catfish Glyptothorax kashmirensis:** The species Glyptothorax kashmirensis, previously only reported from Jhelum River, has been captured from the Poonch River during the October 2013 fish surveys for the Biodiversity Baseline Assessment of the Gulpur Hydropower Project.
3. **Breeding ground for the Fish Fauna of Mangla Reservoir:** Poonch River serves as a huge breeding ground for most of the fish fauna of the Mangla reservoir, which breeds in flowing water conditions. Most of the commercially important cyprinid and catfish breed in backwaters of the reservoir in the Poonch River. The side nullahs meeting to Poonch River form the major breeding grounds for these fishes. These Nullahs also serve as nursery grounds for the fishes breeding in these side streams.
4. **Natural Reserve for Twin-banded Loach, Botia rostrata:** Twin banded loach is a beautiful aquarium fish. It has almost the same story as that of Mahasher. The fish has been quite common in the Himalayan foothill areas but presently its population in the foothill areas is almost depleted or non-existent. The Poonch River has a very good population of this loach and is a hot spot area for this fish.
5. **Supporting Healthy Population of Labeo dyocheilus:** Poonch River holds the largest population of Labeo dyocheilus as compared to any other river in the country. This fish has maximum size in this river and a fish weighing 3-4 kg is commonly caught in the nets.
6. **Supporting Healthy Population of Garra gotyla:** The fish Garra gotyla is also a fish of sub-mountainous areas but it is also found in plains. Its population in plain areas has decreased over the last 20 years and hardly one comes across any fish while sampling. Once upon a time it was very common in Potowar areas but it is no more seen in any of these areas except a few localized places. Poonch River has very healthy population of this fish throughout its length in AJK.
7. **Supporting High Fish Diversity as Compared to its Size:** The Poonch is the smallest river in AJK as compared to other two rivers, the Jhelum and the Neelum. It, however, has a very good fish diversity of 29 species as compared to other rivers of AJK. It is due to optimum water temperature, pristine breeding grounds, wide river valley, and network of side nullahs (tributaries) with suitable physic-chemical environment.”

3.3 Causes for Decline in Fish Resources

A description of the fish resources of the Study Area is given in **Section 4 (Fish Fauna**). Fishing not only provides food for local consumption but is also a source of livelihood for individuals involved in commercial fishing. Fish are also important for recreational and sport fishing and boost tourism.

Fishing is extensive along the entire length of Poonch River and is widespread in the areas of Kotli, Hil Kalan up to confluence of Poonch River and Ban Nullah, as well as in some areas near Kohali and Gulpur. Extensively fishing is also practiced in the River upstream and downstream of Rajdhani (**Exhibit 3.3**). Sport fishing is common, while commercial fishing is also prevalent especially during the summers, when the fish collect near the shallow banks of the river. Some locals are involved in subsistence fishing and catch fish to supplement household food supply.

Unfortunately, the fish population in Poonch River has undergone a decline in recent years due to urbanization, illegal encroachment, over fishing and chemical and physical alterations of the natural habitat of fish. The stress on the fish population is not only due to its over exploitation, but also due to the rise in developmental activities, especially the growing number of hydroelectric and irrigation projects which have fragmented and deteriorated the natural habitat (Ecological Baseline Study of Poonch River, 2012). Fish are sensitive to physical and chemical variations in the water as well as to changes in river flows and volumes. They are, therefore, vulnerable to changes caused by the construction and operation of hydropower projects and dams.

The reasons for decline of fish resources, particularly the Endangered Mahaseer Tor putitora are listed below and have been summarized from the Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012.

- Capture of breeders, juveniles and poaching during the closed breeding season when fish migrates upstream for spawning,
- Intensive fishing during the pre-monsoon period when water level are low in the rivers,
- Unscientific capture of fishes by building temporary stone dams across hill streams and using fine- mesh net or cloth by village people,
- Use of dynamite or hand grenades to kill shoals of large brooder fish for food. This practice is more intensive during winter season when the fish are concentrated in pools along the river,
- Poisoning of streams and rivulets by local poisons (extracts of Derris, Chenapadium, Euphorbia, Artimisia, Cratan etc.) to kill and catch whole schools of Mahaseer and other fishes,
- Destruction of the breeding grounds of Mahaseer and other fish species due to large-scale collection of stones, gravel, pebbles, sand etc. from the river banks especially during the dry season when water volumes in the river are low.
- Construction of dams that form a barrier to fish migration and cause habitat fragmentation especially during the summer season when water volumes are low,

Photographs in **Exhibit 3.1** illustrate the threats to the fish fauna in the Study Area.

Exhibit 3.1: Photographs of Threats to Fish in the Study Area

Dynamite Sticks Used for Killing Fish

Electric Wire Used for Electrocuting Fish

Nets Confiscated from Illegal Fishing

Extraction of Gravel and Sand from River Bed

Water Pumping from River

Pollution in the River by Solid Waste

Source of Photographs: Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahaseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

3.4 Ecosystem Destruction due to Sand and Gravel Mining

Sand and gravel mining and illegal fishing are the main sources of habitat and ecosystem destruction in the Study Area.

Sand and gravel extraction activities are extensively undertaken along the Poonch River and are widely practiced in the areas of Kotli, Hil Kalan up to confluence of Poonch

River and Ban Nullah, in some parts of the river stretch near Kohali and Gulpur, as well near Rajdhani and upstream of Rajdhani (**Exhibit 3.3**).

Sand mining and gravel extraction is more common during the winter months (September to March) than in summers, since during low flows the sand is easier to mine along the exposed river-beds. The mining techniques are crude, and the sand, mined using shovels and spades, is loaded onto trolley-carts, horses and donkeys. The sand and gravel is then collected near the roadside and sold to residents of the nearby villages and construction contractors to be used as construction material. Photographs of sand and gravel extraction in the Study Area are shown in **Exhibit 3.2**.

Exhibit 3.2: Photographs of Sand and Gravel Extraction in Study Area

Sand and Gravel Extraction at Khuairatta

Sand Dumping Area near Sampling Point S17

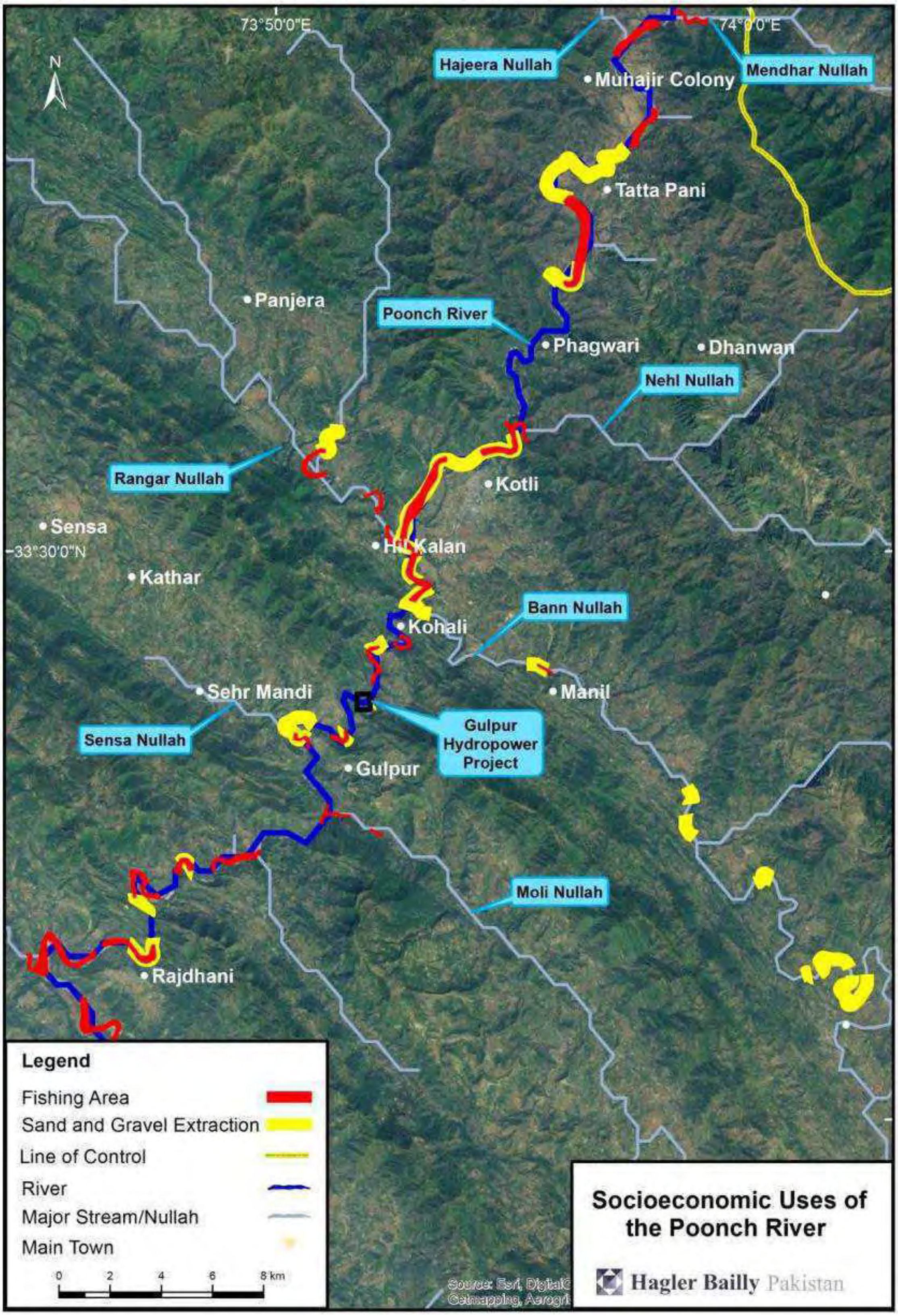
Gravel Extraction near Sampling Point S9

Sand Dumping on Road Side near confluence of Poonch River and Ban Nullah

Gravel collected for Crushing near confluence of Poonch River and Ban Nullah

Gravel Extraction in Poonch River north-west of Kotli

Exhibit 3.3: Socio-Economic Uses of the Poonch River



4. Fish Fauna

This section provides information about the fish fauna of the Study Area from literature review and field surveys conducted during October 2013, December 2013 and May 2014.

Sampling for fish was carried out in October 2013, December 2013 and May 2013 to study abundance and diversity of the fish fauna during autumn, winter and spring season respectively. A total of eight (8) locations were sampled in the October 2013 survey, four (4) during the December 2013 survey while 9 locations were sampled in May 2014 survey. The location of these sampling points for the October 2014 and December 2014 survey is shown in **Exhibit 2.2** and for May 2014 survey is shown in **Exhibit 2.4** in Methodology section of this report **(Section 2)**.

Data collected during this study is included in **Exhibit A.6** in **Appendix A**.

A list of fish species observed in the Study Area is given in **Exhibit B.4** of **Appendix B**.

4.1 Overview of Fish Fauna of Poonch River

The Poonch River is a warm water river and the water temperature approaches almost 30^o C during the summer months. A total of 37 fish species have been recorded from the Poonch River (**Exhibit 4.1**)[19 20]. The diversity is higher in the area where the River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer. The reason is the topography and water temperature of the River Poonch. The Poonch flows gently in a vast and flat valley, which provides numerous breeding grounds for the reproduction of fish. High temperature and gravely, rocky and the sandy river bed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival. The completion of Mangla dam in 1967 created a barrier in the Jhelum River and isolated the Poonch River from the segment of Jhelum downstream of the dam. Mangla dam also created a barrier to movement of riffle dwelling smaller fishes such as the Kashmir Catfish Glyptothorax kashmirensis and the Twin–Banded Loach Botia rostrata between the Jhelum and Poonch rivers.

Of the fish species recorded from the Poonch River, 16 species are species of special importance because of their economic importance or conservation status (endemic or included in IUCN red List). These include Barilius pakistanicus, Schistura punjabensis, Cirrhinus reba, Labeo dero, Labeo dyocheilus, Tor putitora, Schizothorax plagiostomus (richardsonii), Cyprinus carpio, Botia rostrata, Sperata seenghala, Clupisoma garua, Ompok bimaculatus, Glyptothorax naziri, Ompok pabda, Glyptothorax kashmirensis and Mastacembelus armatus. The species Glyptothorax kashmirensis, previously only

19 Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

20 HBP, November 2013, Draft Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

reported from Jhelum River, has been captured from the Poonch River during the October 2013 survey and May 2014 survey and is discussed below. The species recorded in Poonch River and those that are of special importance are listed in **Exhibit 4.1** and **Exhibit 4.2** respectively.

Exhibit 4.1: Fish Fauna Recorded from the Poonch River

No	Scientific Name	Common Name	Distributional Status	IUCN Status	Commercial Value
	Cyprinidae				
1.	*Chela cachius*	Silver hatchet chela	Wide	Least concerned (LC)	Low
2.	*Salmophasia bacaila*	Large razorbelly minnow	Wide	LC	Low
3.	*Aspidoparia morar*	Aspidoparia	Wide	LC	Low
4.	*Barilius pakistanicus*	Pakistani baril	Endemic	Not determined (ND)	Low
5.	*Esomus danricus*	Flying barb	Wide	LC	Low
6.	*Cirrhinus reba*	Reba carp	Wide	LC	Fairly good
7.	*Cyprinion watsoni*	Cyprinion	Wide	ND	Low
8.	*Labeo dero*	Kalbans	Wide	LC	Fairly good
9.	*Labeo dyocheilus*	Pakistani Labeo	Wide	LC	High
10.	*Osteobrama cotio*	Cotio	Wide	LC	Low
11.	*Puntius chola*	Swamp Barb	Wide	LC	Low
12.	*Puntius sophore*	Spotfin Swamp Barb	Wide	LC	Low
13.	*Puntius ticto*	Two spot Barb	Wide	LC	Low
14.	*Tor putitora*	Mahaseer	Wide	Endangered	Very high
15.	*Crossocheilus latius*	Gangetic latia	Wide	LC	Low
16.	*Garra gotyla*	Sucker head	Wide	LC	Low
17.	*Schizothorax plagiostomus (richardsonii)*	Snow carp	Wide	Vulnerable	High
18.	*Securicula gora*	Gora Chela		Least Concern	Low
19.	*Cyprinus carpio*	Common carp	Exotic	Vulnerable	High

No	Scientific Name	Common Name	Distributional Status	IUCN Status	Commercial Value
	Noemacheilidae				
20.	*Acanthocobitis botia*	Mottled Loach	Wide	LC	Low
21.	*Schistura punjabensis*	Hillstream loach	Endemic	ND	Low
	Cobitidae				
22.	*Botia rostrata*	Twin–banded Loach	Wide	Vulnerable	Low
	Bagridae				
23.	*Sperata seenghala*	Giant river cat fish	Wide	LC	Very high
	Schilbeidae				
24.	*Clupisoma garua*	Garua bachwaa	Wide	LC	Very high
	Siluridae				
25.	*Ompok bimaculatus*	Butter catfish	Wide	Near Threatened	Low
	Sisoridae				
26.	*Glyptothorax pectinopterus*	Flat head catfish	Wide	LC	Low
	Channidae				
27.	*Chanda nama*	Elongate glass–perchlet	Wide	LC	Low
28.	*Parambasis baculis*	Himalayan glassy perchlet	Wide	LC	
29.	*Parambasis ranga*	Indian glassy fish	Wide	LC	
	Botidae				
30.	*Botia almorhae*	Pakistani Loach		Least Concern	Low
	Chandidae				
31.	*Channa gachua*	Dwarf Snakehead		Least Concern	Low

No	Scientific Name	Common Name	Distributional Status	IUCN Status	Commercial Value
	Sisoridae				
32.	*Glyptothorax cavia*	Heart Throat Catfish		Least Concern	Low
33.	*Glyptothorax kashmirensis*	Kashmir Catfish		**Critically Endangered**	Low
34.	*Glyptothorax naziri*	Nazirs' Catfish	Endemic	Not Evaluated	Low
35.	*Gagata cenia*	Clown Catfish		Least Concern	Low
	Siluridae				
36.	*Ompok pabda*	Pabdah Catfish		**Near Threatened**	Low
	Mastacembelidae				
37.	*Mastacembelus armatus*	Tire–track spiny eel	Wide	LC	High

Exhibit 4.2: Species of Special Importance Found in the Poonch River, Azad Kashmir

No	Scientific Name	Common Name	Distributional Status	IUCN Status	Commercial Value	Max. Length (cm)	Max. Weight (kg)
	Cyprinidae						
1.	*Barilius pakistanicus*	Pakistani baril	Endemic	–	–	–	–
2.	*Cirrhinus reba*	Reba carp	–	–	Fairly good	30	0.3
3.	*Labeo dero*	Kalbans	–	–	Fairly good	75	0.2
4.	*Labeo dyocheilus*	Pakistani Labeo	–	–	High	90	5
5.	*Tor putitora*	Mahaseer	–	**Endangered**	Very high	275	54
6.	*Schizothorax plagiostomus (richardsonii)*	Snow carp	–	Vulnerable	High	60	2.5
7.	*Cyprinus carpio*	Common carp	–	Vulnerable	High	110	40.1

No	Scientific Name	Common Name	Distributional Status	IUCN Status	Commercial Value	Max. Length (cm)	Max. Weight (kg)
	Cobitidae						
8.	*Botia rostrata*	Twin–banded Loach	–	Vulnerable	–	–	–
	Bagridae						
9.	*Sperata seenghala*	Giant river cat fish	–	–	Very high	150	10
	Schilbeidae						
10.	*Clupisoma garua*	Garua bachwaa	–	–	Very high	61	0.5
	Siluridae						
11.	*Ompok bimaculatus*	Butter catfish	–	Near Threatened	Fairly good	45	0.2
	Sisoridae						
12.	*Glyptothorax kashmirensis*	Kashmir Catfish	Endemic	**Critically Endangered**	Low	11.7	–
13.	*Glyptothorax naziri*	Nazirs' Catfish	Endemic	Not Evaluated	Low		
	Siluridae						
14.	*Ompok pabda*	Pabdah Catfish		Near Threatened	Low		
	Noemacheilidae						
15.	*Schistura punjabensis*	Hillstream loach	Endemic	Not Evaluated	Low		
	Mastacembelidae						
16.	*Mastacembelus armatus*	Tire–track spiny eel	–	–	High	90	0.5 g

4.2 Distribution and Abundance of Fish Fauna

4.2.1 October 2013 survey

During the October 2013 survey, fish fauna were collected from the selected sampling points using cast nets. The river habitats observed in the Poonch River include pools and glides, riffles and rapids in which the riffles are the most dominant habitat observed. Different micro–habitats (biotopes) of the river such as pools, riffles and back water were sampled to understand habitat preferences of the indicator species (**Section 4.3**).

The fish species observed in the Study Area during the October 2013 survey are listed in **Exhibit 4.3**. Fish abundance (number of fish individuals collected) and diversity (number of fish species collected) observed during the survey is presented in **Exhibit 4.4.**

Principal observations of the October 2013 surveys are summarized below.

- A total of 253 fish specimens belonging to 26 fish species were collected.
- Fish abundance was highest at Sampling Point A3 (River at Borali Bridge) where 57 fish specimens belonging to 16 fish species were collected. Gangetic Latia Crossocheilus latius was the most abundant fish species collected at this sampling point, followed by Mahaseer Tor putitora and Twin–banded Loach Botia rostrata.
- Fish diversity was highest at Sampling Point A5 (River at Billiporian Bridge, near Rajdhani) where 18 fish species were collected. Gangetic Latia Crossocheilus latius was the most abundant fish species collected at this sampling point, followed by Mahaseer Tor putitora and Pakistani Labeo Labeo dyocheilus.
- The most abundant fish species was the Gangetic Latia Crossocheilus latius with 63 specimens collected. The second most abundant fish species was Mahaseer Tor putitora followed by Pakistani Baril Barilius pakistanicus with 42 and 21 specimens collected respectively.
- The least abundant fish species collected included Dwarf Snakehead Channa gachua, Common Carp Cyprinus carpio, Elongate Glassy Perchlet Chanda nama and Butter Catfish Ompok bimaculatus.
- The fish abundance and diversity was generally higher in the main River compared to the tributaries **(Exhibit 4.4)**.

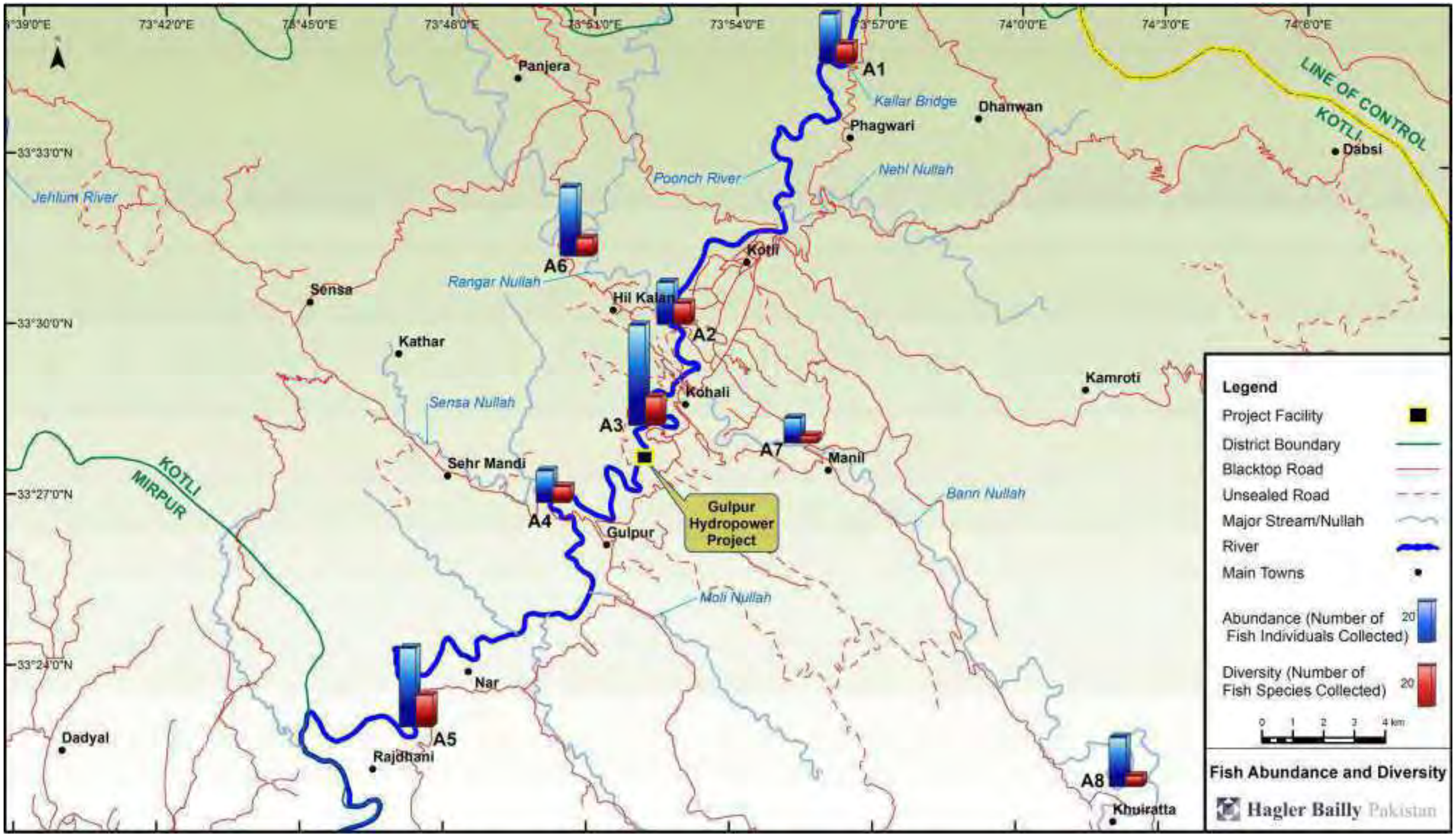
Exhibit 4.3: Fish Fauna Observed During October 2013 Survey of the Study Area

No		Sampling Locations	A1	A2	A3	A4	A5	A6	A7	A8	Total
		EF – Sites	EF – 1	–	EF – 2	EF – 3	EF – 4	–	–	–	
		Location	River at Kallar Bridge	River at Confluence with Rangar Nullah	River at Borali Bridge	River at Gulpur Bridge	River at Billiporian Bridge near Rajdhani	Rangar Nullah (Tributary)	Ban Nullah near Manil Tributary (Tributary)	Ban Nullah near Khuiratta (Tributary)	
		Location with reference to Project	Upstream Project Site	Proposed submerged area	Proposed unindated area	Downstream outlet	Downstream Project	Upstream Project Site	Upstream Inlet	Upstream Inlet	
	Scientific Name	Common name									
1.	*Tor putitora*	Mahaseer	6	4	6	4	6	11	3	2	**42**
2.	*Labeo dyocheilus*	Pakistani Labeo	2	3	3	–	4	1	–	–	**13**
3.	*Crossocheilus latius*	Gangetic Latia	5	5	10	5	9	11	7	11	**63**
4.	*Garra gotyla*	Sucker Head	2	1	2	1	1	1	2	6	**16**
5.	*Botia rostrata*	Twin–banded Loach	1	1	5	2	1	1	–	–	**11**
6.	*Botia almorhae*	Pakistani Loach	2	–	3	1	2	–	–	–	**8**
7.	*Glyptothorax pectinopterus*	Flat Head Catfish	1	1	3	–	–	1	–	–	**6**
8.	*Glyptothorax kashmirensis*	Kashmir Catfish	2	–	2	–	–	–	–	–	**4**
9.	*Glyptothorax cavia*	Heart Throat Catfish	3	2	5	2	3	–	–	–	**15**
10.	*Mastacembelus armatus*	Tire–track Spiny Eel	1	1	2	–	2	1	–	–	**7**
11.	*Barilius pakistanicus*	Pakistani Baril	–	2	3	1	3	6	2	4	**21**
12.	*Acanthocobitis botia*	Mottled Loach	–	2	–	–	1	–	–	–	**3**

No		Sampling Locations	A1	A2	A3	A4	A5	A6	A7	A8	Total
		EF – Sites	EF – 1	–	EF – 2	EF – 3	EF – 4	–	–	–	
		Location	River at Kallar Bridge	River at Confluence with Rangar Nullah	River at Borali Bridge	River at Gulpur Bridge	River at Billiporian Bridge near Rajdhani	Rangar Nullah (Tributary)	Ban Nullah near Manil Tributary (Tributary)	Ban Nullah near Khuiratta (Tributary)	
		Location with reference to Project	Upstream Project Site	Proposed submerged area	Proposed unindated area	Downstream outlet	Downstream Project	Upstream Project Site	Upstream Inlet	Upstream Inlet	
13.	*Ompok pabda*	Pabdah Catfish	–	1	–	–	–	–	–	2	**3**
14.	*Channa gachua*	Dwarf Snakehead	–	1	–	–	–	–	–	–	**1**
15.	*Labeo dero*	Kalbans	–	–	2	1	–	–	–	–	**3**
16.	*Schistura punjabensis*	Punjab Loach	3	–	1	–	–	3	–	–	**7**
17.	*Glyptothorax naziri*	Nazirs' Catfish	–	–	3	–	–	–	–	–	**3**
18.	*Gagata cenia*	Clown Catfish	–	–	5	–	–	–	–	–	**5**
19.	*Clupisoma garua*	Garua Bachwa	–	–	2	–	1	–	–	–	**3**
20.	*Salmophasia bacaila*	Large Razorbelly Minnow	–	–	–	1	1	3	–	3	**8**
21.	*Cyprinus carpio*	Common Carp	–	–	–	–	1	–	–	–	**1**
22.	*Aspidoparia morar*	Chilwa	–	–	–	–	2	–	–	–	**2**
23.	*Securicula gora*	Gora Chela	–	–	–	–	3	–	–	–	**3**
24.	*Parambassis ranga*	Glassy Fish	–	–	–	–	3	–	–	–	**3**
25.	*Chanda nama*	Elongate Glassy Perchlet	–	–	–	–	1	–	–	–	**1**
26.	*Ompok bimaculatus*	Butter Catfish	–	–	–	–	1	–	–	–	**1**
	Total Abundance (number of fish individuals collected)		**28**	**24**	**57**	**18**	**45**	**39**	**14**	**28**	**253**

No		Sampling Locations	A1	A2	A3	A4	A5	A6	A7	A8	Total
		EF – Sites	EF – 1	–	EF – 2	EF – 3	EF – 4	–	–	–	
		Location	River at Kallar Bridge	River at Confluence with Rangar Nullah	River at Borali Bridge	River at Gulpur Bridge	River at Billiporian Bridge near Rajdhani	Rangar Nullah (Tributary)	Ban Nullah near Manil Tributary (Tributary)	Ban Nullah near Khuiratta (Tributary)	
		Location with reference to Project	Upstream Project Site	Proposed submerged area	Proposed unindated area	Downstream outlet	Downstream Project	Upstream Project Site	Upstream Inlet	Upstream Inlet	
	Diversity (number of fish species collected)		**11**	**12**	**16**	**9**	**18**	**10**	**4**	**6**	

Exhibit 4.4: Fish Abundance and Diversity at Sampling Points. Survey Conducted October 2013 Survey



4.2.2 December 2013 survey

During the December 2013 survey, sampling for fish resources was conducted at four sampling locations: EF site 1, EF site 2 (new), EF site 3 and EF site 4 (**Exhibit 2.2**). The fish species observed during this survey are listed in **Exhibit 4.5.**

No fish were found in the main River channel using cast nets. However, deep pools ranging from 10–20 m were sampled using the gill nets and some large sized fish species were collected. Principle observations are summarized below.

- During the winter, small sized fish species such as Twin–banded Loach Botia rostrata move into crevices or beneath the boulders available in and on the river edges and were not collected.
- Large sized species like Labeo dyocheilus and Tor putitora had moved into deep pools for overwintering and were collected by gill nets. The species Labeo dyocheilusis was collected from the pools in the Study Area from all the four sites sampled.
- The main river channel was occupied by the cold water fish Schizothorax plagiostomus from mid–October to mid–March. This fish inhabits the upper cold reaches of the river during summer season and can be seen in the Study Area during winter season. The optimum water temperature for this fish is 15–20°C and therefore it occupies deep pools and crevices during extreme cold months.
- The commercially important species Clupisoma garua was not seen in the Study Area during the December 2013 survey (winter survey) as it migrates down to the Mangla Reservoir for overwintering.
- The fish Tor putitora occupies the main pools in the Poonch River with rocky bottoms and there is very little migration to the Mangla Reservoir for overwintering as the bed of the reservoir is highly muddy and silty and is not a favorable habitat for this fish. It is concentrated in river pools upstream the Mangla Reservoir.

The Poonch River becomes shallow during the low flow period in the winter season. Stones, boulders and cobbles in the river bed are clearly visible. Water temperature of the river drops to 9–11°C. Fish fauna, which mainly consists of warm water species, cannot withstand this low temperature and move to available refuges. The river is characterized by having series of deep pools of variable sizes and rocky edges, with deep crevices serving as wintering places for fish.

During the winter season, fish activity in the main river channel is almost nonexistent and almost all the species migrate into refuges such as pools for over wintering. Overwintering is a surviving strategy as maintenance of the viable populations in the river system makes it necessary for the fish fauna to move away from areas where conditions become unfavorable for survival. It helps the fish to conserve their stored energy reserves and maintain fitness for enhancing growth and reproductive output when conditions become favorable. Thus, during the winter months, fish move to pools where water is deep enough to buffer the cold temperature of winter. These migrations are mainly dependent on the availability of suitable habitats. If suitable refuges are available within the fish individual's normal home ranges, then migration is unnecessary and the fish takes refuge in locally available pools and crevices in the rocks. Therefore, with the onset of the winter season, many fishes move downstream from shallow areas that are warm and productive in summer but which are associated with low water temperature in winter, to deeper slower pools further downstream. Such migrations are not always in the downstream direction but depend on the availability of refuge habitat. These movements are not as conspicuous or concerted in time and space as compared to the breeding migrations. Metabolic activity, swimming capacity, and digestive ability of many fishes is severely reduced during low temperature of winter. Under these circumstances feeding activity may be very low or nonexistent, even when plentiful food is available.

Exhibit 4.5: Fish Fauna Observed During December Survey

No.		*Sampling Location*	*A-1*	*A-3b*	*A-4*	*A-5*
		EF-Site	*EFlow site 1*	*Eflow site 2*	*EFlow site 3*	*EFlow site 4*
		Biotopes	*Pools*	*Pools*	*Pools*	*Pools*
	Scientific Name	*Common Name*				
1	*Schizothorax plagiostomus*	Snow Carp	2	0	0	0
2	*Tor putitora*	Mahaseer	2	3	5	7
3	*Labeo dyocheilus*	Pakistani Labeo	4	6	4	3

4.2.3 May 2014 Survey

During the May 2014 survey, sampling was carried out at nine sampling locations, five sites that were sampled in the October 2013 survey and four additional sites – sites under consideration for future hydropower projects in the Poonch River. The fish species observed during this survey are listed in **Exhibit 4.6**. Fish abundance (number of fish individuals collected) and diversity (number of fish species collected) observed during the survey is presented in **Exhibit 4.7.** Principle observations of May 2014 survey are summarized below.

- A total of 302 fish belonging to 21 species were collected during the May 2014 survey.
- Maximum abundance was seen at sampling A11 where 41 fish specimens were collected followed by A5 where 39 fish specimens were collected.
- The most abundant fish species was Mahaseer Tor putitora with 40 specimens collected. The second most abundant species was Pakistani Labeo Labeo dyocheilus followed by Gangetic Latia Crossocheilus latius with 39 and 34 specimens collected respectively.

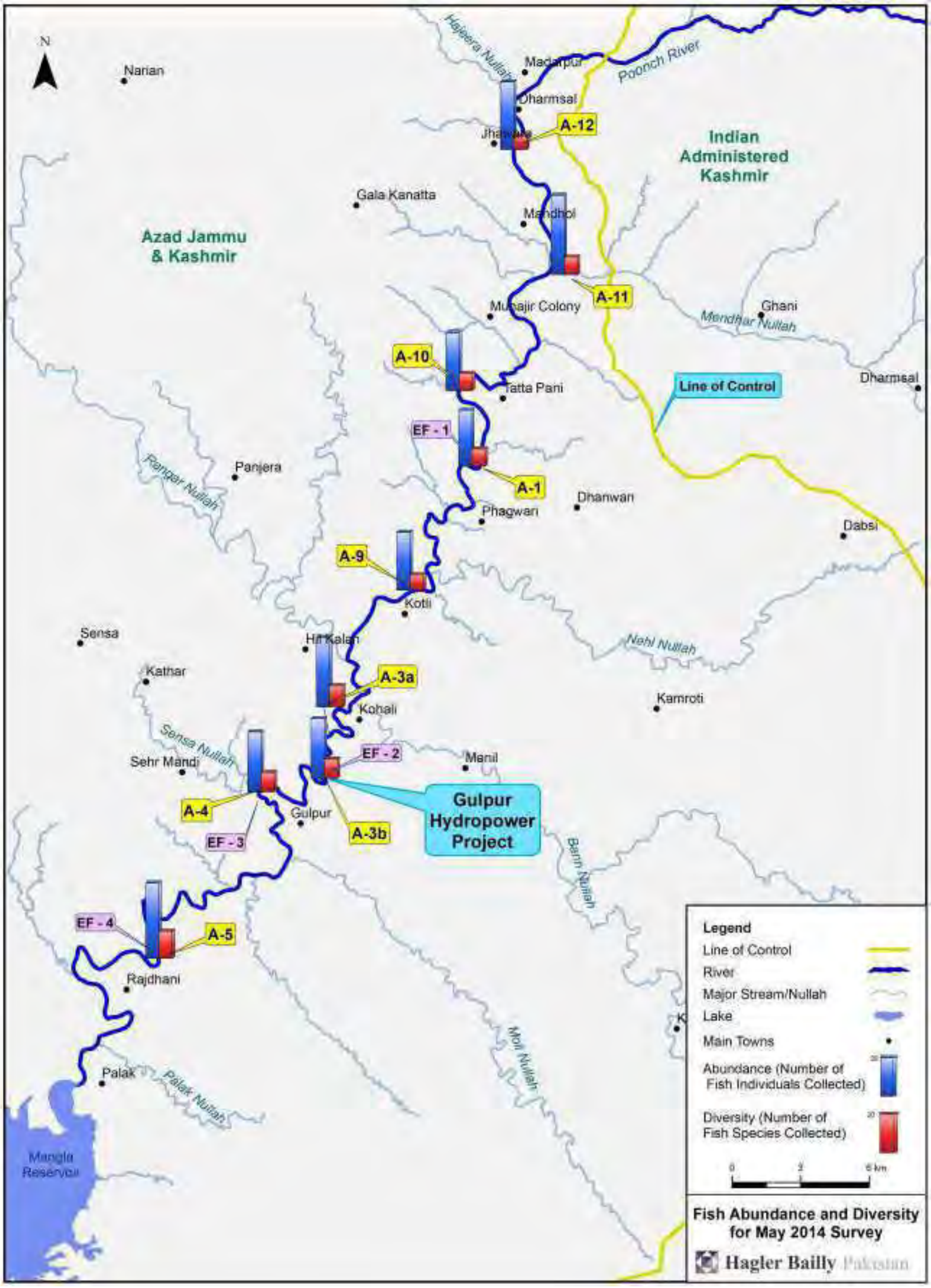
- At this time of the year, the river water was cold (15oC) as compared to tributaries (20oC) due to snow melt in the river. Moreover, there was a clear difference of turbidity between the river water and tributaries. The river water was turbid due to increase in sediment caused by snow melt while the water in the tributaries was clear.
- A higher abundance of fish fauna was observed in the river compared to the tributaries. Concentration of the fish in the river at this time of the year can be attributed to the reproductive triggers provided by snowmelt water, associated turbidity and new flow regime in the river. With the onset of the Monsoon Season (July/August), the temperature, flow and turbidity regimes will change and the fish will migrate into suitable breeding grounds in the river and the tributaries.
- Most of the fish species observed were common other than Clupisoma garua. It is likely that the river waters are too cold from snowmelt to allow upstream migration of this fish from the Mangla reservoir.
- The fish species caught did not show sexual maturity since it was pre-breeding season.
- Schizothorax plagiostomus is a cold water fish and migrates to occupy the cold water of the upper reaches of the river during summer season. It was observed only at Sampling Point A-12 indicating that this fish has already left the downstream reaches of the river with the beginning of the summer season.
- Mahaseer fish was found in good numbers in almost all the sites but fish was not yet sexually fully mature. The fish was evenly distributed in all the microhabitats of the river indicating that it is actively feeding and moving towards its breeding grounds.
- Upstream migration of the fish species found in the Mangla Reservoir was not very prominent at this time of the year. With increasing temperatures in the summer season, this migration will increase.

Exhibit 4.6: Fish Fauna Observed During May 2014 Survey

		Sampling Locations																																			
	Sampling Location	A-12				A-11				A-10				A-3b				A-1				A-9				A-3a				A-4				A-5			
	EF – Sites													EFlow Site 2				EFlow Site 1												EFlow Site 3				EFlow Site 4			
	Location	Sehra Dam Site				Meander Nullah				Sehra Hydropower Project Site				Gulpur Hydropower Project Site				(Kotli Dam Site)				Kotli Hydropower Project Site (Kotli)				River at Barali Bridge				River at Gulpur Bridge				River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,			
	Biotopes	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**
Scientific Name	Common Name																																				
Aspidoparia morar	Chilwa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2
Barilius pakistanicus	Pakistani Baril	–	–	–	–	2	4	2	8	1	2	3	6	1	–	1	2	2	3	1	6	–	–	–	–	–	–	1	1	2	2	–	4	–	–	–	–
Botia almorhae	Pakistani Loach	4	–	–	4	3	–	–	3	2	–	–	2	1	–	–	1	1	1	–	2	3	–	–	3	3	–	–	3	3	1	–	4	2	–	–	2
Botia rostrata	Twin–banded Loach	5	–	–	5	4	–	–	4	4	–	–	4	4	–	–	4	3	–	–	3	3	1	–	4	1	1	–	2	2	2	–	4	2	–	–	2
Chanda nama	Elongate glass–perchlet	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3
Clupisoma garua	Garua bachwaa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	–	2	–	2	1	1	–	2
Crossocheilus latius	Gangetic latia	1	3	1	5	2	3	1	6	–	1	2	3	1	3	1	5	2	1	2	5	2	2	–	4	1	1	–	2	–	1	–	1	–	1	2	3
Gagata cenia	Clown Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	3	–	9	–	–	–	–	–	–	–	–
Garra gotyla	Sucker Head	6	–	–	6	5	–	–	5	4	–	–	4	2	2	–	4	2	1	–	3	3	1	–	4	3	–	–	3	2	–	–	2	1	–	–	1
Glyptothorax cavia	Heart Throat Catfish	–	–	–	–	2	–	–	2	3	–	–	3	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Glyptothorax kashmirensis	Kashmir Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	3	–	–	3
Glyptothorax naziri	Nazirs' Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–
Glyptothorax pectinopterus	Flat head Catfish	–	–	–	–	3	–	–	3	1	–	–	1	–	–	–	–	2	–	–	2	4	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–
Labeo dero	Kalbans	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–
Labeo dyocheilus	Pakistani Labeo	2	3	–	5	3	1	–	4	1	2	–	3	2	2	1	5	–	3	–	3	2	4	–	6	2	2	–	4	2	2	1	5	2	1	1	4
Mastacembelus armatus	Tire–track spiny eel	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	2	–	–	2	1	–	–	1	–	–	–	–	1	1	–	2	1	–	–	1
Parambassis ranga	Indian glassy fish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	4
Salmophasia bacaila	Large razorbelly minnow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	3
Schizothorax	Snow Carp	2	2	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

		Sampling Locations																																				
	Sampling Location	*A-12*				*A-11*				*A-10*				*A-3b*				*A-1*				*A-9*				*A-3a*				*A-4*				*A-5*				
	EF – Sites													*EFlow Site 2*				*EFlow Site 1*												*EFlow Site 3*				*EFlow Site 4*				
	Location	*Sehra Dam Site*				*Meander Nullah*				*Sehra Hydropower Project Site*				*Gulpur Hydropower Project Site*				*(Kotli Dam Site)*				*Kotli Hydropower Project Site (Kotli)*				*River at Barali Bridge*				*River at Gulpur Bridge*				*River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,*				
	Biotopes	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	
plagiostomus																																						
Securicula gora	Gora Chela	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	4	
Tor putitora	Mahaseer	3	2	1	6	3	3	–	6	2	2	–	4	3	1	–	4	1	2	–	3	2	1	1	4	3	1	–	4	3	1	–	4	3	2	–	5	
Abundance (No of Fish Speciemen collected)					**35**				**41**				**30**				**31**				**29**				**30**				**36**				**31**				**39**	**302**
Diversity (No of Fish Species Collected)					**7**				**9**				**9**				**10**				**9**				**8**				**11**				**10**				**14**	

Exhibit 4.7: Fish Abundance and Diversity Observed During May Survey



4.3 Indicator Species

A total of six indicator species were chosen to study the impact of Project induced changes in the river flow on the fish fauna**.** The indicator fish species were chosen on the basis of their conservation importance as well as socio–economic importance for the local communities. Also taken into consideration was the fish size and adequate representation of the major fish families recorded from the Poonch River. The following fish species were chosen as indicators:

- Mahaseer Tor putitora
- Alwan Snow Trout Schizothorax plagiostomus (richardsonii)
- Kashmir Catfish Glyptothorax kashmirensis
- Garua Bachwa Clupisoma garua
- Pakistani Labeo Labeo dyocheilus
- Twin–banded Loach Botia rostrata

The number of the indicator fish species in the river habitats at each sampling point during the October 2013 survey is given in **Exhibit 4.8** and represented in **Exhibit 4.9**. The number of the indicator fish species in the river habitats at each sampling point during the May 2014 survey is given in **Exhibit 4.6** represented in **Exhibit 4.10.** Photographs of these indicator fish species recorded from the Poonch River and their identifying features are included in **Exhibit 4.11**.

Exhibit 4.8: Number of Individuals of Indicator Fish Species collected in October 2013 survey at Sampling stations

No			Sampling Locations																																
			A1				A2				A3				A4				A5				A6				A7				A8				
		EF – Sites	EF – 1				–				EF – 2				EF – 3				EF – 4				–				–				–				
		Location	River at Kallar Bridge				River at Confluence with Rangar Nullah				River at Borali Bridge				River at Gulpur Bridge				River at Billiporian Bridge near Rajdhani				Rangar Nullah (Tributary)				Ban Nullah near Manil Tributary (Tributary)				Ban Nullah near Khuiratta Tributary				
		Location with reference to project	Upstream Project Site				Proposed submerged area				Proposed unindated area				Downstream outlet				Downstream Project				Upstream Project Site				Upstream Inlet				Upstream Inlet				
		Biotopes	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	**Total**
	Scientific Name	Common Name																																	
1.	*Tor putitora*	Mahaseer	3	2	1	6	2	2	–	4	3	3	–	6	2	2	–	4	3	1	2	6	3	5	3	11	2	1	–	3	1	1	–	2	**42**
2.	*Labeo dyocheilus*	Pakistani Labeo	–	1	1	2	2	1	–	3	1	2	–	3	–	–	–	–	1	3	–	4		1	–	1	–	–	–	–	–	–	–	–	**13**
3.	*Botia rostrata*	Twin–banded Loach	1	–	–	1	1	–	–	1	5	–	–	5	2	–	–	2	1	–	–	1	1	–	–	1	–	–	–	–	–	–	–	–	**11**
4.	*Glyptothorax kashmirensis*	Kashmir Catfish	2	–	–	2	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**4**
5.	*Clupisoma garua*	Garua Bachwa	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**3**
6	*Schizothorax plagiostomus*	Alwan Snow Trout	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
	Total Abundance		**6**	**3**	**2**	**11**	**5**	**3**	**–**	**8**	**13**	**5**	**–**	**18**	**4**	**2**	**–**	**6**	**5**	**5**	**2**	**12**	**4**	**6**	**3**	**13**	**2**	**1**	**–**	**3**	**1**	**1**	**–**	**2**	**73**

Exhibit 4.9: Number of Indicator Fish Species Collected in the Study Area during October 2013 survey

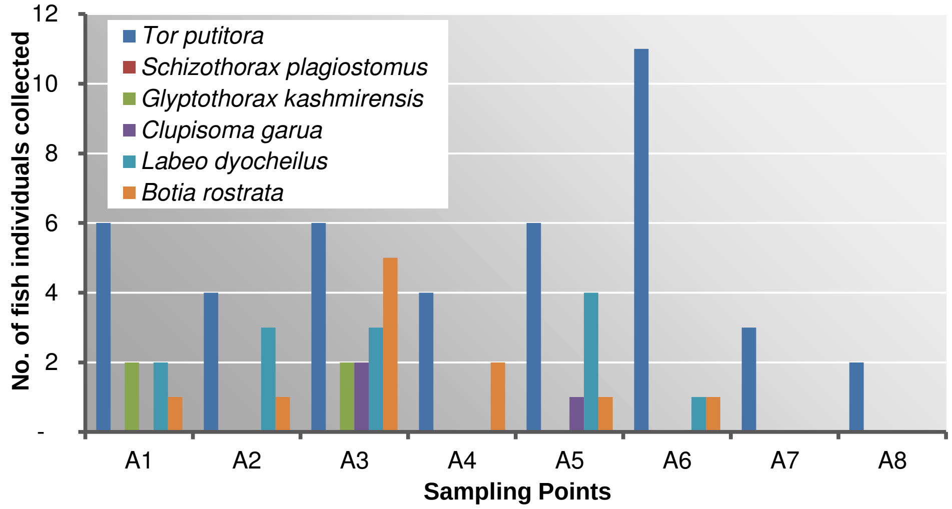
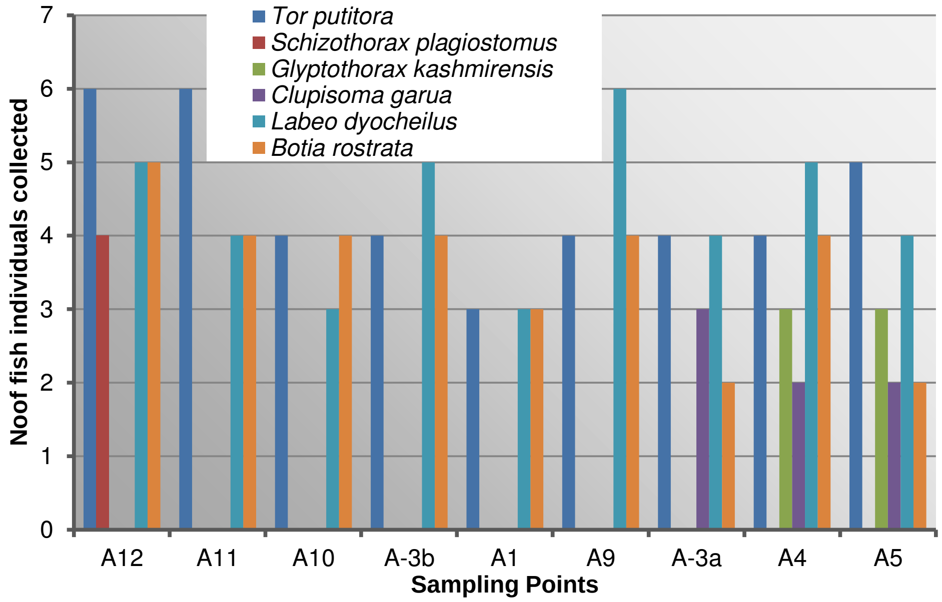


Exhibit 4.10: Number of Indicator Fish Species Collected in the Study Area during May 2013 survey



Mahaseer Tor putitora

Mahaseer Tor putitora inhabits the montane and submontane regions, in streams and rivers. It is distributed in mid hills stretches of Himalayan region. It inhabits rapid streams with rocky bottom, riverine pools and lakes. It is a column feeder in freshwater found in pH ranges 7.4–7.9 and in temperatures of 15°C–30°C. The adults are omnivorous in nature while the juveniles feed on algae and diatoms. The commercial importance of this fish is very high. It can reach 50 kg in weight and 275 cm in length. It is listed Endangered in IUCN Red List 2013[21].

Mahaseer Tor putitora is under severe threat from overfishing, loss of habitat, decline in quality of habitat resulting in loss of breeding grounds. In addition several dams are planned for construction in future in the Himalayan region which will have a more drastic effect on Mahaseer Tor putitora populations blocking their migrations and affecting their breeding. The population of this species have declined by more than 50% in the past across the entire distribution range, if the current trends continue the population may decline even up to 80% in the future. The species is therefore assessed as Endangered and is in need of urgent conservation efforts.[22]

Mahaseer Tor putitora prefers to live in fast flowing streams, riverine pools and lakes. Maximum abundance of this fish was seen at Sampling Point A6 (River at Rangar Nullah) while least abundance was seen at Sampling Point A8 (Ban Nullah near Khuiratta). It was seen in all three biotopes (riffles, pools and backwater) during October 2013 survey (**Exhibit 4.8**). The species was collected in all three biotopes (riffles, pools and backwater) during the May 2014 survey (**Exhibit 4.6**). It was collected in Pools during the December 2014 survey (**Exhibit 4.5**).

Alwan Snow Trout Schizothorax plagiostomus

Alwan Snow Trout Schizothorax plagiostomus richardsonii is a cold and cool water fish having an extended range of distribution and habitat tolerance. It is found in all the hill stream areas of Pakistan, as well as in India, Afghanistan, and Nepal. It is an omnivore but prefers plant matter and algae. It prefers fast flowing streams and tributaries with riffles and pools that have gravely or sandy beds. Its preferred temperature range is 8–20°C, while the optimum water temperature for breeding is 15°C. It spawns in a habitat with moderate currents, turbid snow melts, logs, grassy patches, or bushes. Breeding is triggered by a rise in temperature after the Dry Season. It can attain a size of up to 24 cm in length, and is one of the major food fish of the area.

Although Alwan Snow Trout Schizothorax plagiostomus richardsonii is widely distributed along the Himalayan foothills, recent observations over the last 5 to 10 years, indicate drastic declines in many areas of its range due to introduction of exotic species, dam construction and overfishing. While in some areas the declines are more than 90%, the overall reduction in population is less than 50% with similar rates predicted in the future. The species is therefore assessed as Vulnerable.[23]

Alwan Snow Trout Schizothorax plagiostomus richardsonii prefers to live in fast flowing water with rocky river bed. Adults need streams for spawning and rivers, deep pools and reservoirs for wintering at lower altitudes. Alwan Snow Trout Schizothorax plagiostomus

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[21] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 18 November 2013.

[22] Jha, B.R. & Rayamajhi, A. 2010. *Tor putitora*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **22 November 2013**.

[23] Vishwanath, W. 2010. *Schizothorax richardsonii*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **22 November 2013**.

richardsonii was not seen during October 2013 (**Exhibit 4.8**) nor during May 2014 survey (**Exhibit 4.6**).

Kashmir Catfish *Glyptothorax kashmirensis*

Kashmir Catfish Glyptothorax kashmirensis is a rare and Critically Endangered (IUCN Red List 2013) fish. According to IUCN Red List it is reported only from the Jhelum River. However, specimens of this fish species have been caught from the Poonch River during the October 2013 survey. The spawning period is from June to August. Fecundity ranges from 1650 to 6000 eggs and is more closely related to ovary weight and fish weight than ovary and fish length. This fish species inhabits fast–flowing streams and is adapted to living in the fast water currents. It attaches itself to rocks by means of an adhesive apparatus on its underside that prevents it from being washed away. It is a carnivore fish and feeds on aquatic macro invertebrates.

The species is assessed as Critically Endangered due to a predicted decline of more than 80% over the next five to ten years due to the severe, irreversible threats from construction of dams. Dams cause pools formation and alterations to the river flow regime, which will affect this species drastically as it is a fast flowing river species. In addition the practice of fisheries department to release exotics into reservoirs may push to species to local extinctions in several or most locations.[24]

Kashmir Catfish Glyptothorax kashmirensis prefers to live in fast flowing river with rocky bed. It was seen at Sampling Point A1 (River at Kallar Bridge) and Sampling Point A3 (River at Borali Bridge) where 2 specimens were observed at each sampling point. Kashmir Catfish Glyptothorax kashmirensis was only seen in riffles during the October 2013 survey (**Exhibit 4.8**). During the May 2014 survey, it was seen in two biotopes (riffles and pools) (**Exhibit 4.6**).

Garua Bachwa *Clupisoma garua*

Garua Bachwa Clupisoma garua inhabits fresh water and tidal rivers. It feeds on insects, shrimps, other crustaceans and small fish. The juveniles feed on macro–invertebrates. Breeding time is May–August and during this time they move in shoals and breed in shallow water. The ideal spawning temperature is between 20^0C– 21^0C.

Garua Bachwa Clupisoma garua is common in the rivers of Indus plain. It grows to a length of 60 cm and has a weight of upto 500 grams. It is considered a good food fish throughout its range. It is popular among the people who prefer fish without bones, so it has high market values.

Garua Bachwa Clupisoma garua prefers to live in fast flowing deep parts of the river with rocky bed. This fish was seen at Sampling Point A3 (River at Borali Bridge) and Sampling Point A5 (River at Billiporian Bridge near Rajdhani) in two biotopes (riffles and pools) during October 2013 survey (**Exhibit 4.8**). During the May 2014 survey, it was collected in two biotopes (riffles and pools) (**Exhibit 4.6**).

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[24] Ng, H.H. 2010. *Glyptothorax kashmirensis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **22 November 2013**.

Pakistani Labeo *Labeo dyocheilus*

Pakistani Labeo Labeo dyocheilus is a medium sized fish. It lives in clear active currents of large rivers. It is a migratory species that spends the winter months in the lower reaches of the Himalayan rivers but migrates upstream for breeding and feeding. It is an omnivore but prefers plant matter and algae and is a column feeder. Breeding time extends from May to August. The ideal spawning temperature is from 190C– 230C.

Pakistani Labeo Labeo dyocheilus is economically very important fish. It has high consumer preference as well as high market values. It grows up to 90 cm and attains a weight of 5 kg. It is common species of the Himalayan region but due to overfishing, the population of this species is declining throughout its range.

Pakistani Labeo Labeo dyocheilus prefers to live in clear active currents of the river. Maximum abundance of this fish was seen at Sampling Point A5 (River at Billiporian Bridge near Rajdhani). It was seen in three river biotopes (riffles, pools and backwater) during October 2013 survey (**Exhibit 4.8**). The species was collected in all three biotopes (riffles, pools and backwater) during the May 2014 survey (**Exhibit 4.6**).

Twin–banded Loach *Botia rostrata*

Twin–banded Loach Botia rostrata is a small sized fish. It inhibits medium to fast water currents. It is a carnivore fish and feeds on insect larvae and benthic organisms. Breeding time extends from May to August. The spawning temperature is from 18^0C– 20^0C. It is listed as Vulnerable in the IUCN Red List 2013.

Botia rostrata is widespread in the hill streams across its range but faces threats destructive fishing practices and habitat destruction due to sand and boulder mining. Population estimates of this species records a decline of more than 60% in five years. In some other areas, it is believed that the species may have undergone more than 30% decline in its population. It is therefore assessed as Vulnerable.[25]

Twin–banded Loach Botia rostrata prefers to live in medium currents of the river. Maximum abundance of this fish was seen at Sampling Point A3 (River at Borali Bridge) Twin–banded Loach Botia rostrata was only seen in riffles during October 2013 survey (**Exhibit 4.8**). The species was not collected during the May 2014 survey (**Exhibit 4.6**).

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[25] Chaudhry, S. 2010. *Botia rostrata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **22 November 2013**.

Exhibit 4.11: Indicator Fish Species in the Study Area

Species Name		*Diagnostic Characters*	*Photograph*
Scientific	*Common*		
Tor putitora	Mahaseer	Body streamlined, oblong and somewhat compressed. The ventral and dorsal profiles are greatly arched. Body depth is 1 to 1.4 times in standard length. Head broadly pointed . Length of head is more than depth of body and 3 to 3.6 times in standard length. Lips fleshy and continuus at corners of mouth. Two pairs of barbels, of equal length and equal to diameter of eye. Scales large, lateral line with 25-28 scales. Colour of live specimens various according to the the nature of water inhabited by fish. The back is redish sap-green, the flanks below the lateral line light orange which fade into silvery white on belly. Pectoral pelvic and anal fins yellowish.	
Labeo dyocheilus	Pakistani Labeo	Body elongated and snout projecting beyond mouth with distinct lateral lobes. Mouth is wide and inferior with thick lips. Lower lip with an interrupted fold joined to isthmus by a narrow bridge. Barbels one short maxillary pair. Dorsal fin inserted equidistance between snout-tip and base of caudal fin. Pectoral fins extended to pelvic fins. Caudalfin deeply forked. Scales moderate, lateral line with about 43 scales. Tubercles on the snout prominent. Clour of the live specimens is dull green, darker above. Fins darkest in center.	
Schizothorax plagiostomus	Alwan Snow Trout	Elongated body with projecting, inferior and wide mouth. The lower jaw has a keratinised cutting edge. Lower lip fold expanded and papilose. A series of enlarged scales are present along the anal fin base. Scales very small, almost 100 in the lateral line. Dark grey colour on dorsum, lighter on sides and silvery white below. Often small dark spots scattered over sides, more prominent in smaller specimens (Heekle, 1838).	

Species Name		Diagnostic Characters	Photograph
Scientific	Common		
Botia rostrata	Twin–banded Loach	Body elongate and laterally compressed. Head moderate, length of snout less than remaining part of head. Mouth small, barbels four pairs (two pairs rostral, one pair mixillary, and one pair mandibular). Dorsal fin inserted midway between snout tip and caudal fin base. Caudal fin moderatly forked. Scales minute. Live specimes are silvery grey or earthy brown with a series of Y shaped markings, arms of Y from each side meet on top of body so that a top view shows about O shaped markings.	
Clupisoma garua	Garua Bachwa	Body elongated and laterally compressed. Eye with board adipose lids. Mouth moderate and sub–terminal. Upper jaw longer than lower jaw. Barbels present and 4 pairs. Wide gill opening. Dorsal spine slender and comparatively weak than pectoral. No adipose fin in adult. Body dark on back and whitish or silvery at the sides and abdomen. Lateral line present but not so conspicuous.	
Glyptothorax kashmirensis	Kashmir Catfish	It is a small fish reaching upto 10 cm in length. The head is short, wide and depressed. Eyes are very small and covered by skin. Body and the fin bases are covered by small tubercles. The fish has four pairs of barbles, the nasal, maxillary and two mental pairs. Thorax adhesive apparatus about oval in outline with a prominent central depression. Adipose final situated apposite to anal fin. The dorsal, anal, pelvic and adipose fins relatively small. The dorsal fin has a strong spine which is serrated posteriorly.	

References:

Jayaram, K.C. 1999. The Freshwater Fishes of Indian Region. Narendra Publishing House, Delhi, India. 551 p.

Talwar, P. K. and A.G. Jhingran, 1991. Inland Fishes of India and Adjacent Countries - Vol.I, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 541 pp.

IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

4.4 Fish Indicators and their Flow–related Needs

As mentioned earlier, the following six species of fish were selected as indicators for ecological assessment:

- Mahaseer Tor putitora
- The Alwan Snow Trout Schizothorax plagiostomus (richardsonii)
- Kashmir Catfish Glyptothorax kashmirensis
- Garua Bachwa Clupisoma garua
- Pakistani Labeo Labeo dyocheilus
- Twin–banded Loach Botia rostrata

All the species selected as indicators demonstrate a comparatively higher degree of specialization in habitat preference in the Study Area. In other words, the habitat range of these species was observed to terminate either moving upstream or downstream within the Study Area. Changes in flow regime are therefore likely to have a comparatively higher level of impact on these species.

The preferences for flow–dependent habitat, breeding, and migratory behavior of the indicator fish species as well as a summary of the annual cycle of breeding and growth of these fish are discussed in **Exhibit 4.12** to **Exhibit 4.23** below.

The variations in abundance of fish species in response to variations in selected flow indicators for the Poonch River are described in terms of a series of response curves. The complete response curves for the fish indicator species at each EFlow site will be presented in the Interim Impact Assessment Report.

4.4.1 Links to and Dependence on Flow Regime

Kullander (1999)[26] presents a comprehensive account on all the fish fauna found in Kashmir and covers various ecological aspects of the fish fauna. Rafique and Qureshi (1977)[27] and Rafique (2000)[28] cover the breeding patterns, triggers and other physico–chemical requirements of the fish fauna of Azad Kashmir. Jhingran (1979)[29] and Sunder (1997)[30] have elaborated on the breeding, feeding and distributional patterns of various fish species especially the cold water fish fauna including the snow trout of Kashmir.

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[26] Kullander, S.O., F. Fang, B. Delling and E. Åhlander 1999.*The Fishes of the Kashmir Valley*. p. 99–167 In L. Nyman (ed.) River Jhelum, Kashmir Valley: impacts on the aquatic environment.

[27] Rafique, M. R., M. Y. Qureshi. (1997). *A contribution to the Fish and Fisheries of Azad Kashmir*. In *Biodiversity of Pakistan* (eds. S. A. Mufti, C. A. Woods and S. A. Hasan) , pp. 335–343. Pak. Mus. Nat. Hist. Islbd. & Fl. Mus. Nat. Hist. USA

[28] Rafique, M.R.2000. Technical Report on Assessment and Management of Riverine Fisheries Resources in Azad Kashmir. UNDP project Pak/96/005. Pp, 30.

[29] Jhingran, V.G. 1979. *Fish and Fisheries of India* (3rd Edition, Hindustan publ. Corp., Delhi

[30] Sunder, S. 1997. A Review on the Biological studies of Schizothoracids in J. & K. state and Elsewhere in India and their Cultural Possibilities. In: Recent Research in Cold water Fisheries (ed. K. L. Sehgal), pp. 157–171. Today and Tomorrows' Printers and Publishers, New Delhi.

General biological information regarding various ecological requirements of the fish fauna of the subcontinent and of the world is available in Talwar and Jhingran (1979)[31] and fish database Fishbase.org.[32] Relevant information available in the literature was supplemented with information collected and observations made as a part of this study.

Exhibit 4.12: Preferences for Flow–dependent Habitat, Breeding, and Migratory Behavior of the Schizothorax plagiostomus

	Adults	*Juveniles*	*Spawning*
Depth of Water	0.5-1.5 m	0.1-0.5 m	0.1-0.3 m
Velocity	1-3 m/s	0-0.5 m/s	0.5-1 m/s
Habitat	Swift running water with rocky beds. Adults need streams for spawning and need river, deep pools and reservoir for wintering at lower altitudes.	Quiet parts of the streams or in the side branchesof the main streams.	Spawnig is done in shallow water with gravel or fine pebbles bed with size of 50-60 mm
Substrate	Rocky/cobbly/Gravely	Cobble/Gravel	Gravel
Temperature	14-20 °C	14-20 °C	18-22 °C
Dissolved O2	6-8 mg/l and can survive 5-6 mg/l	6-8 mg/l	6-8 mg/l
Food	Insect larvae and eggs, Detritus	Micro-invertebrates	–
Spawning Period	May–July		
Breeding Period and Trigger	May-June in the Flood Season. Breeding is triggered by rise in temperature after the Dry Season. Spawning in side channels in shallow waters (10-30 cm) with boulders and low currents.		
Movement Pattern	Long distance, from upper Jhelum and Neelum to lower Jhelum and Mangla reservoir and back.		
Movement Triggers	Availability of side pools with shallow waters, rise in temperature		
Other Flow–related Needs	Is sensitive to pollution. Can tolerate turbidity.		

31 Talwar, P. K. and Jhingran, A. G. 1991.*Inland Fishes*(2 vols.). Oxford and IBHPublishingCo.NewDehli.

32 FishBase: A Global Information System on Fishes. www.fishbase.org. Accessed: May 2011

Exhibit 4.13: Annual Cycle of Breeding and Growth of the Schizothorax plagiostomus

Months	*Flow Conditions*	*Fish Behaviour*
May-June	Flood Season	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles. Eggs hatch in this period, and fries and fingerlings remain in shallow waters in side channels under the cobbles.
July-October	Flood Season – Transition-2 and Dry Onset	Spent fish move to areas with boulders, cobbles in its general preffered habitat ranging from a depth of 0.5-1.0 m. Fries and fingerlings remain in the side channels. Both adult and young fish feed actively in this period to gain fat for wintering.
November-March	Dry Season	Fish move mainly to crevices under cobbles or in pools for overwintering. Food intake drops and also supplemented by fat reserves for survival.
April	Transition-1	Fish becomes active, takes maximunm food and move to areas with where it could get maximum food.

Exhibit 4.14: Preferences for Flow–dependent Habitat, Breeding, and Migratory Behavior of the Tor putitora

	Adults	*Juveniles*	*Spawning*
Depth of Water	0.5-2 m	0.1-0.3 m	0.3-0.5 m
Velocity	0-3 m/s	0-0.5 m/s	0.5-1 m/s
Habitat	Inhibit streams, pools and lakes. Found in rapid streams with rocky bed.	Slow moving water with rocky bed.	Spawnig is done in well oxygenated and calm water with gravel bed.
Substrate	Rocky, stony	Cobbles	Stones, cobbles
Temperature	15-25 °C	20-25 °C	21-25°C
Dissolved O2	6–8 mg/l	6–8 mg/l	6–8 mg/l
Food	Omnivorous, food consists of Macroinvertebrates, dipteran larvae and plant matter.	Diatoms, ciliates, rotifers,crustaceans and fish fry.	Planktons
Spawning Period	May–August		
Breeding Period and Trigger	May–August in the Flood Season. Breeding is triggered by rise in temperature after the Dry Season. Breeds both in river as well as in tributaries in suitable habitat.		
Movement Pattern	From Mangla reservoir or deep waters to breeding areeas in side nullahs. It migrates upstream from the main river into rivulets mainly during the sothwest monsoon. Migration process is due to the reproductive biology of the fish and also in search of fresh feeding grounds.		
Movement Triggers	Rise in water temperature, swollen river and expansion of habitat.		
Other Flow–related Needs	Is sensitive to pollution.		

Exhibit 4.15: Annual Cycle of Breeding and Growth of the Tor putitora

Months	*Flow Conditions*	*Fish Behaviour*
June–August	FloodSeason	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in tributries and side streams and channels of the river with cobbles and gravely beds. Eggs hatch in this season, and fries and fingerlings remain in shallow waters in side channels.
September–October	Transition–2 and Dry Onset	Spent fish move to mainstream. Fingerlings mainly remain in shallow side channels. Both adult and young fish feed actively in this period.
November–March	Dry Season	Fish move mainly to deep pools for overwintering. Food intake drops significantly as fish is inactive and also utilizes fat reserves for survival.
April–May	Transition–1 and Flood Season	Fish emerge and move to banks, avoiding fast flows, in search of food to get ready for the breeding season.

Exhibit 4.16: Preferences for Flow–dependent Habitat, Breeding, and Migratory Behavior of the Labeo dyocheilus

	Adults	*Juveniles*	*Spawning*
Depth of Water	0.5-1 m	0.1-0.3 m	24-30 cm
Velocity	0-3 m/s	0-0.5 m/s	0.75-0.95 m/s
Habitat	Adults live in clear active currents of river.	Pools and the slow moving patches of the streams.	Slow running water with small and medium size stones nearby the confluence of the small tributaries in the side of the Riverbank.
Substrate	Rocky, stony	Cobbles	Stones, cobbles
Temperature	15-25 °C	20-25 °C	19-23 °C
Dissolved O2	6–8 mg/l	6–8 mg/l	6–8 mg/l
Food	Omnivorous, column feeding, food consists of green algae, diatoms, sand and debris, zooplankton along with insects and macrophytesas a food.	Diatoms, Zooplanktons	Small patches of slow running water on small and medium sized stones nearby the confluence of small tributaries in side of riverbank at a depth of 24 to 30 cm.
Spawning Period	May–August		
Breeding Period and Trigger	May–August in the Flood Season. Breeding is triggered by rise in temperature and beginning of rainy season after the Dry Season. Breeds both in river as well as in tributaries in suitable habitat.		
Movement Pattern	Local breeding migration		
Movement Triggers	Rise in water temperature, rains ,swollen river and expansion of habitat.		
Other Flow–related Needs	Is sensitive to pollution.		

Exhibit 4.17: Annual Cycle of Breeding and Growth of the Labeo dyocheilus

Months	*Flow Conditions*	*Fish Behaviour*
June–August	FloodSeason	Breeding is triggered by beginning of Monsoon, snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, tributaries, and channels of the river with slow moving water and cobbles and gravely beds. Eggs hatch in this season, and fries and fingerlings remain in shallow waters in side channels.
September–October	Transition–2 and Dry Onset	Spent fish move to mainstream. Fingerlings remain in shallow side channels and tributaries . Both adult and young fish feed actively in this period.
November–March	Dry Season	Fish move mainly to pools for overwintering. Food intake drops significantly as fish is inactive and also utilizes fat reserves for survival.
April–May	Transition–1 and Flood Season	Fish emerge and move to banks, avoiding fast flows, in search of food to get ready for the breeding season.

Exhibit 4.18: Preferences for Flow–dependent Habitat, Breeding, and Migratory Behavior of the Glyptothorax kashmirensis

	Adults	*Juveniles*	*Spawning*
Depth of Water	0.5-1 m	0.3-0.5 m	0.3-0.5 m
Velocity	1-2 m/s	0.5-1 m/s	0.5-1 m/s
Habitat	Fast flowing parts of the river with rocky bed.	Fast Moving water with rocky bed.	Mainly on stony pebble ground.
Substrate	Rocky	Cobble	Cobble
Temperature	16-20 °C	18-22 °C	18-20 °C
Dissolved O2	6-8 mg/l and can survive 5-6 mg/l	6-8 mg/l	6-8 mg/l
Food	Aquatic insect larvae and eggs.	Micro-invertebrates	_
Spawning Period	May–August		
Breeding Period and Trigger	May-August in the Flood Season. Breeding is triggered by rise in temperature after the dry Season. Spawning in side channels in shallow waters (10-20 cm) with boulders and low currents.		
Movement Pattern	Migrates in search of suitable habitat in main channel in crevices and underneath the boulders.		
Movement Triggers	Availability of side pools with shallow waters, rise in temperature		
Other Flow–related Needs	Is sensitive to pollution. Can tolerate turbidity.		

Exhibit 4.19: Annual Cycle of Breeding and Growth of the Glyptothorax kashmirensis

Months	*Flow Conditions*	*Fish Behaviour*
May-June	Flood Season	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles. Eggs hatch in this period, and fries and fingerlings remain in shallow waters in side channels under the cobbles.
July-October	Flood Season – Transition-2 and Dry Onset	Spent fish move to areas with boulders and rocks avoiding fast flowing water. Fingerlings remain under the cobbles. Both adult and young fish feed actively in this period.
November-March	Dry Season	Fish move mainly to crevices under cobbles for overwintering. Avoid pools. Food intake drops and also supplementedby fat reserves for survival.
April	Transition-1	Fish becomes active and move to areas with boulders, cobbles where food in the form of aquatic insects is available avoiding fast flows. It actively takes food to get itself ready for the breeding season.

Exhibit 4.20: Preferences for Flow–dependent Habitat, Breeding, and Migratory Behavior of the Botia rostrata

	Adults	*Juveniles*	*Spawning*
Depth of Water	0.3-0.7 m	0.1-0.3 m	0.3-0.5 m
Velocity	1-2 m/s	0.5-1 m/s	0.3-0.7 m/s
Habitat	Medium current with rocky bed.	Side streams of the river with mild flows.	Mainly in transparent water with sand pebbles at the bed.
Substrate	Rocky, stony	Cobbles	Stones, cobbles
Temperature	15-25 °C	18-22 °C	18-20 °C
Dissolved O2	6–8 mg/l	6–8 mg/l	6–8 mg/l
Food	Carnivorous, feeds on insect larvae and benthic organisms.	Zooplanktons and small insect larvae	Carnivorous, feeds on insect larvae and benthic organisms
Spawning Period	May–August		
Breeding Period and Trigger	May–August in the Flood Season. Breeding is triggered by rise in temperature after the Dry Season. Breeds both in river as well as in tributaries in suitable habitat.		
Movement Pattern	Limited migration for wintering.		
Movement Triggers	Rise in water temperature, swollen river and expansion of habitat.		
Other Flow–related Needs	Is sensitive to pollution.		

Exhibit 4.21: Annual Cycle of Breeding and Growth of the Botia rostrata

Months	*Flow Conditions*	*Fish Behaviour*
June–August	FloodSeason	Breeding is triggered by snow melt and rise in turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles and gravely beds. Eggs hatch in this season, and fries and fingerlings remain in shallow waters in side channels.
September–October	Transition–2 and Dry Onset	Spent fish move to banks of the mainstream. Fingerlings remain in shallow side channels. Both adult and young fish feed actively in this period.
November–March	Dry Season	Fish move mainly to crevices for overwintering. Food intake drops significantly as fish is inactive and also utilizes fat reserves for survival.
April–May	Transition–1 and Flood Season	Fish emerge and move to banks, avoiding fast flows, in search of food to get ready for the breeding season.

Exhibit 4.22: Preferences for Flow–dependent Habitat, Breeding, and Migratory Behavior of the Clupisoma garua

	Adults	*Juveniles*	*Spawning*
Depth of Water	0.5-1 m	0.1-0.3 m	0.3-0.5 m
Velocity	0-3 m/s	0.5-1 m/s	0.5-1 m/s
Habitat	Fast flowing deep parts of the river with rcky bed.	Slow moving water with rcky bed.	Shallow streams
Substrate	Rocky/cobbly/sandy	Rocky/cobbly/sandy	Cobble
Temperature	15-25 °C	20-25 °C	21-25 °C
Dissolved O2	4-6mg/l	4-6mg/l	4-6mg/l
Food	Carnivorous, feeds on insects, shrimps, other crustaceans and small fish.	Micro-invertebrates	_
Spawning Period	May–August		
Breeding Period and Trigger	May-June in the Flood Season. Breeding is triggered by rise in temperature after the dry Season. Spawning in side channels in shallow waters (10-20 cm) with boulders, sand and low currents.		
Movement Pattern	Limited migration for breeding, feeding and wintering.		
Movement Triggers	Availability of side pools with shallow waters, rise in temperature		
Other Flow–related Needs	Is sensitive to pollution. Can tolerate turbidity.		

Exhibit 4.23: Annual Cycle of Breeding and Growth of the Clupisoma garua

Months	*Flow Conditions*	*Fish Behaviour*
May-June	Flood Season	Breeding is triggered by rise in temperature and turbidity. Fish move to breeding grounds in shallow side pools, and channels of the river with cobbles. Eggs hatch in this period, and fries and fingerlings remain in shallow waters in side channels in sandy or rocky area.
July-October	Flood Season – Transition-2 and Dry Onset	Spent fish move into the main river channel. Fingerlings remain in side channel. Both adult and young fish feed actively in this period.
November-March	Dry Season	Fish move mainly to crevices or in deep channel. Food intake drops and also supplemented by fat reserves for survival.
April	Transition-1	Fish becom active and move to areas with food abundance, takes maximum food to get ready for the breeding season.

5. Macro-invertebrates

5.1 Overview of Benthic Fauna

Benthic macro-invertebrates are an important part of the food chain in aquatic ecosystems, especially for fish. Many invertebrates feed on algae and bacteria, which are at the lower end of the food chain. Some shred and eat leaves and other organic matter that enters or is produced in the water. Because of their abundance and position as 'intermediaries' in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients (Williams & Feltmate, 1992)[33].

Stream regulation by damming of rivers and ensuing impoundment are one of the most frequent causes of depletion of biological diversity of aquatic ecosystems resulting in interference with the natural process of dispersal. (Richter et al., 1997[34]; Zalewiski et al., 1997[35]). Some authors have described several beneficial aspects of water regulation and impoundment, but the loss of aquatic habitat and the associated species and populations cannot be underestimated. Any variation in community structure of primary producers is reflected in subsequent changes in higher components of food chain e.g., benthic macro-invertebrates and fish fauna (Bhatt et al., 2005)[36].

The composition of invertebrate communities varies along and between rivers, with the main influences on distribution and abundance being current velocity, water temperature, substratum type, stability of both aquatic and riparian vegetation, dissolved substances, competition, and human practices. Large, stable substrata–such as boulders and cobbles–support larger, more productive invertebrate populations than do unstable gravels and sand. On mobile bottoms, such as gravel and sand, invertebrates are readily displaced and may be at risk through mechanical damage. A decrease in substratum size results in lower macro-invertebrate diversities and production. The Poonch River is rich in invertebrate species because of the abundant riffle habitat, warm water temperatures (30 °C in summers), and a predominantly rocky and cobble substratum.

Aubert, 1959[37] reported twenty species of stoneflies (extremely pollution intolerant organisms) belonging to seven genera from Pakistan (Hindukush including Gilgit-Baltistan and Chitral; Karakorum including Neelum valley, Kaghan valley; Rawalpindi including Murree).

Ali, 1971[38] reported five orders of benthic invertebrates from Poonch River. These include Oligochaeta, Ephemeroptera, Trichoptera, Chironomidae and Tabanidae. That

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[33] Williams D. D. and Feltmate, B. W. 1992. Aquatic Insects. CAB International Wallingford, Oxon. 360 pp.

[34] Richter, B.D., Braun, D.P., Mendelson, M.A., Master, L. L. 1997. Threats to imperiled freshwater fauna. Conservation Biology. 11, 1081-1093.

[35] Zalewski, M., Janauer, G. A., Jolankai, G., 1997. Ecohydrology. IHP-V, UNESCO. 7, 7-18.

[36] Zalewski, M., Janauer, G. A., Jolankai, G., 1997. Ecohydrology. IHP-V, UNESCO. 7, 7-18.

[37] Aubert, J. (1959): Plécoptères du Pakistan. Memoires de la Societe vaudoise des Sciences naturelles, 75, Vol. 12, fasc. 3:65-91.

[38] Ali, S.R. 1971. Certain Mayflies of Swat and Azad Kashmir. Pak. J. Sci. 23 (5 & 6): 209-214.

publication, however, provides very limited information about the composition of the benthic macro-invertebrate assemblages as identification was limited to order level.

Sehgal et al., 1991[39] reported six taxa (order level identification) of benthic macro-invertebrates from streams of the Jhelum River (Indian territory) along with their per square meter abundance at specified locations.

Bhatt et al., 2005 reported twelve taxa (order level identification) from Neelum river (Indian territory) along with their per square meter abundance at specified locations.

A review of some unpublished data indicates that the benthic macro-invertebrate families observed in the Neelum and Jhelum rivers also occur at the outlet zones of the lakes in the Kaghan Valley[40] (Dudipatsar Lake, Gittidas wetland complex, and Lulusar Lake) and outlets of the lakes in the Neelum Valley (Patlian Lake and Rattigali Lake).

A total of 8 locations were sampled in the October 2013 survey to study macro-invertebrate abundance and diversity in the Study Area. The methodology for sampling is explained in **Section 2** (Methodology) and the location of the sampling points is given in **Exhibit 2.2**.

Data collected during this study is included in **Exhibit A.7** in **Appendix A**.

5.2 Results of the Macro-invertebrate Surveys

A total of 37 macro-invertebrate taxa were identified in the Study Area during the October 2013 survey (**Exhibit 5.1**). Some of these were identified up to the genus level while others could only be identified up to family / sub-family level.

Exhibit 5.1: Average Abundance /m^2 of Macro-invertebrate Taxa Survey Conducted October 2013 survey

No.	*Taxa*	*A1*	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*A8*	***Total***
1.	Perlidae (Neoperla)	–	1.5	–	–	1.7	8	4.5	8	**23.66**
2.	Baetidae (Acentrella)	11	11.5	8.5	54	10.7	6	–	–	**101.66**
3.	Baetidae (Baetis)	18	12.5	26.5	12	42.3	21	11.5	35.5	**179.33**
4.	Baetidae (Baetiella)	–	–	1.5	9	0.0	–	3.5	–	**14**
5.	Baetidae (Centroptilum)	–	–	–	–	–	–	–	12.5	**12.5**
6.	Caenidae (Caenis)	6	2	0	2	25.7	19	3	13	**70.66**
7.	Caenidae (Brachycerus)	–	–	–	–	–	–	12	–	**12**

[39] Sehgal, K. L., 1991. Distributional patterns, structural modifications and diversity of Benthic biota in Mountain streams of North Western Himalaya. In: D. Bhatt and P.K. Pandey (Eds.), Ecology of the Mountain Water, pp. 199-247. Ashish Publishing House, New Delhi.

[40] Kunar River, which is a tributary of the Jhelum River, drains the Kaghan Valley located immediately west of the Neelum Valley.

No.	Taxa	A1	A2	A3	A4	A5	A6	A7	A8	Total
8.	Heptageniidae (Stenonema)	24	11.5	18.5	19	91.7	64	8.5	–	**237.16**
9.	Heptageniidae (Rhithrogena)	5	2.5	4.5	7	6.3	–	–	–	**25.33**
10.	Leptophebiidae (Choroterpes)	13	3.5	6	17	99.3	94	26	90.5	**349.3**
11.	Ephemerellidae	–	–	–	2	–	5	–	–	**7**
12.	Hydropsychidae (Hydropsyche)	43	–	–	–	–	–	–	–	**43**
13.	Hydropsychidae (Chematopsyche)	22	8	0.5	17	52.3	15	54.5	28.5	**197.83**
14.	Hydroptilidae	–	–	–	–	–	–	–	13	**13**
15.	Philopotamidae (Chimarra)	–	6	1.5	8	58.3	8	41	1.5	**124.33**
16.	Chironimidae	53	32	50	50	–	107	123.5	164.5	**580**
17.	Tipulidae	–	0.5	–	–	0.3	–	–	–	**0.83**
18.	Athericidae (Atherix)	10	5	1	14	5.7	–	3	–	**38.66**
19.	Culicidae	–	–	–	–	–	–	–	0.5	**0.5**
20.	Tabanidae (Tabanus)	–	–	1	–	–	3	3	2	**9**
21.	Psychodidae (Psychoda)	1	–	–	–	–	4	–	–	**5**
22.	Simulidae	–	4	–	23	–	–	–	–	**27**
23.	Elmidae	–	8	33	10	29.7	–	1	1	**82.66**
24.	Scirtidae	0	0.5	–	–	–	–	–	–	**0.5**
25.	Gyrinidae	–	–	–	–	–	2	–	2	**4**
26.	Psephenidae	–	–	–	–	–	–	–	2	**2**
27.	Aphelocheiridae (Aphelocheirus)	0	2	0.5	5	12.0	–	2	–	**21.5**
28.	Corixidae	–	–	–	–	–	–	–	2.5	**2.5**
29.	Gerridae	–	–	–	–	–	–	–	3	**3**
30.	Corydalidae Corydalus	–	0.5	–	–	0.3	2	2	0.5	**5.33**
31.	Gomphidae	1	–	–	–	5.0	–	1	7.5	**14.5**
32.	Libellulidae	1	–	–	–	–	–	–	3	**4**
33.	Cordulidae	–	–	1	–	–	–	–	1	**2**

No.	Taxa	A1	A2	A3	A4	A5	A6	A7	A8	Total
34.	Potamidae	–	0.5	–	–	–	–	0.5	–	**1**
35.	Unionidae	–	–	–	–	–	–	–	8	**8**
36.	Enchyrtraeidae	–	–	–	–	–	–	–	22	**22**
37.	Tubificidae	2	0.5	0.5	–	–	–	–	–	**3**
	Abundance/m2	**210**	**112.5**	**154.5**	**249**	**441.3**	**358**	**300.5**	**422**	
	Diversity (no of species observed)	**14**	**19**	**15**	**15**	**15.0**	**14**	**17**	**22**	

Abundant macro-invertebrate taxa observed in the Study Area during the October 2013 surveys included Chironimidae Choroterpes sp., Stenonema sp. and Chematopsyche sp. The least abundant taxa observed were Culicidae and Scirtidae.

No macro-invertebrate survey was conducted during the December 2013 survey.

5.2.1 Distribution and Abundance in the Study Area

Exhibit 5.2 shows the average abundance of macro-invertebrates seen at each sampling point during October 2013 survey. The location of these sampling points is shown on a map in **Exhibit 2.3** (**Section 2, Methodology**). The Sampling Points A1, A2, A3, A4, A5 were located on the main Poonch River while the Sampling Points A6, A7 and A8 were located in tributaries (nullahs).

The average abundance of macro-invertebrates was generally higher in the tributaries (with the exception of Sampling Point A5) compared to the main river. This is because the low water velocity in nullahs and streams allow better opportunities for macro-invertebrate to attach to substrates in the river. In addition, the low water velocities promote growth of algae that provide food for macro-invertebrates.

The maximum average macro-invertebrate abundance/m^2 was seen at Sampling Point A5 (River at Billiporian Bridge) where 441 macro-invertebrate specimens/m^{2}were observed. Large cobbles of approximately 1 foot diameter were present in the riverbed at this location that provided suitable substrate for macro-invertebrate attachment. Moreover, the predominant water biotope at this location was riffles (even though some pools were present) that is the preferred biotope of macro-invertebrates.

The second highest average abundance/m^2 was seen at Sampling Point A8 (Ban Nullah at Khuiratta) where 422 macro-invertebrate specimens/m^2 were observed. This sampling point is located on Ban Nullah. Thelow water velocity in nullahs and streams allow better opportunities for macro-invertebrate to attach to substrates in the river and also promote algal growth.

The least average macro-invertebrate abundance was seen at Sampling Point A2 (River at confluence with Rangar Nullah) where 113 specimens/m^2 were observed. The likely reason for the low abundance at this sampling point is the comparatively higher pollution levels in the River due to proximity to Kotli city (**Exhibit 5.2**).

The most abundant macro-invertebrate taxon observed during October 2013 survey was Chironimidae with average abundance/m^2 of 580 followed by Choroterpes sp. and Stenonema sp with an average abundance/m^2 of 349 and 237 respectively.

Exhibit 5.3 shows the diversity of macro-invertebrate taxa observed at each sampling point during October 2013 survey.

Similar to abundance, diversity of macro-invertebrates observed was higher in the tributaries compared to the River due to lower water volume and velocity in the nullahs.

Maximum diversity of macro-invertebrate taxa was seen at Sampling Point A8 (Ban Nullah near Khuiratta) where 22 taxa were seen during the October 2013 survey. Chironimidae was the most abundant taxon seen at this sampling point followed by Choroterpes sp. and Baetis sp.

Least diversity of macro-invertebrate taxa was seen at Sampling Points A1 (Poonch River at Kallar Bridge) and A6 (Rangar Nullah) where 14 taxa were seen at each sampling point during the October 2013 survey. The low macro-invertebrate diversity at Sampling Point A1 (Poonch River at Kallar Bridge) was due to the high water turbidity at this location. Sampling Point A6 (Rangar Nullah) had a low diversity of macro-invertebrates (**Exhibit 5.3**) but the average abundance observed was high (**Exhibit 5.2**).

Exhibit 5.2: Macro-invertebrates Abundance at Sampling Points during October 2013 Survey

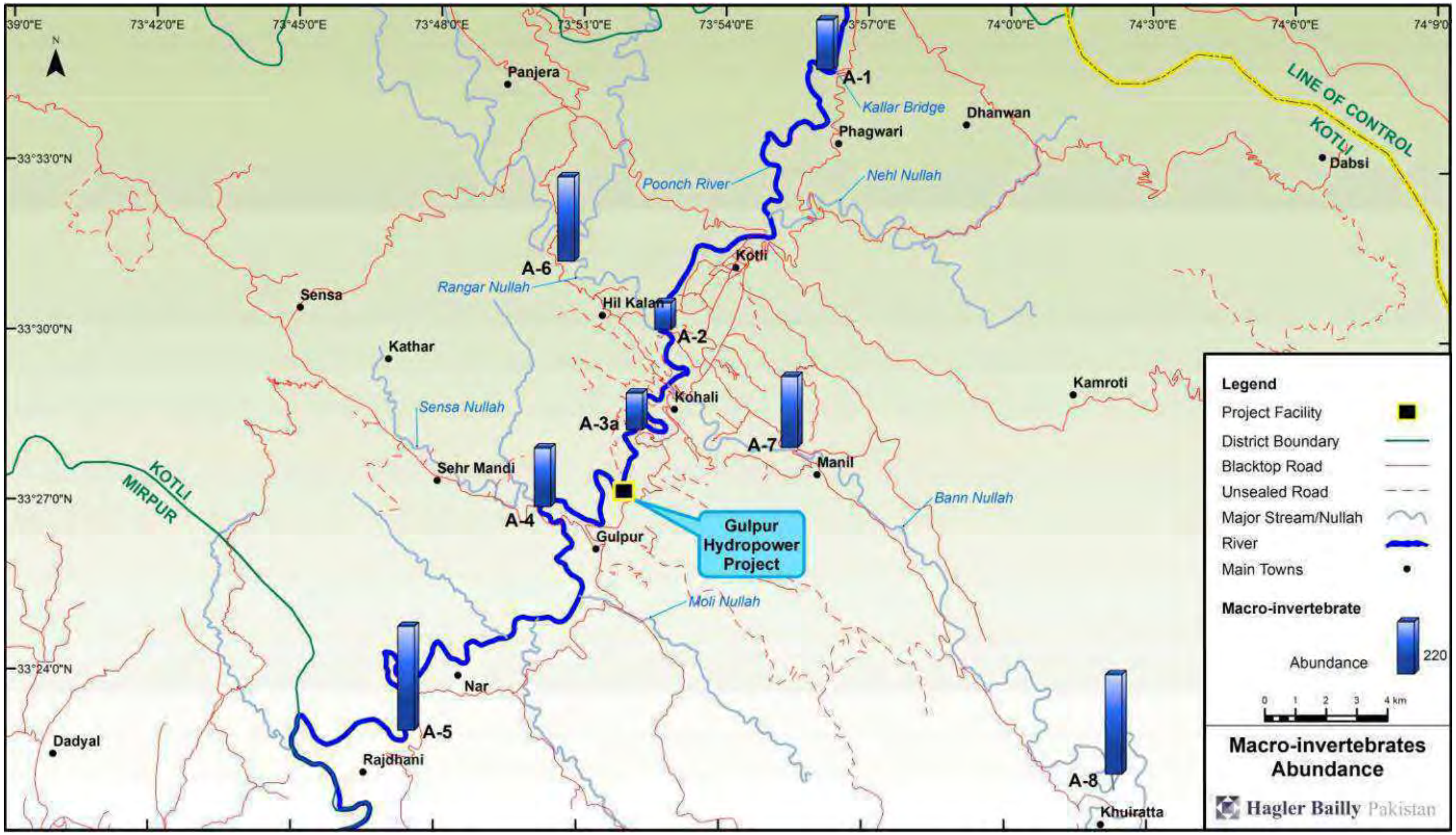
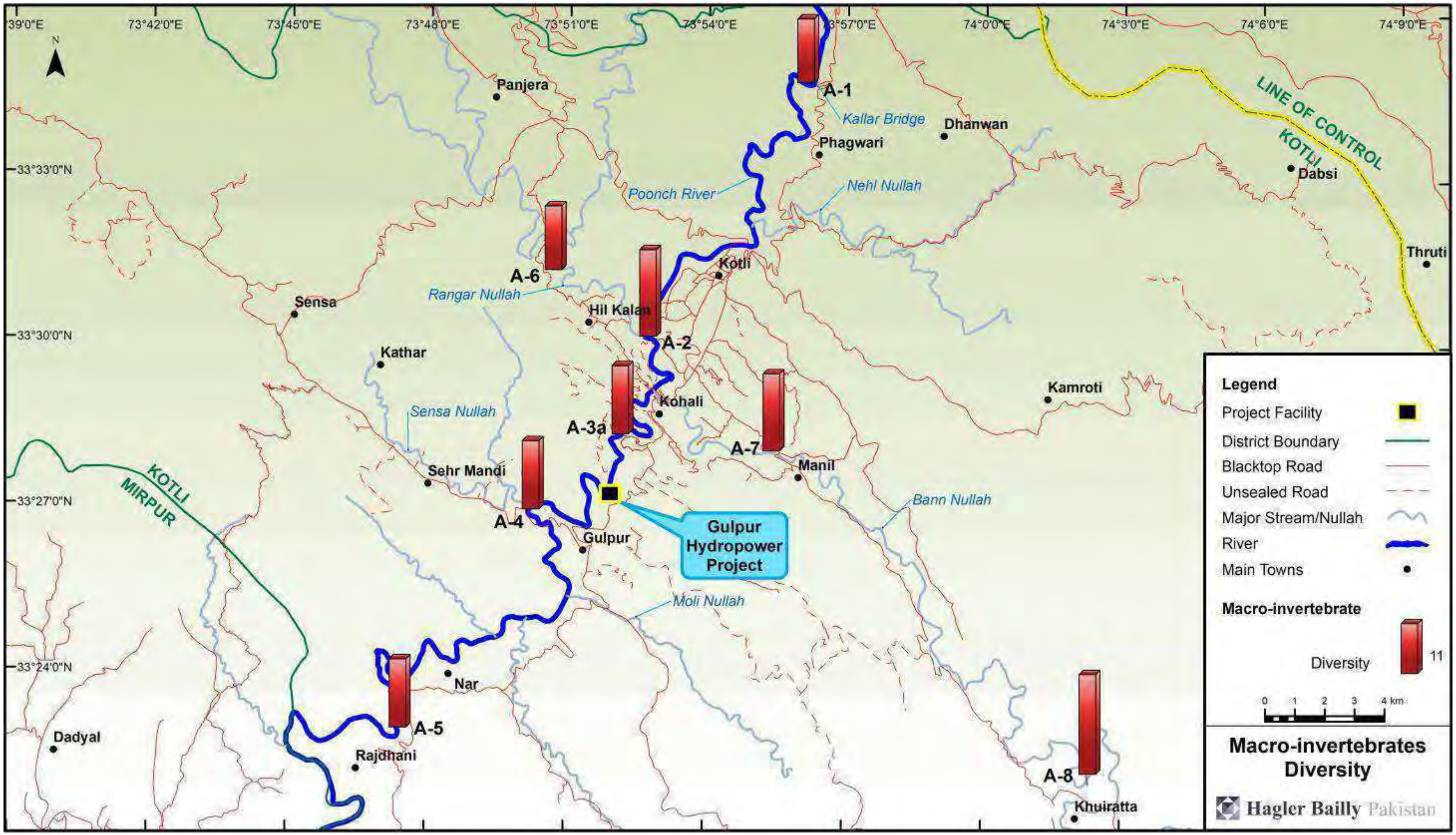


Exhibit 5.3: Macro-invertebrates Diversity at Sampling Points during October 2013 Survey



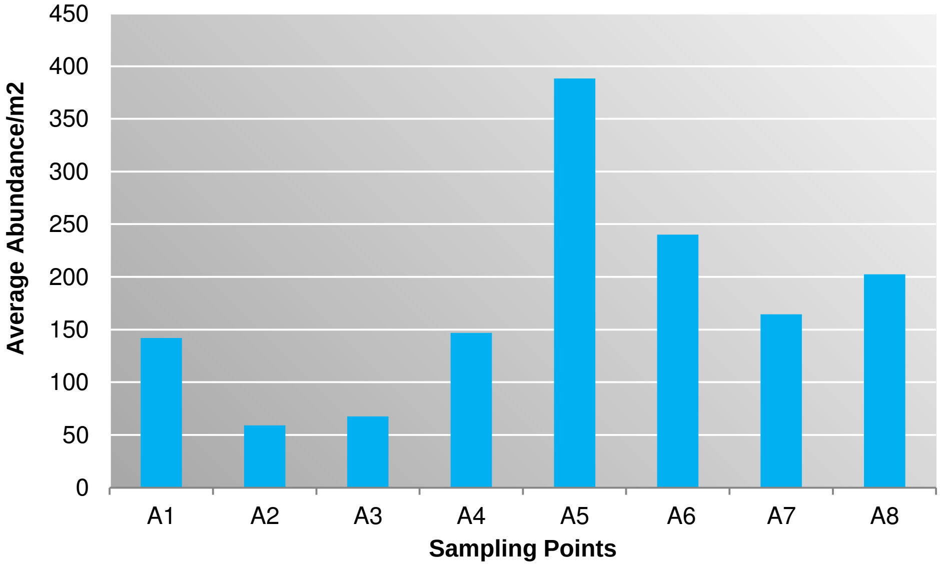
5.3 Macro-invertebrate Indicators

Two indicator macro-invertebrate groups have been chosen to study the impact of Project induced changes in the river flow on the macro-invertebrate populations. These are the EPT (Ephemeroptera, Plecoptera, Tricoptera) and Simuliidae. The EPT group is considered the most important indicator for macro-invertebrate fauna as a whole because they are the most abundant group, sensitive to flow and pollution, and also serve as food for fish. Simuliidae are relatively more tolerant to lower winter temperatures in comparison to EPT and serve as food for fish. They were chosen as an indicator since under altered conditions Simuliidae proliferations can reach pest proportions with negative consequences for livestock and people.

EPT

The average abundance/m^2 of EPT fauna observed in the Study Area during the October 2013 survey is shown in **Exhibit 5.4**. The number of families/taxa within the EPT group is an indication of the ability of the ecosystem to support diverse taxa. Maximum average abundance/m^2 of EPT was observed at Sampling Point A5 (River at Billiporian Bridge) followed by A6 (Rangar Nullah) and A8 (Ban Nullah at Khuiratta). Least average abundance/m^2 of EPT was observed at Sampling Point A2 (River at confluence with Rangar Nullah).

Exhibit 5.4: Average Abundance/m^2 of EPT Fauna

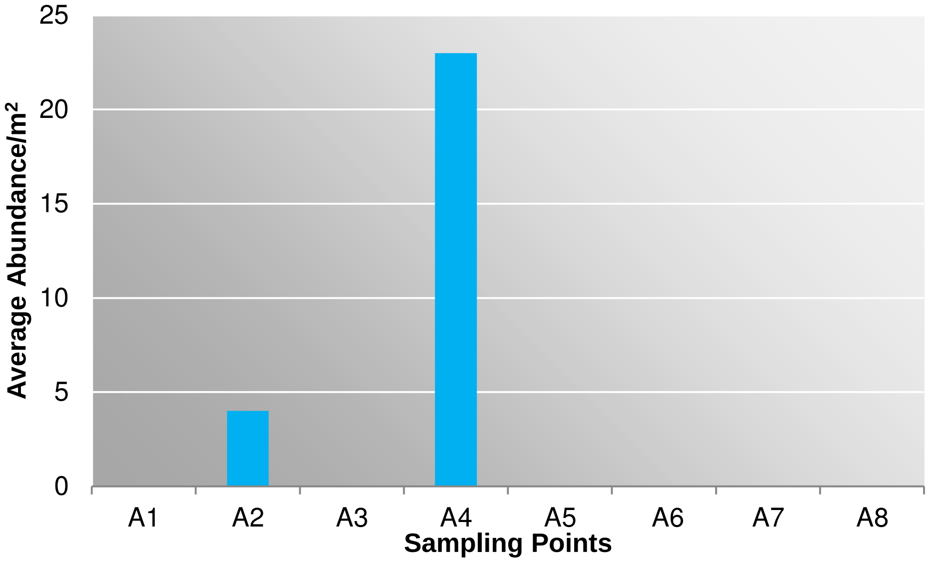


Simuliidae

The average abundance/m^2 of Simuliidae observed during the October 2013 survey is shown in **Exhibit 5.5.** Fly species in the Family Simuliidae have a relatively shorter life cycle with multiple cycles per year and consequentially higher growth rates than the EPT. Spatial and seasonal variations in the population of Simuliidae in a flowing river are therefore also likely. High water velocities in the floods do not favour the anchorage of Simuliidae, nor do the turbid waters of the Flood Season and the limited availability of food at that time.

Simuliidae were observed only at Sampling Point A4 (River at Gulpur Bridge) and A2 (River at confluence with Rangar Nullah) during the October 2013 survey. Maximum average abundance/ m^2 of the Simuliidae was observed at Sampling Point A4 (Gulpur Bridge).

Exhibit 5.5: Average Abundance/m^2 of Simuliidae



5.4 Macro-invertebrate Indicators for the Poonch River and their Flow-Related Needs

There is very limited literature available on the benthic macro-invertebrate fauna of Pakistan in general and Poonch River in particular. Therefore, direct information on the flow needs, temperature requirements, and feeding, breeding, and migratory behaviour of the macro-invertebrates of the Neelum Valley is not available. Observations regarding these aspects in this study, however, were generally consistent with those reported in literature. Lewis (1973)[41] and Rubtsov (1990)[42] provide information regarding fauna, biology, flow requirement, food, breeding and migration of Black flies (Simuliidae). William and Feltmate (1992)[43], Bispo et al. (2006)[44] and Nurcan et al. (2010)[45] cover general information on biology, habitat and food of aquatic insects (including EPT taxa)

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41 Lewis, D.J. 1973. The Simuliidae of Pakistan. Bulletin of Entomological Research, 62:453-470.

42 Rubtsov, I.A. 1990. Blackflies (Simuliidae). Fauna of the USSR Diptera. Volume 6 Part 6. Published by Brill. Leiden, 1042.

43 William, D.D. and Feltmate, B.W. 1992. Aquatic Insects. CAB International. ISBN 0-85198-782-6, xiii-358p.

44 Bispo, P.C., Oliveira, L.G., Bini, L.M. and Sousa, K.G. 2006. *Ephemeroptera Plecoptera Trichoptera assemblage from Riffle in mountain streams of central Brazil: Environmental factor influencing the distribution and abundance of immatur*e. Braz. J. Biol. 66(2B): 611-622

45 Nurcan Ozken., Joel Moubayed, Breil Belgin and Camur-Elipek. 2010. Ecological analysis of Chironomid larvae (Diptera: Chironomidae) in Eregne River Basin (Tirkish Thrace). *Turkish Journal Fisheries and Aquatic Sciences*, 10:93-99.

and Mackie (2001)[46] discusses the role of aquatic insects in aquatic habitat and their dependence on various environmental factors such as oxygen, pH, and habitat. Benthic macro-invertebrates are important living resources that can be sensitive to changes in flow regimes. Flow affects the volume and velocity of the river, which directly affects benthos. Biomass per unit area also varies considerably with water level. Biomass is low in the Flood Season (May-August). Under extremely high flows, benthic organisms may be physically washed out of the system. At mid-water (Transition Seasons), benthic productivity is medium and at low water in the Dry Season it is generally very high. The general scarcity of benthos is, therefore, related to shifting substrata, high floods, high silt load, fluctuating water levels and the absence of aquatic vegetation, all of which militate against high production amongst benthic organisms. The biomass of benthos is also strongly affected by the presence or absence of fish, as fish exert a predation pressure on the benthos. Submerged vegetation, where present, acts as a centre of concentration for benthic invertebrates.

Although the deposition of organic sediment at slow current velocities may increase benthic production for some of the invertebrates, such as midges (Chironomidae) and earthworms (Oligochaeta), the filling of interstitial spaces with fine, inorganic sediment can eliminate potential habitat for other invertebrates.

Exhibit 5.6 summarizes the flow-related needs for the two indicators of macro-invertebrate fauna selected for this study. The activity cycle of these indicator groups are outlined in **Exhibit 5.7 and Exhibit 5.8** for the EPT and Simuliidae respectively.

The response of the macro-invertebrate indicators to changes in the flow regime in view of their flow-related needs will be presented in the Interim Impact Assessment Report.

Exhibit 5.6: Flow-related Needs of Macro-invertebrates

	EPT	*Simuliidae*
Flow Needs	Sensitive to flow regime and pollution. Require clean well-oxygenated, fast-flowing water. Prefer riffles with rocky and cobblestone beds. Most of the taxa are intolerant to slight changes in water-soluble oxygen concentration. Their density increases during low flow due to clustering of individuals. Floods and heavy rainfall reduce their density, as the population can be disturbed and washed out.	Prefer areas of moderate and fast currents and attach to hard substrata. Silty and sandy bottoms in areas of stagnant water or with a current less than 0.1 to 0.2 m/sec are unfavourable habitat. Larval concentrations are found in medium and large rivers at current speeds of 0.6-0.8 m/sec, and in mountainous streams at current speeds higher than 1.0 m/sec. Larvae can survive one week of zero flow below stones in highly humid environment.

[46] Mackie, G.L. 2001. *Applied Aquatic Ecosystem Concepts*. Kendall/Hunt Publishing Company, xxv, 744 pp. ISBN 0-7872-7490-9.

	EPT	Simuliidae
		Constant flow due to construction of dams and reservoirs creates ideal conditions for immature larvae to increase in number in riffles immediately downstream of such structures.
Temperature	Most of the EPT fauna flourish at water temperatures ranging from 0 °C to 15 °C. They have a high oxygen demand, ranging from 8 mg/l to 10 mg/l. A few species are able to survive at temperatures ranging from 20 °C to 27 °C and low oxygen concentrations ranging from 4 mg/l to 6 mg/l.	Most species flourish in temperatures ranging from 10 °C to 15 °C. They have high oxygen demand, ranging from 8-10 mg/l. Simuliids are unable to survive in stationery water with a low oxygen concentration below 4-6 mg/l. Some species can tolerate higher temperatures, ranging from 20 °C to 30°C.
Food	Nymphs feed on pieces of organic matter, such as plant material or algae, diatoms, mosses, and immature aquatic invertebrates and debris that accumulate on rocks or other substrata in flowing water.	Larvae feed on suspended food particles through filter feeding. Adult females feed on the blood of animals for maturation of eggs, while males feed on flower nectar.
Breeding	Mating occurs in flight during the Flood Season. Most nymphs develop in shallow streams and rivers that are well-oxygenated and relatively free of pollution. Females deposit eggs while flying low over the water, or by dipping the abdomen into the water; some species submerge themselves and lay eggs underwater. Nymphs develop through several stages by moulting. Mature nymphs swim to the water surface or crawl onto rocks or aerial shoots of plants, then moult into winged adults.	Larvae develop in running water of all types, from the smallest seepages and streams to the largest rivers and waterfalls; they attach themselves to underwater rocks and other objects by means of small hooklets in a sucker-like disc at the tip of the abdomen. Most northern species have one generation per year; some species have multiple generations; overwintering is either as an egg or as a larva, depending on species and/or latitude.
Migration	During the final stages of nymphal life (around May, start of Flood Season) there is a movement to and a concentration in the shallower areas of the river. In running waters, springtime mass movements of nymphs along the banks of the main river and into slower flowing tributary streams or into areas	After emergence from pupae at the start of the Flood Season the adults become terrestrial. Adults have a life span of the order of a few days. Male flies feed on flower sap and female flies search for blood (human and livestock) to enhance maturation of their

	EPT	Simuliidae
	flooded by spring snowmelt have been observed. In running water, nymphs may move down into the substratum in response to spates or as a part of a daily rhythm. Generally, nymphs do not extend far down into the substratum (i.e., the hyporheic zone).	eggs. They return to water to lay eggs. Adults have low mobility and may be present in a specific location, depending on species and latitude.

Exhibit 5.7: Generalized Activity Calendar for EPT Fauna

Months	*Flow Season*	*Life Cycle Pattern*
Generalized Activity Calendar for *Ephemeroptera*		
November-March	Dry Season	Slow growth of nymphs because of low temperature.
April	Transition Season-1	Rapid growth of nymphs, depending on temperature increase.
May	Flood Season	Rapid growth of nymphs. Nymphs grow larger.
June		Rapid growth of nymphs. Nymphs grow larger. Emergence of adults (adult life lasts about 24 hours), egg laying starts
July-September	Flood through Transition Season-2	Emergence of adults, breeding swarms and egg laying; appearance of new nymphs/rapid growth of hatched nymphs.
October	Start of Dry Season	New generation grows rapidly.
Generalized Activity Calendar for *Plecoptera*		
November-March	Dry Season	Slow growth of nymphs.
April	Transition Season-1	Emergence of adults, egg laying starts.
May	Flood Season	Emergence of adults, egg laying starts, fast growth of nymphs.
June-October	Flood Season through Transition Season-2	Fast growth of nymphs.
Generalized Activity Calendar for *Trichoptera*		
November-March	Dry Season	Mature larvae overwinter/hibernation.
April	Transition Season-1	Pupal stage in last week of April.
May		Emergence starts, egg laying.
June-October	Flood Season through Transition Season-2	Fast growth of larvae inside their larval cases.

Exhibit 5.8: Generalized Activity Calendar for Simuliidae

Months	*Flow Season*	*Life Cycle Pattern*
November-March	Dry Season	Mature larvae overwinter/ hibernate.
April	Transition Season-1	Onset of pupal stage, emergence of adults, egg laying starts.
May	Flood Season	Fast growth of larvae.
June	Flood Season	Fast growth of larvae. Convert to pupal stage from mid-June.
July	Flood Season	Emergence of adults, egg laying starts, emergence of larvae.
August	Flood Season	Fast growth of larvae. In the second week of August, larvae convert to pupal stage.
September	Transition Season-2	Emergence of adults, egg laying starts, eggs hatch into larvae.
October	Start of Dry Season	Fast growth of larvae, convert to pupal stage. In the last week, adults emerge and egg laying starts, emergence of larvae.

6. Floral Diversity

Kashmir has a rich and varied flora. There are about 3,054 native species of plants, which are found in a variety of habitats.[47] These include about 152 flowering species which are endemic to Kashmir (Dar et al., 2006)[48].

Kashmir has very extensive topographic variations leading to diversity of flora and fauna. The flora ranges from the thorn bush type of the arid plains to the temperate and alpine flora of the higher altitudes. The common trees found in the Kashmir are Taxus wallichiana, Cornus macrophylla, Diospyros lotus, Vibernum cylindricum, Acer oblongum, Rhus succedanea etc. The common shrubs found in the area include Juniperus squamata, Sageretia theezans, Dodonaea viscosa, Solanum verbascifolium, Lonicera quinquelocularis, and Lyonia ovalifolia. The perennial herbs found in the area include Geranium nepalense, Boenninghausenia albiflora, Oxalis acetosella, and Androsace umbellata (Ali & Qaiser, 1986)[49]. At higher altitudes Birch Betula utilis, Barbers Berberis lycium and a large number of herbal plants are found. Mountainous region in the area are covered with dense Deodar Cedrus deodara, Fir Abies pindrow, and Pine Pinus wallichiana. At lower altitudes Walnut Juglans regia, and Willow Salix sp. are the common trees found in the area (Prithivi, 1978)[50].

The Study Area is mostly composed of hilly areas and riparian areas along the Poonch River and tributaries. The vegetation of the area is characterized by the presence of subtropical broad leaved forest (Shaheen et al., 2011a)[51] and mainly consist of Chirpine forest type (Malik & Malik, 2004)[52]. Common vegetation species of the area include Pinus roxburghii, Dalbergia sissoo, Ziziphus mauritiana, Dodonaea viscosa and Carissa opaca. The vegetation in the riparian areas is mainly dominated by Dalbergia sissoo, Parthenium hysterophorus, Xanthium strumarium and Ricinus communis. Other common species include Acacia modesta, Olea sp. and Lantana camara.

According to the definition given in IFC's Performance Standard 6[53], "modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native

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47 State of the Environment report Jammu and Kashmir, 2012-13. Department of Environment Ecology and Remote Sensing, Government of Jammu and Kashmir.

48 *Dar, A. R., Dar, G. H. and Reshi, Z. 2006. Recovery and Restoration of some Critically Endangered, Endemic Angiosperms of Kashmir Himalaya. Journal of Biological Sciences, 6(6), 985-991.*

49 *Ali, S.I. and M. Qaiser. 1986. A Phytogeographic analysis of the Phanerogams of Pakistan and Kashmir. Proceedings of the Royal Society of Edinburgh*, 89B: 89-101.

50 Prithivi, A.K. 1978. *Geography of the Jammu and Kashmir State*. pp. 193-195. Light and Life Publishers.

51 Shaheen H, Qureshi, R.A. & Shinwari, Z.K., 2011, Forest structure, vegetation dynamics and anthropogenic impact on lesser Himalayan Subtropical forests in Bagh District, Kashmir. Pak. J. Bot., 43(4): 1861-1866.

52 Malik, N., & Malik, Z. (2004). Present status of subtropical Chir-Pine vegetation of Kotli Hills, Azad Jammu and Kashmir. Journal of Research Science, 5(1), 85-90.

53 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands." The Study Area lies in a modified habitat since almost 35 % of the area is used for agriculture. In addition, grazing and fuel wood collection by local communities is common at several locations.

A total of 32 plant species were observed in the Ecological Study Area. The vegetation at high altitude is mainly dominated by Pinus roxburghii. The vegetation at the lower altitude is scrub forest dominated by Dalbergia sissoo, Ziziphus mauritiana, Dodonaea viscosa and Carissa opaca. The vegetation of the riparian areas is mainly dominated by Dalbergia sissoo, Parthenium hysterophorus, Xanthium strumarium and Ricinus communis.

Most of the observed plant species were common and found in more than one habitat. No threatened or endemic plant species were observed in the Ecological Study Area during the surveys or from the literature available.

This section provides results of the detailed vegetation assessment studies conducted during October 2013, December 2013 and May 2014 in the Study Area.

Sampling points are indicated in **Exhibit 2.2** and **Exhibit 2.3** in the Methodology section of this report (**Section 2**).

Vegetation field data for the October 2013, December 2013 and May 2014 survey is included in **Exhibit A.1** in **Appendix A**.

The plant species recorded from the Study Area are shown in **Exhibit B.5** in **Appendix B**.

6.1 Habitat Classification

Geomorphic landforms provide correlates for predicting habitat and define the ranges of vertebrate species (Forman and Godron 1986)[54]. They affect abiotic conditions, the flow of organisms, propagules[55], energy and material, and the frequency and spatial pattern of disturbance regimes, as well as constraining the very geomorphic processes that create them (Swanson et al 1988[56], McAuliffe 1994[57]).

Habitat classification approaches are subjective in nature, devised to assist in the understanding of ecological systems, the functions of those systems, and the interrelationship with species. Classically, wildlife habitat is described as containing three

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54 Forman, R.T.T., and Godron, M. 1986. Landscape Ecology. Wiley, New York.

55 A propagule is any of various usually vegetative portions of a plant, such as a bud or other offshoot, that aids in dispersal of the species and from which a new individual may develop

56 Swanson, F.J., Kratz, T.K., Caine, N., and Woodmansee, R.G. 1988. Landform effects on ecosystem patterns and processes: geomorphic features of the earth's surface regulate the distribution of organisms and processes.

57 McAuliffe, J.R. 1994. Landscape evolution, soil formation, and ecological patterns and processes in Sonoran Desert bajadas. Ecological Monographs 64:111–148.

basic components: cover, food, and water (Morrison et al 2006)[58] with vegetation as the core descriptive component.

Habitats in the Study Area were classified relying primarily upon vegetation type and soil texture. Following this classification approach, four types of habitats were defined: Riverbank/Riparian, Agricultural Fields, Scrub Forest and Pine Forest. **Google Earth™** images were used to initially delineate spatial distribution of habitat types within the Study Area and this habitat characterization was confirmed during the field surveys.

Phytosociological attributes of the plant species in the habitats for the surveys conducted in October 2013, December 2013 and May 2014 are given in **Exhibit 6.6**, **Exhibit 6.7** and **Exhibit 6.8** respectively. Three values were developed from sampling individual vegetation: density, cover and frequency. These values were averaged to provide the Importance Value Index (IVI) (Mueller-Dombois and Ellenberg1974)[59] which is a reasonable measure to assess the overall significance (dominance) of a species in a vegetation community since it takes into account several properties of the species in the vegetation.

The spatial distribution of habitat types in the Terrestrial Study Area is shown on a map in **Exhibit 6.1.** This habitat distribution in the Study Area is listed in **Exhibit 6.2**. Representative photographs of the habitats are shown in **Exhibit 6.3**.

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58 Morrison, M.L, Marcot, B., Mannan, W. 2006. *Wildlife-Habitat Relationships: Concepts and Applications*. Island Press, Washington, D.C.

59 Mueller-Dombois, Dieter, and Ellenberg, Heinz. 1974. Aims and methods of vegetation ecology. New York: John Wiley & Sons. 547pp.

Exhibit 6.1: Habitat Distribution in the Terrestrial Study Area

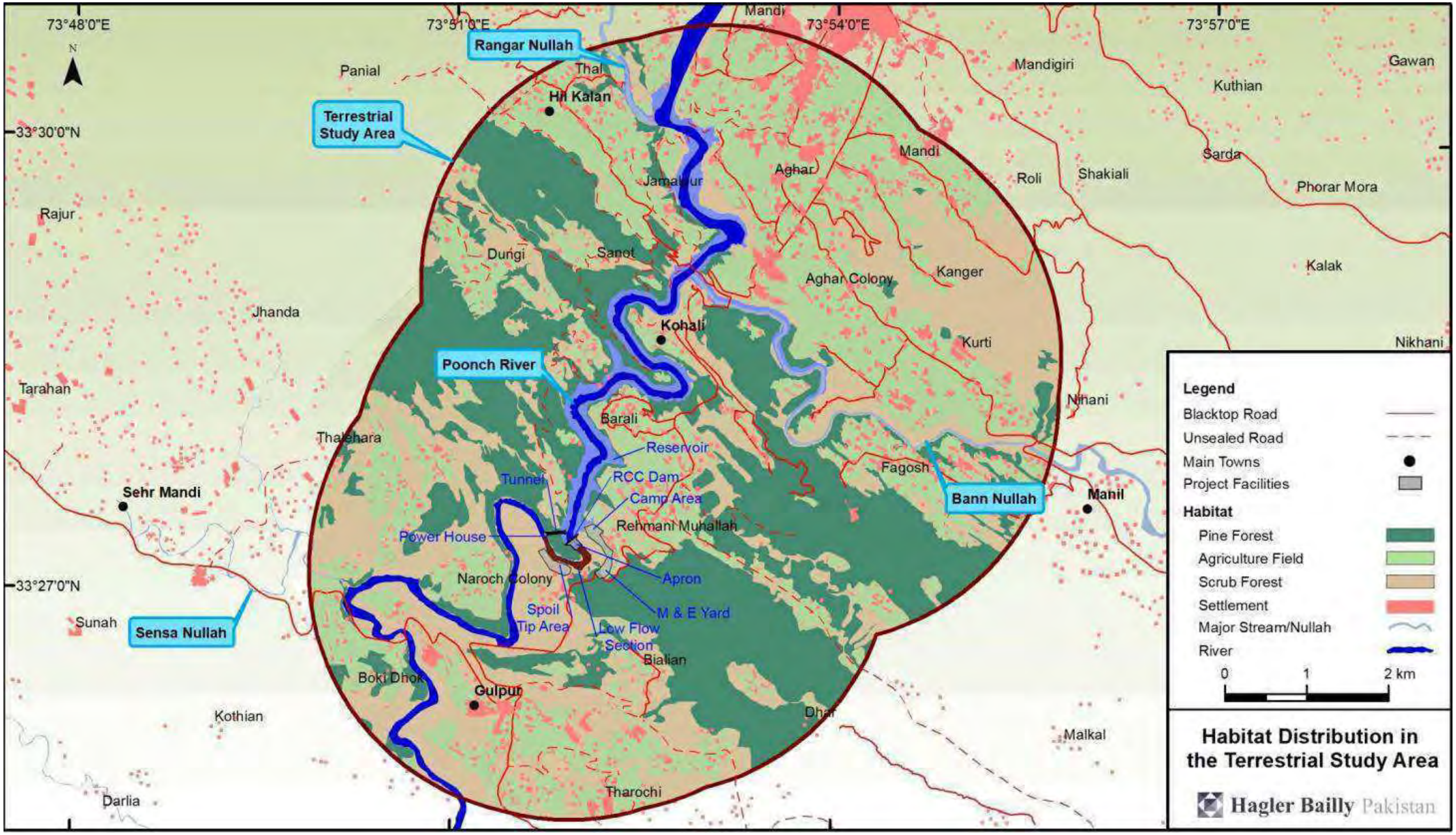

Exhibit 6.2: Distribution of Different Habitats in the Study Area

No.	Habitat Types	Area (Sq km)	Habitat in Percentage
1.	Agricultural Fields	24	35%
2.	Pine Forest	21	30%
3.	Scrub Forest	19	28%
4.	Riverbank/Riparian	2	3%
5.	Settelments	3	4%
	Total	**69**	**100.0%**

Exhibit 6.3: Photographs of Different Habitats in the Study Area

a. *Agricultural Fields*

b. *Pine Forest*

c. *Riverbank/Riparian*

d. *Scrub Forest*

6.2 October 2013 Survey

During the October 2013 survey, sampling was conducted at 26 points in the Study Area, of which eight (8) were in Riverbank/Riparian, five (5) in Agricultural Fields, six (6) in Scrub Forest and five (5) in Pine Forest.

A total of 30 plant species were observed in the Study Area. The vegetation at high altitude is mainly dominated by Pinus roxburghii. The vegetation at the lower altitude is scrub forest dominated by Dalbergia sissoo, Ziziphus mauritiana, Dodonaea viscosa and

Carissa opaca. The vegetation in the riparian areas is mainly dominated by Dalbergia sissoo, Parthenium hysterophorus, Xanthium strumarium and Ricinus communis.

Most of the observed plant species were common and found in more than one habitat. No threatened or endemic plant species were observed in the Study Area during the surveys or from the literature available.

Photographs of some of common plant species found in the Study Area are shown in **Exhibit 6.4.**

The four main habitats found during October 2013 survey are briefly discussed below:

Agriculture Fields

Agriculture Fields are the most dominant habitat, constituting 35% of the habitat of the Study Area (**Exhibit 6.2**). The agricultural fields mostly lie in the plains. The range of vegetation cover in this habitat during October 2013 survey was from 0.5% to 16.5%, while average count was 33. The floral diversity and density observed in this habitat was higher than that recorded in Riverbank/Riparian but lower than that observed in Scrub Forest and Pine Forest. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The dominant plant species in this habitat as reflected by the Importance Value Index were Broussonetia papyrifera 23.1, Parthenium hysterophorus 15.05, Dalbergia sissoo 12.64 and Malvastrum coromandelianum 7.79 **(Exhibit 6.6)**.

Pine Forest

Pine Forest is the second most abundant habitat, constituting 30% of the total habitat of the Study Area (**Exhibit 6.2**). This habitat is characterized by vegetation dominated by Pine trees. The range of vegetation cover in this habitat during October 2013 survey was from 1.9% to 25.9% while average count is 199. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The floral diversity and density observed in this habitat was highest among all habitats of the Study Area. The dominant plant species in this habitat as reflected by the Importance Value Index were Imperata cylindrical 34.19, Pinus roxburghii 28.92, Dalbergia sissoo 9.81 and Dodonaea viscosa 5.61 **(Exhibit 6.6)**.

Scrub Forest

Scrub Forest constitutes 28% of the total habitat of the Study Area (**Exhibit 6.2**). This habitat is characterized by vegetation dominated by shrubs with some trees, grasses and herbs. The range of vegetation cover in this habitat during October 2013 survey was from 0.4% to 15% while average count was 43. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The floral diversity and density observed in this habitat was higher than that recorded in Riverbank/Riparian and Agriculture Fields but lower than observed in Pine Forest. The dominant plant species in this habitat as reflected by the Importance Value Index were Ziziphus mauritiana 16.22, Dalbergia sissoo 14.85, Parthenium hysterophorus 13.91 and Imperata cylindrical 10.36 **(Exhibit 6.6).**

Riverbank/Riparian

Riverbank/Riparian constitutes 3% of the habitat of the Study Area (**Exhibit 6.2**). The range of vegetation cover observed in this habitat during October 2013 survey was from

0.5% to 10.9% while average count was 25. The floral diversity in this habitat was 2 species per sampling point (**Exhibit 6.5**). The floral diversity and density observed in this habitat was lowest among all habitats of the Study Area. The dominant plant species in this habitat as reflected by the Importance Value Index were Dalbergia sissoo 49.15, Parthenium hysterophorus 14.02, Saccharum sp 13.34 and Dodonaea viscosa 8.13 **(Exhibit 6.6)**.

6.3 December 2013 Survey

During the December 2013 survey, three locations in Scrub Forest were sampled. A total of 13 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 1.5% to 4.3% while average plant count was 36. The floral diversity in this habitat was 4 species per sampling point (**Exhibit 6.5**). The dominant plant species in this habitat as reflected by the Importance Value Index were Dalbergia sissoo 26.6, Dodonaea viscosa 20 and Acacia modesta 13.5 (**Exhibit 6.7**).

6.4 May 2014 Survey

During the May 2014 survey, three locations in Scrub Forest were sampled. A total of 9 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 3.9% to 10.1% while average plant count was 50. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The dominant plant species in this habitat as reflected by the Importance Value Index were Dalbergia sissoo 34.5, Dodonaea viscosa 19.5 and Nerium oleander 13.1 (**Exhibit 6.8**).

6.5 Medicinal Plants of the Study Area

Medicinal plants of the Study Area are listed in the **Appendix B**, Species List. Berberis sp., Dodonaea viscosa, Nerium oleander and are the medicinal plants commonly found in the Study Area, while Solanum nigrum and Traxicum sp are rare in the Study Area but have good medicinal value. Dodonaea viscosa is used for the treatment of gout, rheumatism, swellings and burns. All parts are used as medicine. Nerium oleander is used for treatment of skin diseases and cutaneous eruption. Twigs are used to cure tooth decay, while paste made from the roots is useful against scorpion stings and snake bites. Solanum nigrum is considered to be anti-oxidant, anti-inflammatory, diuretic and anti-pyretic. Leaves, fruit and stem is used in treatments. The bark and leaves of Berberis sp is used for the treatment of fractures and weakness. Traxicum sp leaves are considered to be affective against hepatitis and stomach ailments.

6.6 Plant Species in Area of Habitat Loss

The Area of Habitat Loss is defined as the areas that will be occupied due to construction of Project infrastructure. It has been demarcated taking into consideration the footprint of each Project facility and a 50 meter zone around it, as well as the area that will be submerged under water due to formation of the reservoir. The plant species observed in this Area of Habitat Loss are outlined in **Exhibit 6.9**.

Exhibit 6.4: Photographs of Common Plant Species of the Study Area

a. *Dodonaea viscosa*

b. *Ricinus communis*

c. *Parthenium hysterophorus*

d. *Ipomea carnea*

e. *Xanthium strumarium*

f. *Euphorbia hirta*

Exhibit 6.5: Vegetation Cover, Plant Count and Diversity by Habitat Types, Survey Conducted October 2013, December 2013 and May 2014

Habitats	*Plant Cover*			*Plant Count*			*Diversity*
	Avg	*Max*	*Min*	*Avg*	*Max*	*Min*	
October 2013 Survey							
Riverbank/Riparian	4.3%	10.9%	0.5%	25	30	17	2
Agricultural Fields	8.4%	16.5%	0.5%	33	49	23	3
Scrub Forest	5.5%	15.0%	0.4%	43	129	24	3
Pine Forest	13.5%	25.9%	1.9%	199	844	35	3
December 2013 Survey							
Scrub Forest	2.5%	4.3%	1.5%	36	49	28	4
May 2014 Survey							
Scrub Forest	6.3%	10.1%	3.9%	50	58	42	3

Exhibit 6.6**:** Phytosociological Attributes of Plant Communities in Habitats, Survey conducted October 2013

Habitat	*Species Name*	*Medicinal Plants*	*Count*	*Total Cover (Sq. feet)*	*Occurance*	*D1*	*D3*	*C1*	*C3*	*F1*	*F3*	*IVI*
Riverbank/ Riparian	*Acacia modesta*		1.00	53.48	1.00	0.04	0.50	53.48	4.83	0.04	1.52	2.28
	Berberis sp.	√	1.00	1.12	1.00	0.04	0.50	1.12	0.10	0.04	1.52	0.71
	Dalbergia sissoo		79.00	858.90	20.00	3.29	39.50	10.87	77.64	0.83	30.30	49.15
	Dodonaea viscosa	√	23.00	8.61	8.00	0.96	11.50	0.37	0.78	0.33	12.12	8.13
	Euphorbia hirta		2.00	0.27	1.00	0.08	1.00	0.14	0.02	0.04	1.52	0.85
	Lantana camara		2.00	0.82	1.00	0.08	1.00	0.41	0.07	0.04	1.52	0.86
	Malvastrum coromandelianum		8.00	0.87	3.00	0.33	4.00	0.11	0.08	0.13	4.55	2.87
	Nerium oleander	√	5.00	22.67	3.00	0.21	2.50	4.53	2.05	0.13	4.55	3.03
	Parthenium hysterophorus		43.00	9.42	13.00	1.79	21.50	0.22	0.85	0.54	19.70	14.02
	Ricinus communis		1.00	2.95	1.00	0.04	0.50	2.95	0.27	0.04	1.52	0.76
	Saccharum sp.		27.00	142.51	9.00	1.13	13.50	5.28	12.88	0.38	13.64	13.34
	Solanum surrattense		1.00	0.09	1.00	0.04	0.50	0.09	0.01	0.04	1.52	0.67
	Xanthium strumarium		7.00	4.54	4.00	0.29	3.50	0.65	0.41	0.17	6.06	3.32
Agricultural Fields	*Acacia modesta*		1.00	80.26	1.00	0.04	0.60	80.26	5.89	0.04	1.85	2.78
	Broussonetia papyrifera		17.00	653.71	6.00	0.71	10.24	38.45	47.94	0.25	11.11	23.10
	Dalbergia sissoo		27.00	93.20	8.00	1.13	16.27	3.45	6.83	0.33	14.81	12.64
	Dodonaea viscosa		11.00	4.91	3.00	0.46	6.63	0.45	0.36	0.13	5.56	4.18
	Euphorbia hirta		3.00	0.43	2.00	0.13	1.81	0.14	0.03	0.08	3.70	1.85
	Lantana camara		10.00	11.07	3.00	0.42	6.02	1.11	0.81	0.13	5.56	4.13
	Malvastrum		20.00	3.01	6.00	0.83	12.05	0.15	0.22	0.25	11.11	7.79

Habitat	Species Name	Medicinal Plants	Count	Total Cover (Sq. feet)	Occurance	D1	D3	C1	C3	F1	F3	IVI
	coromandelianum											
	Melia azedarach		1.00	3.90	1.00	0.04	0.60	3.90	0.29	0.04	1.85	0.91
	Olea ferruginea		6.00	186.23	3.00	0.25	3.61	31.04	13.66	0.13	5.56	7.61
	Parthenium hysterophorus		43.00	9.86	10.00	1.79	25.90	0.23	0.72	0.42	18.52	15.05
	Populus mexicana		4.00	168.28	1.00	0.17	2.41	42.07	12.34	0.04	1.85	5.53
	Ricinus communis		1.00	27.74	1.00	0.04	0.60	27.74	2.03	0.04	1.85	1.50
	Saccharum sp.		7.00	16.46	3.00	0.29	4.22	2.35	1.21	0.13	5.56	3.66
	Xanthium strumarium		8.00	4.85	3.00	0.33	4.82	0.61	0.36	0.13	5.56	3.58
	Ziziphus mauritiana		7.00	99.84	3.00	0.29	4.22	14.26	7.32	0.13	5.56	5.70
Scrub Forest	*Acacia modesta*		1.00	92.49	1.00	0.04	0.29	92.49	8.01	0.04	1.16	3.16
	Achyranthes aspera		3.00	0.47	1.00	0.13	0.88	0.16	0.04	0.04	1.16	0.69
	Berberis sp.	√	4.00	4.52	3.00	0.17	1.17	1.13	0.39	0.13	3.49	1.68
	Broussonetia papyrifera		6.00	51.68	2.00	0.25	1.76	8.61	4.48	0.08	2.33	2.85
	Carissa opaca		3.00	2.59	1.00	0.13	0.88	0.86	0.22	0.04	1.16	0.76
	Chenopodium album		9.00	2.03	3.00	0.38	2.64	0.23	0.18	0.13	3.49	2.10
	Conyza canadensis		5.00	0.93	3.00	0.21	1.47	0.19	0.08	0.13	3.49	1.68
	Dalbergia sissoo		45.00	147.17	16.00	1.88	13.20	3.27	12.75	0.67	18.60	14.85
	Dodonaea viscosa	√	38.00	10.84	11.00	1.58	11.14	0.29	0.94	0.46	12.79	8.29
	Euphorbia hirta		6.00	0.71	2.00	0.25	1.76	0.12	0.06	0.08	2.33	1.38
	Ficus carica	√	3.00	130.10	2.00	0.13	0.88		11.27	0.08	2.33	4.82
	Imperata cylindrica		100.00	6.69	1.00	4.17	29.33		0.58	0.04	1.16	10.36
	Ipomea carnea		2.00	1.74	1.00	0.08	0.59	0.87	0.15	0.04	1.16	0.63

Habitat	Species Name	Medicinal Plants	Count	Total Cover (Sq. feet)	Occurance	D1	D3	C1	C3	F1	F3	IVI
	Juglans regia	√	1.00	2.87	1.00	0.04	0.29	2.87	0.25	0.04	1.16	0.57
	Lantana camara		4.00	8.18	2.00	0.17	1.17	2.05	0.71	0.08	2.33	1.40
	Malvastrum coromandelianum		3.00	0.21	1.00	0.13	0.88	0.07	0.02	0.04	1.16	0.69
	Melia azedarach		1.00	53.82	1.00	0.04	0.29		4.66	0.04	1.16	2.04
	Morus nigra		1.00	36.80	1.00	0.04	0.29		3.19	0.04	1.16	1.55
	Olea ferruginea		2.00	171.53	1.00	0.08	0.59	85.76	14.86	0.04	1.16	5.54
	Parthenium hysterophorus		70.00	16.47	17.00	2.92	20.53	0.24	1.43	0.71	19.77	13.91
	Saccharum sp.		3.00	12.82	1.00	0.13	0.88	4.27	1.11	0.04	1.16	1.05
	Solanum nigrum	√	1.00	0.27	1.00	0.04	0.29	0.27	0.02	0.04	1.16	0.49
	Solanum surrattense		1.00	0.29	1.00	0.04	0.29		0.03	0.04	1.16	0.49
	Xanthium strumarium		11.00	5.70	4.00	0.46	3.23	0.52	0.49	0.17	4.65	2.79
	Ziziphus mauritiana		18.00	393.54	8.00	0.75	5.28	21.86	34.09	0.33	9.30	16.22
Pine Forest	*Berberis sp.*	√	21.00	11.14	7.00	0.88	2.11	0.53	0.51	0.29	11.67	4.76
	Carissa opaca		2.00	0.16	1.00	0.08	0.20	0.08	0.01	0.04	1.67	0.63
	Chenopodium album		12.00	2.22	3.00	0.50	1.21	0.19	0.10	0.13	5.00	2.10
	Conyza canadensis		3.00	0.47	1.00	0.13	0.30	0.16	0.02	0.04	1.67	0.66
	Dalbergia sissoo		28.00	254.01	9.00	1.17	2.81	9.07	11.63	0.38	15.00	9.81
	Dodonaea viscosa	√	31.00	8.52	8.00	1.29	3.12	0.27	0.39	0.33	13.33	5.61
	Imperata cylindrica		800.00	447.85	1.00	33.33	80.40	0.56	20.50	0.04	1.67	34.19
	Ipomea carnea		4.00	3.76	1.00	0.17	0.40	0.94	0.17	0.04	1.67	0.75
	Malvastrum		5.00	94.22	2.00	0.21	0.50	18.84	4.31	0.08	3.33	2.72

Habitat	Species Name	Medicinal Plants	Count	Total Cover (Sq. feet)	Occurance	D1	D3	C1	C3	F1	F3	IVI
	coromandelianum											
	Olea ferruginea		2.00	19.90	1.00	0.08	0.20	9.95	0.91	0.04	1.67	0.93
	Parthenium hysterophorus		27.00	5.06	7.00	1.13	2.71	0.19	0.23	0.29	11.67	4.87
	Pinus roxburghii		45.00	1,323.47	13.00	1.88	4.52	29.41	60.58	0.54	21.67	28.92
	Saccharum sp.		6.00	11.01	2.00	0.25	0.60	1.84	0.50	0.08	3.33	1.48
	Solanum nigrum		1.00	0.12	1.00	0.04	0.10	0.12	0.01	0.04	1.67	0.59
	Traxicum sp.	√	4.00	0.34	1.00	0.17	0.40	0.08	0.02	0.04	1.67	0.69
	Ziziphus mauritiana		4.00	2.49	2.00	0.17	0.40	0.62	0.11	0.08	3.33	1.28

Exhibit 6.7: Phytosociological Attributes of Plant Communities in Habitats, Survey Conducted December 2013

Habitat	Species Name	Medic	Count	Total Cove (Sq. feet)	Occurance	D1	D3	C1	C3	F1	F3	IVI
Scrub Forest	*Acacia modesta*		8	55	3	1.00	7.48	6.82	24.15	0.38	9.09	13.57
	Berberis sp.	√	12	15	3	1.50	11.21	1.24	6.57	0.38	9.09	8.96
	Broussonetia papyrifera		2	2	1	0.25	1.87	0.80	0.70	0.13	3.03	1.87
	Carissa opaca		7	8	2	0.88	6.54	1.13	3.51	0.25	6.06	5.37
	Cassia fistula		1	18	1	0.13	0.93	18.31	8.10	0.13	3.03	4.02
	Dalbergia sissoo		17	63	7	2.13	15.89	3.72	27.97	0.88	21.21	21.69
	Dodonaea viscosa		32	14	8	4.00	29.91	0.42	6.00	1.00	24.24	20.05
	Ipomea carnea		5	10	1	0.63	4.67	2.06	4.55	0.13	3.03	4.09
	Lantana camara		3	4	1	0.38	2.80	1.37	1.82	0.13	3.03	2.55

Habitat	Species Name	Medic	Count	Total Cove (Sq. feet)	Occurance	D1	D3	C1	C3	F1	F3	IVI
	Nerium oleander	√	5	3	2	0.63	4.67	0.52	1.16	0.25	6.06	3.96
	Olea ferruginea		3	28	1	0.38	2.80	9.43	12.52	0.13	3.03	6.12
	Saccharum sp.		8	3	2	1.00	7.48	0.41	1.46	0.25	6.06	5.00
	Ziziphus mauritiana		4	3	1	0.50	3.74	0.84	1.49	0.13	3.03	2.75

Exhibit 6.8: Phytosociological Attributes of Plant Communities in Habitats, Survey Conducted May 2014

Habitat	Species Name	Count	Total Cove (Sq. feet)	Occurance	D1	D3	C1	C3	F1	F3	IVI
Scrub Forest	*Berberis sp.*	11	9	4	1.22	7.33	0.79	1.43	0.44	11.11	6.63
	Cassia fistula	5	180	2	0.56	3.33	36.06	29.83	0.22	5.56	12.91
	Dalbergia sissoo	45	310	8	5.00	30.00	6.89	51.32	0.89	22.22	34.51
	Dodonaea viscosa	43	30	9	4.78	28.67	0.70	4.95	1.00	25.00	19.54
	Mentha longifolia	1	0	1	0.11	0.67	0.24	0.04	0.11	2.78	1.16
	Monotheca buxifolia	1	14	1	0.11	0.67	13.63	2.25	0.11	2.78	1.90
	Nerium oleander	23	45	6	2.56	15.33	1.96	7.47	0.67	16.67	13.16
	Saccharum sp.	20	16	4	2.22	13.33	0.81	2.68	0.44	11.11	9.04
	Traxicum sp.	1	0	1	0.11	0.67	0.18	0.03	0.11	2.78	1.16

Exhibit 6.9: Plant Species observed in Area of Habitat Loss Surveys conducted October 2013, December 2013 and May 2014

No	Vegetation Species	Status in Study Area	Observed at Sampling Point		
			October Survey	December Survey	May Survey
1	*Acacia modesta*	Common	Not Observed	D1 and D2	Not Observed
2	*Berberis sp.*	Very Common	Not Observed	D2 and D3	D2 and D3
3	*Broussonetia papyrifera*	Common	Not Observed	D1	Not Observed
4	*Carissa opaca*	Common	Not Observed	D2	Not Observed
5	*Cassia fistula*	Infrequent	Not Observed	D3	D3
6	*Delbergia sissoo*	Very Common	A2 and A3	D1, D2 and D3	D1, D2 and D3
7	*Dodonaea viscosa*	Very Common	A3	D1, D2 and D3	D1, D2 and D3
8	*Ipomea carnea*	Infrequent	Not Observed	D2	Not Observed
9	*Lantana camara*	Very Common	A2	D2	Not Observed
10	*Nerium oleander*	Common	Not Observed	D1	D1 and D2
11	*Olea ferruginea*	Common	Not Observed	D2	Not Observed
12	*Saccharum sp*	Common	A2 and A3	D1 and D3	D1, D2 and D3
13	*Ziziphus mauritiana*	Infrequent	Not Observed	D1	Not Observed
14	*Mentha longifolia*	Infrequent	Not Observed	Not Observed	D2
15	*Monotheca buxifolia*	Infrequent	Not Observed	Not Observed	D3
16	*Traxicum sp.*	Infrequent	Not Observed	Not Observed	D2
17	*Xanthium strumarium*	Very Common	A2	Not Observed	Not Observed
18	*Parthenium hysterophorus*	Very Common	A2	Not Observed	Not Observed
19	*Malvastrum coromandelianum*	Common	A2	Not Observed	Not Observed

7. Mammals

The mammalian fauna of the Azad Jammu and Kashmir has affinities with Palearctic, Oriental and the Sino-Himalayan region. This zoo-geographical region comprises a variety of ecological zones. Though most of the mammals are typically affiliated with the Oriental region, there are some elements of the Palearctic and Sino-Himalayan region (Roberts, 1997[60]; Mirza, 1998[61]).

A comprehensive account of the mammals found in the Poonch River basin (where the Study Area is located) is not available. Sixteen (16) mammalian species have been reported in literature from the Pir Lasura National Park in Kotli District that is located approximately 12 km away from the Study Area. These include large mammals from the Family Canidae, Bovidae and Felidae as well as small mammals from the Family Muridae, Cricetidae, and Soricidae (Manzoor et al)[62].

Surveys were conducted in October 2013 and December 2013 in the Study Area to study mammalian abundance and diversity. Sampling Points are indicated in **Exhibit 2.2** and **Exhibit 2.3** in the Methodology section of this report.

Data collected during this baseline study is included in **Exhibit A.2** and **Exhibit A.3** in **Appendix A**.

The mammal species known to occur in the Study Area are listed in **Exhibit B.2** in **Appendix B**.

Exhibit 7.1 provides a summary of Sampling Points by habitat type. It presents the sign data for mammals (excluding rodents), abundance and diversity by habitat type for October 2013 survey. Sampling was conducted at 26 points, of which five (5) were in Agricultural Fields, eight (8) in Scrub Forest, five (5) in Pine Forest and eight (8) in Riverbank/Riparian. In December 2013 Sampling was conducted at 3 sampling points in Scrub Forest.

Exhibit 7.2 presents the trapping data, abundance and diversity by habitat type for the small mammals.

Exhibit 7.3 presents species accumulation curves (SAC) (SAC is a curve built upon the total number of species counted for incremental number of individuals recorded, Thompson and Thompson 200)[63]) for the October 2013 survey for the four habitat types: Agricultural Fields, Pine Forest, Scrub Forest and Riverbank/Riparian. The curves for three habitats Agricultural Fields, Scrub Forest and Riverbank/Riparian show a

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60 Roberts TJ. 1997. *Mammals of Pakistan.* Oxford University Press, Karachi.

61 Mirza, ZB. 1998. Illustrated Hand Book of Biodiversity of Pakistan. CERC. BHC. Islamabad.

62 Manzoor M., Riaz A., Iqbal Z. and Mian A. 2013. Biodiversity of Pir Lasura National Park, Azad Jammu and Kashmir, Pakistan. Sci., Tech. and Dev., 32 (2): 182-196.

63 Thompson, G.G., and Thompson, S.A. 2007. Using species accumulation curves to estimate trapping effort in fauna surveys and species richness. Austral Ecology: Volume 32, Issue 5, Pages 564 -569 (Published Online: 20 June 2007).

decreasing rate of discovery of new species, indicating adequacy of sampling effort. The curve for the Pine Forest does not level off showing inadequacy of sampling effort. To compensate for any inadequacy in sampling, a literature review of the mammals reported from the area was completed. The Species Accumulation Curve for December 2013 survey for the Scrub Forest habitat is shown in **Exhibit 7.4.** It shows a decreasing rate of discovery of new species, indicating adequacy of sampling effort.

Exhibit 7.1: Signs Data for Mammals Excluding Rodents, Abundance and Diversity by Habitat Type, Surveys Conducted and October 2013 and December 2013

Habitat	*No. of Sampling Points*	*Abundance (Total Signs/ Sightings)*	*Density (Signs/ sightings per Sampling Point)*	*Diversity (No. of Species)*
October 2013				
Pine Forest	5	14	2.8	9
Scrub Forest	8	11	1.3	5
Agricultural Fields	5	11	2.2	6
Riverbank/Riparian	8	71	8.8	11
Total	**26**	**107**		
December 2013				
Scrub Forest	3	16	5.3	3
Total	**3**	**16**		

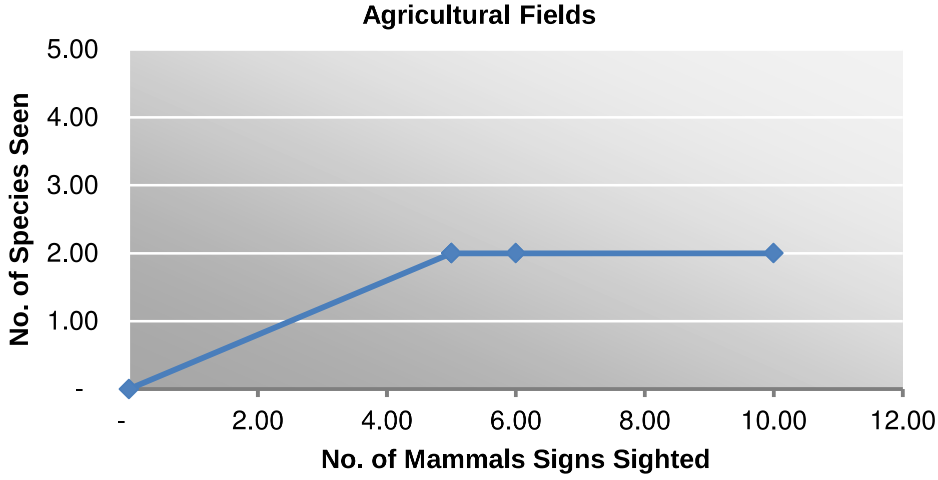
Note: Abundance is the total number of sightings/signs observed while diversity is the number of species that were sighted/signs observed.

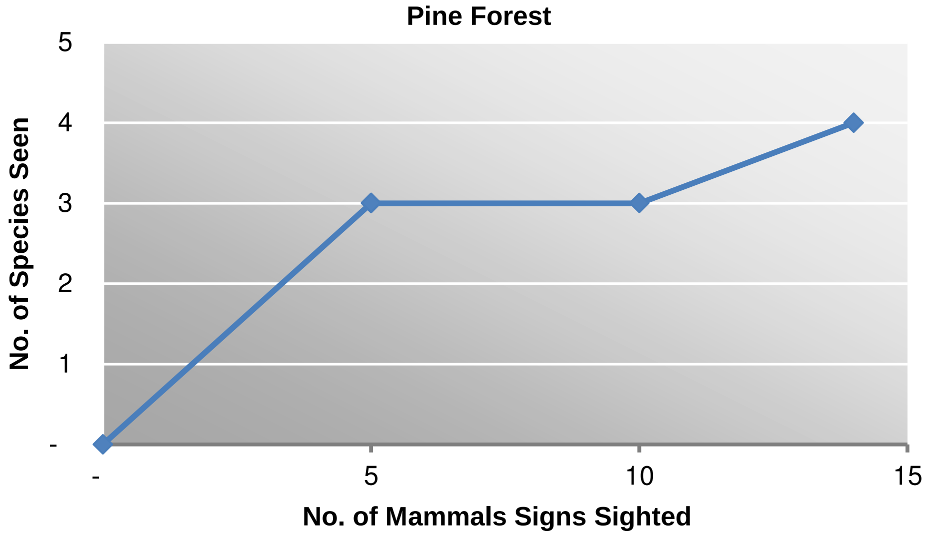
Exhibit 7.2: Small Mammals - Rodents Trapping Data, Abundance and Diversity by Habitat Type, Survey Conducted October 2013 and December 2013

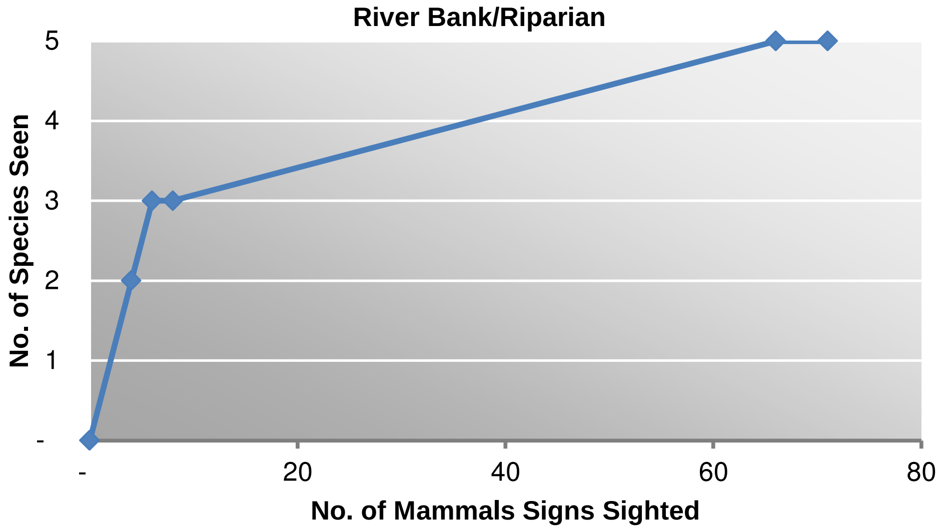
Habitat	*No. of Sampling Points*	*Abundance (Total Trappings)*	*Density (Trappings per Sampling Point)*	*(Diversity) No. of Species*
October 2013				
Pine Forest	2	4	2	3
Scrub Forest	2	5	3	3
Agricultural Fields	2	5	3	3
Riverbank/Riparian	1	4	4	2
Total	**7**	**18**		
December 2013				
Scrub Forest	3	2	1	1
Total	**3**	**2**		

Note: Abundance is the total number of individuals trapped while diversity is the number of species that were trapped.

Exhibit 7.3: Species Accumulation Curves for October 2013 Survey






River Bank/Riparian
No. of Species Seen
No. of Mammals Signs Sighted
5
4
3
2
1
-
-
20
40
60
80

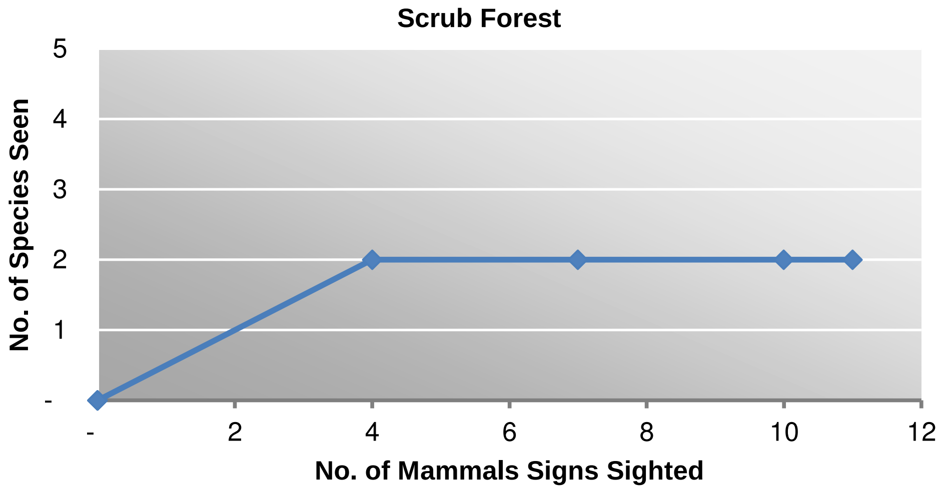
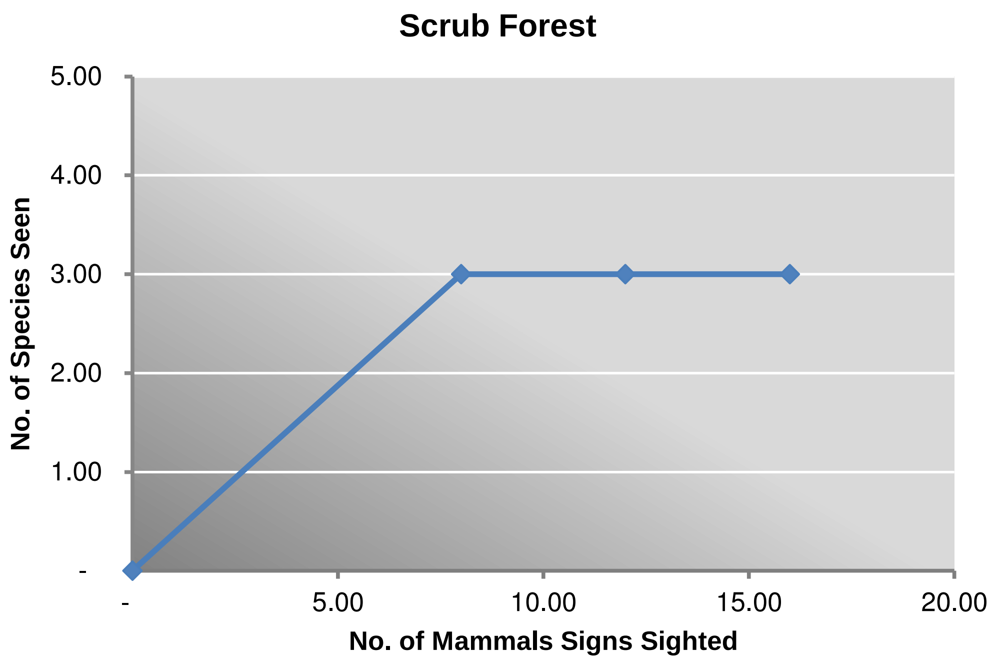

Scrub Forest
No. of Species Seen
No. of Mammals Signs Sighted
5
4
3
2
1
-
-
2
4
6
8
10
12

Exhibit 7.4: Species Accumulation Curves for December 2013 Survey



7.1 Large Mammals

7.1.1 October 2013 Survey

Exhibit 7.5 presents the abundance of mammals in the Study Area for the October 2013 survey.

The Common Red Fox Vulpes vulpes is an abundant mammal species found in the Study Area. During October 2013 survey, the Common Red Fox Vulpes vulpes was sighted at four sampling points including Sampling Points S10, S1, A7 and S15. In addition, signs of a fox species Vulpes sp were observed in all four habitats during the October 2013 survey i.e. Agricultural Fields, Pine Forest, Scrub Forest and Riverbank/Riparian.

The Asiatic Jackal Canis aureus belonging to Family Canidae is common in the Study Area. It is a very adaptable animal readily entering mountainous areas, forest plantations and riverine thicket.[64] According to interviews with locals conducted for the ESIA of the Project, the Jackal is the most abundant and most frequently encountered large mammal in the Study Area.[65] Signs of this species were observed at Sampling Point S1 during the October 2013 survey.

Rhesus Monkey Macaca mulatta was the most commonly observed mammal species during the October 2013 survey. A total of 50 Rhesus Monkeys were seen at Sampling

64 Roberts, T.J. 1997. *The Mammals of Pakistan.* Oxford University Press Karachi. 525 pp.

65 ESIA of Gulpur Hydropower Project, August 2013.

Point A5. This animal usually lives in the mountainous areas and is distributed in the mountainous areas of Pakistan and Azad Jammu and Kashmir.

Signs of a cat Felis sp were observed at Sampling Points A5 and A7 during October 2013 survey though it was not possible to identify the cat species from the signs alone.

According to interviews conducted with members of the local communities, the Common Leopard Panthera pardus is present in the Study Area but is uncommon and rarely encountered (ESIA of Gulpur Hydropower Project, August 2013). The abundance of this species in the area has not been assessed. The Common Leopard Panthera pardus is listed as Near Threatened in the IUCN Red List 2013. It was not observed during the October 2013 survey.

There are some animals of conservation importance that are not found in the Study Area but have been recorded from other parts of Kotli district. These include the Gray Goral Naemorhedus goral, Indian Pangolin Manis crassicaudata and Barking Deer Muntiacus muntjak. Both the Grey Goral Naemorhedus goral and the Indian Pangolin Manis crassicaudata are listed as Near Threatened in the IUCN Red List 2013[66] and both of them are listed as Vulnerable in the Pakistan's Mammals National Red List 2006[67]. The Barking Deer Muntiacus muntjak is not included in the IUCN Red List but listed as Endangered in the Pakistan's Mammals National Red List 2006. All three species have been reported from the Pir Lasura National Park.[68]

The Pir Lasura National Park is the only terrestrial protected area in the vicinity of the Study Area. It was notified as National Park by AJK government in 2005 and has an area of 1580 hectors. It is located approximately 12 km from the boundary of the Terrestrial Study Area. A map showing the Pir Lasura National Park is given in **Exhibit 7.6**. Some of the mammal species present in the Pir Lasura National Park include the Common Leopard Panthera pardus, Rhesus Monkey Macaca mulatta, Palm Civet Paradoxurus hermaphroditus, Asiatic Jackal Canis aureus, Common Red Fox Vulpes vulpes, Leopard Cat Prionailurus bengalensis, Barking Deer Muntiacus muntjak, Grey Goral Naemorhedus goral, Jungle Cat Felis chaus, Wild boar Sus scrofa, Indian Pangolin Manis crassicaudata.

7.1.2 December 2013 Survey

Exhibit 7.5 presents the abundance of mammals in the Study Area for the December 2013 survey.

During December 2013 survey, 3 locations were sampled in Scrub Forest habitat. Signs and sightings of three mammal species were observed **(Exhibit 7.1)**.

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66 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 11 October 2013

67 Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan

68 AJK Government Official Website. Available at: http://forest.ajk.gov.pk/index.php?option=com_content&view=article&id=72&Itemid=103. Accessed on 12 November 2013.

One specimen each of the Indian Grey Mongoose Herpestes edwardsii was observed at Sampling Points D-1 and D-3. One specimen of the Asiatic Jackal Canis aureus was sighted at Sampling Point D-3.

Signs of Asiatic Jackal Canis aureus and Fox Vulpes sp. were observed at all three sampling points, while the signs of Indian Grey Mongoose Herpestes edwardsii were only observed at Sampling Point D-1.

Exhibit 7.5: Abundance of Mammals in the Study Area (for both signs and sightings)
Survey Conducted October 2013 and December 2013

No.	*Scientific Name*	*Common Name*	*Habitat*				***Total***	***No. of Habitats in which Occurring***
			Pine Forest	*Scrub Forest*	*Agricultural Fields*	*Riverbank/ Riparian*		
October 2013								
1.	*Canis aureus*	Asiatic Jackal	1	–	–	–	**1**	**1**
2.	*Felis sp.*	Cat	–	–	–	2	**2**	**1**
3.	*Herpestes edwardsii*	Indian Grey Mongoose	1	2	4	1	**8**	**4**
4.	*Hystrix indica*	Indian Crested Porcupine	1	–	–	2	**3**	**2**
5.	*Macaca mulatta*	Rhesus Monkey	–	–	–	50	**50**	**1**
6.	*Vulpes vulpes*	Common Red Fox	11	9	6	16	**42**	**4**
Total			**14**	**11**	**10**	**71**	**106**	
No. of Species			**4**	**2**	**2**	**5**	**6**	
No. of Sampling Points			**5**	**8**	**5**	**8**	**26**	
December 2013								
1.	*Canis aureus*	Asiatic Jackal		6			6	**1**
2.	*Herpestes edwardsii*	Indian Grey Mongoose		4			4	**1**
3.	*Vulpes sp.*	Fox		6			6	**1**
Total				**16**			**16**	**1**
No. of Species				**3**			**3**	
No. of Sampling Points				**3**			**3**	

Exhibit 7.6: Location of Pir Lasura National Park

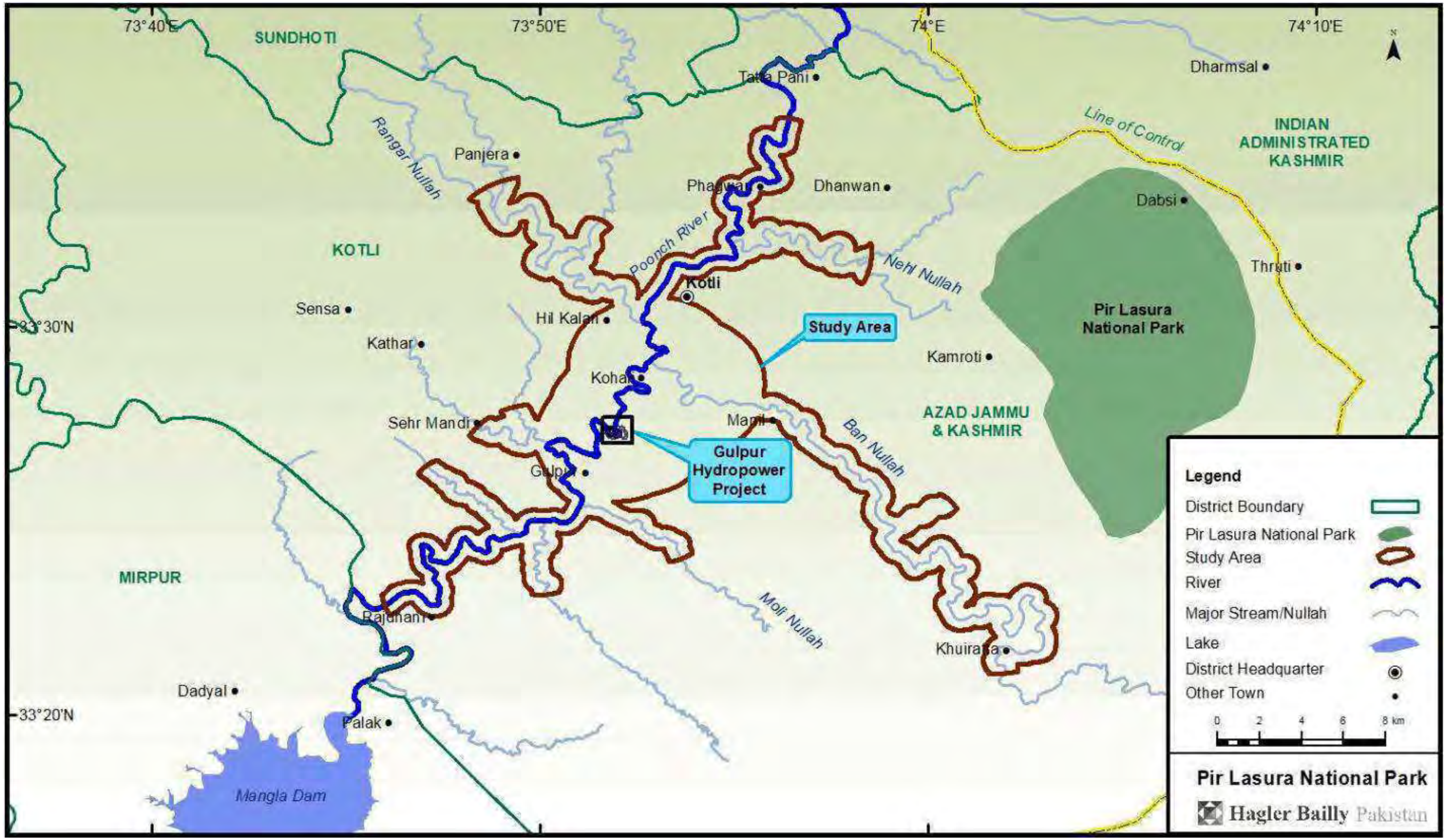
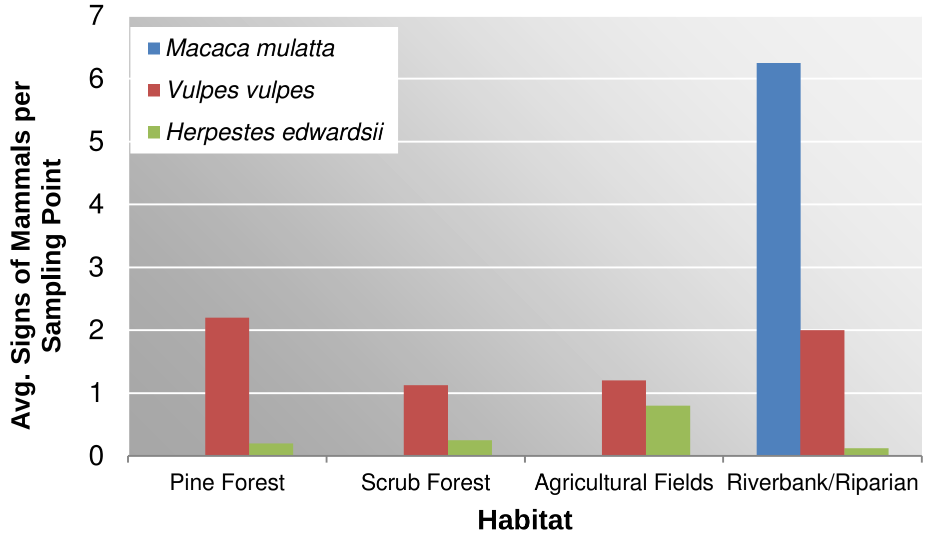


Exhibit 7.7 shows habitat preference of the three common mammal species of the Study Area, namely Common Red Fox Vulpes vulpes, Rhesus Monkey Macaca mulatta and Indian Grey Mongoose Herpestes edwardsii. The Rhesus Monkey Macaca mulatta was only observed in the Riverbank/Riparian habitat while the other two species were observed in all four habitats.

Exhibit 7.7: Distribution of Mammal Signs in Habitat Types in the Study Area Survey Conducted October 2013



7.2 Small Mammals

7.2.1 October 2013 Survey

The Small Asian Mongoose Herpestes javanicus is well adapted to living in the outskirts of villages and towns and avoids mountainous areas (Roberts 1997). This species was observed during the October 2013 survey at Sampling Points S2, S4, S5, S10, S14, S15 and A3.

Signs of the Indian Crested Porcupine Hystrix indica were observed at Sampling Point S1and A1 during October 2013 survey.

Rodents: The habitats of the Study Area have a diverse species of rodents. Common rodent species in the Study Area include Indian Field Mouse Mus Booduga, House Mouse Mus Musculus, House Rat Rattus rattus and House Shrew Suncus Murinus.

Locations for trapping of rodents are indicated on a map in **Exhibit 2.3** of the Methodology section of this report.

Exhibit 7.8 provides the results for rodents trapped in the Study Area (using Sherman Live Traps)[69].

[69] EIAO Guidance Note No. 10/2004. Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys, Environment Protection Department, Hong Kong.

House Mouse Mus musculus was the most common species with a trapping success of 33% followed by Indian Field Mouse Mus booduga with trapping success of 28%, and House Shrew Suncus murinus with trapping success of 22%.

Exhibit 7.8: Trapping Success for Rodents in the Study Area Survey Conducted October 2013

Scientific Names	*Common Names*	*Captured/100 Trap Nights*	*Percent of Trapping*
Mus Booduga	Indian Field Mouse	1.79	28%
Mus Musculus	House Mouse	2.14	33%
Rattus rattus	House Rat	1.07	17%
Suncus Murinus	House Shrew	1.43	22%
Total		**6.43**	**100%**

7.2.2 December 2013 survey

During the December 2013 survey, small mammal trapping was carried out at only one sampling location: Sampling Point D2 located in Scrub Forest. Two specimens of House Shrew Suncus Murinus were trapped.

7.3 Otters

Otters are the only water mammals associated with the Poonch River. Keeping in view the habitat available, the species likely to be found in the Study Area is the Common Otter lutra lutra. The Otter lives in a wide variety of aquatic habitats, including highland and lowland lakes, rivers, streams, marshes, and swamps. This species is considered to be Near Threatened (IUCN Red List 2013) due to an ongoing population decline over the years. The aquatic habitats of otters are extremely vulnerable to man-made changes. Canalization of rivers, removal of bank side vegetation, dam construction, draining of wetlands, aquaculture activities and associated man-made impacts on aquatic systems are all unfavorable to otter populations[70].

Otter sampling was carried out at six sampling locations in the Study Area during the December 2013 survey (**Exhibit 7.10)**. Each sampling location was surveyed for sightings as well as signs of the species including dens (holts), tracks, spraints (droppings). In addition, locals were interviewed regarding the presence of the Otter in their areas.

No Otter signs were observed in disturbed areas near the river, especially areas of sand and gravel extraction. Otter signs were also not observed in the areas where suitable

70 Ruiz-Olmo, J., Loy, A., Cianfrani, C., Yoxon, P., Yoxon, G., de Silva, P.K., Roos, A., Bisther, M., Hajkova, P. & Zemanova, B. 2008. *Lutra lutra*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **02 January 2014**.

habitat in the form of dense vegetation, deep pools and boulders or broken rocks on the river side were absent. Otters were found to be active (based on the observation of foot-prints and droppings) in the vicinity of deep and long pools in the river containing wintering fish species.

A summary of the survey findings are presented in **Exhibit 7.9**. Otter signs were observed at the following sampling locations: A1, A3, A4 and Nar area. Otter signs were absent at D1 (Project location) and Sampling Point A5. Three Otters were sighted on 17 February, 2014 by Hagler Bailly Pakistan's Socio-economic survey team, about 1 km upstream of Sampling Point A4. The Otters were sitting on a rock in the River about 3 meters from the left bank (**Exhibit 7.10**).

Photographs of Otter signs and Otter spraints are given in **Exhibit 7.11**.

Exhibit 7.9: Summary of Otter Signs in Study Area. Surveys conducted December 2013

	Sampling Locations						
	A1	*A3,*	*D1(Project Location)*	*A4*	*Narr Area*	*A5*	*Upstream A4*
Otter Signs - holts (dens)	1	2	No	1 (On the right bank of River along Sensa Nullah)	2	No	No
Otter Signs -Tracks	yes	yes	No	Yes (On the right bank of River along Sensa Nullah)	yes	No	No
–	yes	yes	No	Yes (On the right bank of River along Sensa Nullah)	yes	No	No
Results of Interviews with Locals regarding Otter sightings and signs	3 persons - yes 1 person - No	No one was interviewed	2 persons - No	2 persons - yes	3 persons- yes	2 persons - No	No
Otter Sightings	No	No	No	No	No	No	Yes (during February 2014)
General Habitat observed	Caves, crevices, broken rocks, deep pools, disturbance level high at most places	Thick riverside vegetation, deep pools, Huge boulder piles, broken rocks, least disturbance in area one km downstream bridge	No proper otter habitat, disturbance level very high	Limited otter area along the water fall at the confluence of Sensa stream with the Poomnch River. Highly disturbed area.	The best Otter habitat with very long and deep pool reportedly full of fish, thick side vegetation, broken rocks, gentle slope, less disturbance	Disturbed area due to sand mining and monkeys habitat	Presence of rocks in river. Good habitat for Otters

Exhibit 7.10: Otter Sampling Locations in Study Area. Surveys conducted December 2013

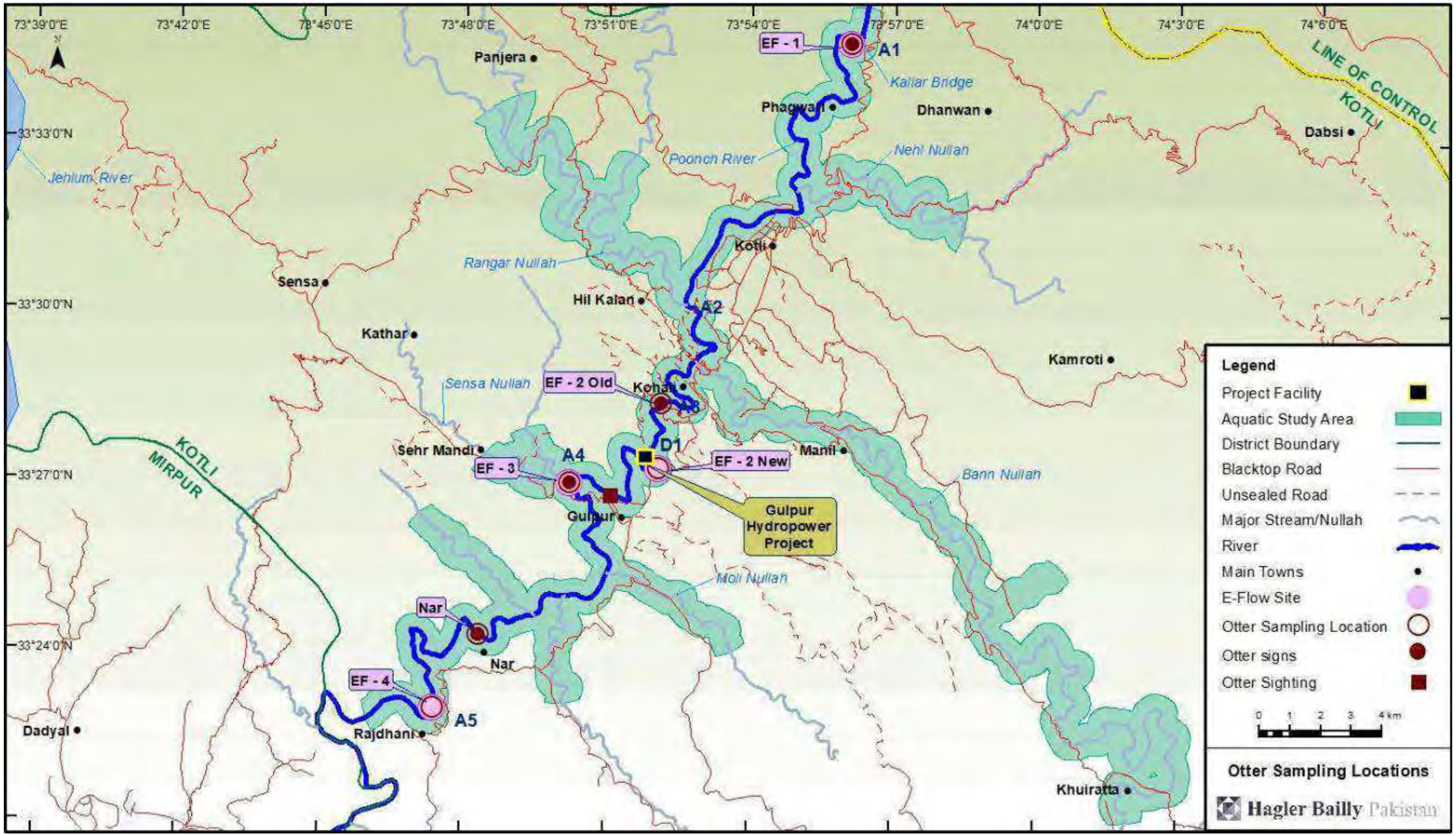


Exhibit 7.11: Photographs of Otter Signs Observed in Study Area during December 2013 Survey

g. Otter footprint

h. Otter footprint

i. Otter spraints

j. Otter spraints

7.4 Conservation and Protection Status

The mammals of conservation importance reported from the Study Area and vicinity are discussed below. The only mammals included in the IUCN Red List 2013[71] are the Common Leopard Panthera pardus and the Common Otter lutra lutra that are listed as Near Threatened.

Asiatic Jackal Canis aureus: It is generally accepted that the population occurring throughout Pakistan belongs to the nominate sub-species Canis aureus aureus. (Roberts 1997). It is found throughout the plains, as well as areas of Balochistan and the North West Frontier Province and Kashmir. This is a very adaptable animal, readily entering mountainous areas, forest plantations, and riverine thickets. In the irrigated colonies, there is some evidence that jackals have decreased in number in recent years, which might be the result of increased human disturbances, as well as the effect of chemical pesticides, which are usually highly toxic to mammals. The Asiatic Jackal Canis aureus

71 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 11 October 2013

is included in Appendix III of the CITES Species List[72] and listed as Near Threatened in Pakistan's Mammals National Red List 2006. The signs of this species were observed at Sampling Point S1 in October 2013 surveys. During December 2013 survey, it was seen at Sampling Point D-3 as well as sign of this species were seen at Sampling Points D-1, D-2 and D-3.

Common Red Fox Vulpes vulpes: The Common Red Fox is a very variable species both in size and coloration and has several sub-species, at least three of which are known to occur in Pakistan. It occurs throughout the mountainous areas of Balochistan, North West Frontier Province, and the Himalayas, both in the valleys and higher mountain slopes as well (Roberts 1997). The Common Red Fox is hunted in other countries for its valuable pelt, yet it is still widespread in Pakistan. It is placed in Appendix III of the CITES list and listed as Near Threatened in the Pakistan's Mammals National Red List 2006. It was sighted in the Study Area at four sampling points including Sampling Points S10, S1, A7 and S15 during the October 2013 survey and signs of this species were seen at Sampling Points D-1, D-2 and D-3 during December 2013 survey.

Indian Gray Mongoose Herpestes edwardsii: The Gray Mongoose is easily distinguished in the field by its longer contour hairs which form almost a cape along the flanks and over the hind quarters. It is adapted to arid conditions and is, consequently, widespread in Pakistan. It is common throughout the central and northern parts of Sindh, but sparse in southern Balochistan (Roberts 1997). It is included in Appendix III of the CITES Species List. It was observed in the October 2013 survey at Sampling Points S2, S4, S5, S10, S14, S15 and A3. During the December 2013 survey, it was observed at Sampling Points D-1 and D-3.

Indian Crested Porcupine Hystrix indica: The lower parts of this large rodent's body are covered with short brown bristle like hairs. From the fore part of the crown to behind the shoulders, the hairs on the top of the body are modified into very long slender spines, generally of an all-black color, which can be erected when the animal is excited or angry. The porcupine is remarkably adaptable ecologically, and is found over most parts of Pakistan and Kashmir (Roberts 1997). A gradual destruction in wilderness area is responsible for the decline in its numbers. It is listed as Near Threatened in Pakistan's Mammals National Red List 2006. Signs of this species were observed at Sampling Point S1 and A1 during the October 2013 survey. It was not observed during December 2013 survey.

Common Leopard Panthera pardus: The Common Leopard Panthera pardus has a deep laterally compressed body with comparatively short stout legs and very broad massive fore-paws (Roberts 1997). It is covered by a thick layer of fur with rosettes. A good market for furs has decreased numbers of the Common Leopard Panthera pardus in most of its former habitats thus it is encountered rarely in some of the most remote and rugged mountain regions. Despite a ban on the trade of its skins, leopard skins are openly sold by vendors in the major cities of Pakistan (Habibi 2003)[73]. It is listed as Near Threatened in the IUCN Red List 2013, Critically Endangered in the Pakistan's

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[72] UNEP-WCMC. 14 November 2013. UNEP-WCMC Species Database: CITES-Listed Species

[73] Habibi, K. 2003. Mammals of Afghanistan. Zoo Outreach Organization, Coinmbatore, India, 168 pp

Mammals National Red List 2006, and included in CITES Appendix 1. The Common Leopard was neither seen nor were signs of this species observed in the Study Area during October 2013 and December 2013surveys.

The Common Otter Lutra lutra: The Common Otter Lutra lutra is adapted to life in aquatic conditions. It has dense short fur of an olive-brown color. The tail of the Common Otter Lutra lutra is muscular and flat, modified into a paddle which help in swimming (Roberts, 1997). It is listed as Near Threatened in the IUCN Red List 2013. It is also listed as Near Threatened in the Pakistan's Mammals National Red List 2006 and included in CITES Appendix I. The aquatic habitats of otters are extremely vulnerable to man-made changes. Canalization of rivers, removal of bank side vegetation, dam construction, draining of wetlands, aquaculture activities and associated man-made impacts on aquatic systems are all unfavorable for otter populations[74]. During the December 2013 survey, otter signs were observed at the following sampling locations: A1, A3, A4 and Nar area. Otter signs were absent at D1 (Project location) and Sampling Point A5. Three Otters were sighted on 17 February, 2014 by Hagler Bailly Pakistan's Socio-economic survey team, about 1 km upstream of Sampling Point A4.

Barking Deer Muntiacus muntjak: Barking Deer Muntiacus muntjak is a small sized deer. It has short body fur which is soft and glossy. The color of the fur is generally bright yellowish-red. Males have small antlers having two branches. Males have tusk like canines and glands under the chin (Roberts, 1997). It is listed as Endangered in the Pakistan's Mammals National Red List 2006. Barking Deer Muntiacus muntjak was not observed in the Study Area during October 2013 and December 2013 surveys.

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[74] Ruiz-Olmo, J., Loy, A., Cianfrani, C., Yoxon, P., Yoxon, G., de Silva, P.K., Roos, A., Bisther, M., Hajkova, P. & Zemanova, B. 2008. *Lutra lutra*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on **13 November 2013**.

8. Herpeto-fauna

Pakistan has a wide range of habitats, most of which are inhibited by amphibians and reptiles. Therefore Pakistan's herpeto-fauna is also highly diverse, comprising 21 species of amphibians and about 190 reptiles, representing 26 families (Masroor, 2012[75]). The herpeto-fauna of the northern Pakistan is not very well studied. However, parts of Potwar Plateau and Azad Kashmir have been studies by researchers (Baig 1988[76], 1996[77], 1998[78], 2001[79], 2002[80]; Baig & Gvozdik 1998[81]; Baig & Rafique 2005[82]; Khan 1989[83], 1997[84], 1998[85]; Khan & Baig 1992[86]; Khan & Khan 1996[87]; Khan & Baig 1999[88]; Khan & Tasnim 1989[89], 1990[90]; Telford 1980[91]).

Azad Jammu and Kashmir (AJK) harbours a high reptilian diversity due to its unique topography (Baig 1998). The Poonch River Basin, where the Study Area is located, has a

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75 Masroor, R. 2012. A contribution to the Herpetology of Northern Pakistan. The Amphibians and Reptiles of Margalla Hills National Park and Surrounding Regions. Society for the Study of Amphibians and Reptiles (SSAR), USA in cooperation with Chimaira Buchhandelsgesellschaft mbH (Germany), 217 pp.

76 Baig, K.J. 1988. Anurans (Amphibia) of northern Pakistan: with special reference to their distribution. Pak. J. Sci.Ind. Res., 31 (9): 651-655.

77 Baig, K.J. 1996. Herpetofauna of the sub-Himalayan region of Pakistan including Islamabad area. Proc. DAAD 4th Follow-up Seminar, Islamabad :35-42.

78 Baig, K.J. 1998. The amphibian fauna of Azad Jammu and Kashmir with new record of *Paa liebigii.* Proc. Pakistan Academy of Sciences. 35 (2): 117-121.

79 Baig, K.J. 2001. Annotated Checklist of amphibians and reptiles of the northern mountain region and Potwar Plateau of Pakistan. Proc. Pakistan Acad. Sci. 38(2):121-130

80 Baig, K.J. 2002. Rediscovery of Murree Hill Frog, *Paa vicina* after 130 years from Ayubia National Park. Proc.Pakistan Acad. Sci. 39(2): 261-262.

81 Baig, K.J. & Gvozdik, L., 1998. *Uperodon systoma*: Record of a new microhylid frog from Pakistan. *Pak. J. Zool.*, 30 (2): 155-156.

82 Baig, K.J. and Rafique, M. 2005. Two new records of snake species from Machiara National Park, Azad Jammu and Kashmir. Proc. Pak. Acad. Sci., 42(2): 151-152.

83 Khan, M.S. 1989. Rediscovery and redescription of the highland ground gecko *Tenuidactylus montiumsalsorum* (Annandale, 1913). Herpetologica 45: 46-54.

84 Khan, M.S. 1997. A new toad of genus *Bufo* from the foot of Siachin Glacier, Baltistan, northeastern Pakistan. *Pak. J. Zool.,* 29 (1): 43-48.

85 Khan, M.S. 1998. *Typhlops ductuliformrs* a new species of blind snakes from Pakistan and a note on *Typhlops porrectes* Stoliczka, 1871 (Squamata: Serpentes: Scolicophidia). Pak.J. zool., 31 (4): 385-390.

86 Khan, M.S. & K.J. Baig 1992. A new tenuidactylid gecko fron northeastern Gilgit Agency, north Pakistan. Pak.J. Zool. 24: 273-277.

87 Khan, A.Q. & Khan, M.S. 1996. Snakes of state of Azad Jammu and Kashmir. Proceedings of Pakistan Congress of Zoology, 16: 173-182.

88 Khan, A.Q. & Khan, M.S. 1996. Snakes of state of Azad Jammu and Kashmir. Proceedings of Pakistan Congress of Zoology, 16: 173-182.

89 Khan, M.S. & Tasnim, R., 1989. A new frog of the genus Rana, subgenus Paa, from southwestern Azad Kashmir. J.Herpetology., 23 (4): 419-423.

90 Khan, M.S. & Tasnim, R., 1990. A new gecko of the genus *Tenuidactylus* from northwestern Punjab, Pakistan and southwestern Azad Kashmir. Herpetologica 46: 142-148.

91 Telford, S. R., III. 1980. Notes on *Agkistrodon himalayanus* from Paksitan's Kaghan Valley. Copeia 1980:154-155.

distinct altitudinal range and relatively high precipitation leading to high diversity of herpeto-fauna overlapping with the fauna of the northern regions and Potwar Plateau. A total of 35 amphibian and reptiles have been reported from the Study Area[92]. The occurrence of three species viz., Indian flap-shell turtle Lissemys punctata, Red Sand Boa Eryx johnii, Himalayan Rock Agama Laudakia himalayana is presently not confirmed and may have been erroneously listed.

This current report addresses the ecological herpeto-faunal wealth from the Study Area as a result of fieldwork conducted during October 2013. A total of 26 locations were sampled in the October 2013 survey to study reptile abundance and diversity in the Study Area. Of these, 18 sampling points were located in the terrestrial habitats while 8 were located in the riparian habitat. In addition, to these points, nocturnal trapping of reptiles was conducted at Sampling Point S6. The location of these sampling points is shown in **Exhibit 2.2** and **Exhibit 2.3** in Methodology section of this report **(Section 2)**. No survey of the herpeto-fauna was conducted in December 2013 as reptiles and amphibians hibernate in the winter and are difficult to observe during the winter months.

Data collected during this study is included in **Exhibit A.5** in **Appendix A**.

Exhibit 8.1 presents Species Accumulation Curves (SAC is a curve built upon the total number of species counted for incremental numbers of individuals recorded) for the October 2013 survey in the Study Area for the habitats sampled (Agricultural Fields, Pine Forest, Scrub Forest and Riverbank/Riparian). For each habitat type, Species Accumulation Curves (Thompson and Thompson 2007)[93] are presented for all reptile species to represent sample adequacy in the October 2013 survey. The curves for Agricultural Fields show a decreasing rate of discovery of new species, indicating adequacy of sampling effort. The curves for the other three habitats do not level off showing inadequacy of sampling effort. To compensate for any inadequacy in sampling, a literature review of the herpeto-fauna reported from AJK was completed. Special emphasis was given to the reptiles of conservation importance.

Exhibit 8.2 provides a summary of sampling points by type of habitat, number of sightings, and the number of species sighted.

Exhibit 8.3 shows the abundance of herpeto-fauna in the Study Area for all habitat types.

Photographs of the common species observed during the surveys are included in **Exhibit 8.4.**

Exhibit B.1 in **Appendix B** provides a list of species observed in the Study Area during the survey of October 2013.

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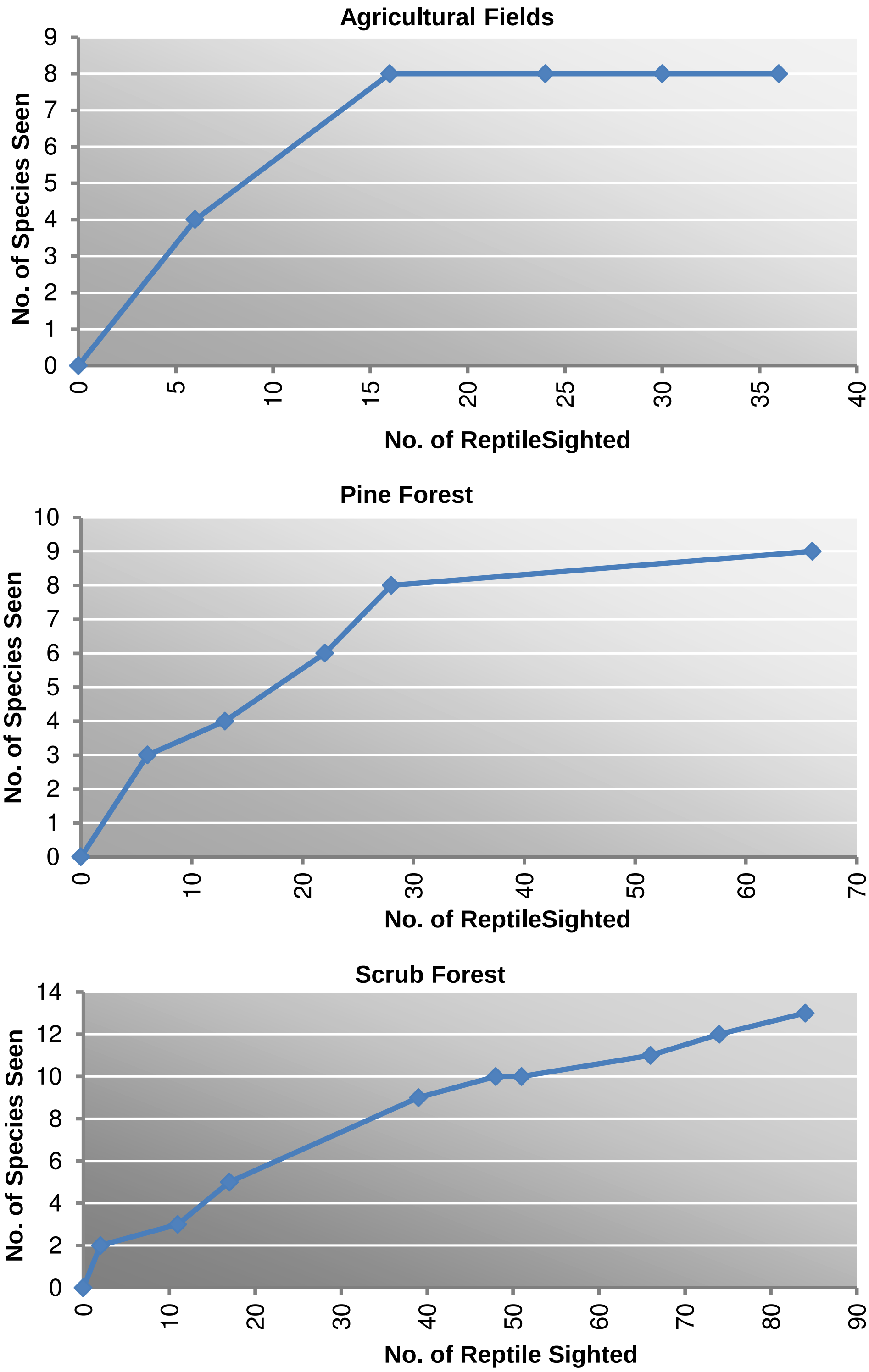
[92] Khan, W.A. 2013. A preliminary baseline report on amphibians and reptiles of Gulpur Hydroelectric Power, Kotli, Azad Jammu and Kashmir, 7 pp.

[93] Thompson, G.G., and Thompson, S.A. 2007. Using species accumulation curves to estimate trapping effort in fauna surveys and species richness. Austral Ecology; Volume 32 Issue 5: 564 -569 (published online: 20 June 2007).

Exhibit 8.1: Species Accumulation Curves for October 2013 Survey



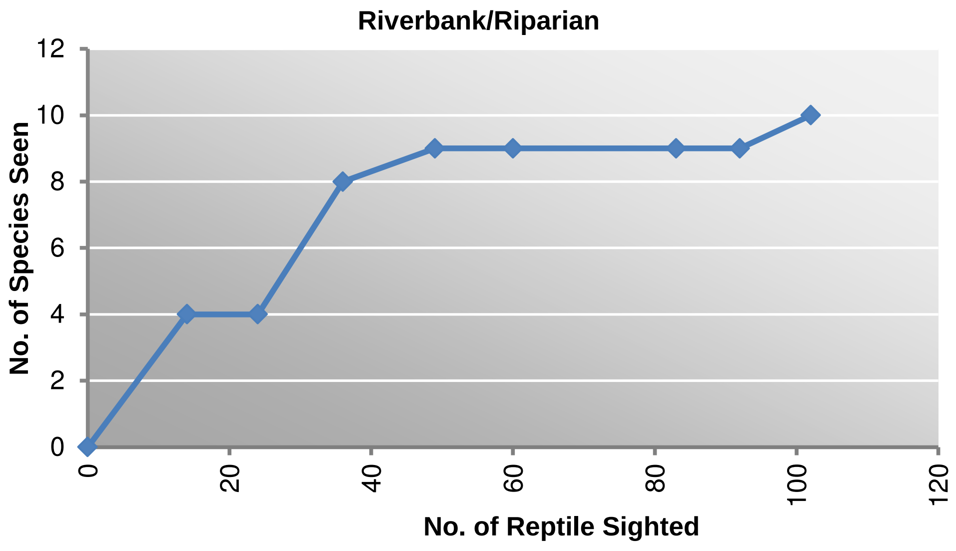


Exhibit 8.2: Abundance and Diversity of Herpeto-fauna by Habitat Type, Survey Conducted October 2013

Habitat	*No.of Sampling Points*	*Abundance (Total Sightings)*	*Density (Sightings per Sampling Point)*	*Diversity (No. of Species)*
October 2013				
Agricultural Fields	5	66	13.2	9
Pine Forest	5	36	7.2	8
Scrub Forest	9	84	9.3	13
Riverbank/Riparian	8	102	12.7	10
Total	**27**	**288**		

Exhibit 8.3: Abundance of Herpeto-fauna in the Study Area
Survey Conducted October 2013

No.	Common Names	Scientific Names	Habitats					
			Agricultural Fields	*Pine Forest*	*Riverbank/Riparian*	*Scrub Forest*	***Total***	***No of Habitats***
1.	Striped Grass Skink	*Eutropis dissimilis*	8	2	9	16	**35**	**4**
2.	Punjab Snake-Eyed Lacerta	*Ophisops jerdonii*	6	5	5	12	**28**	**4**
3.	Agror Valley Agama	*Laudakia agrorensis*	15	17	18	18	**68**	**4**
4.	Bengal Monitor	*Varanus bengalensis*	1	–	1	2	**4**	**3**
5.	Asian Snake-eyed Skink	*Ablepharus pannonicus*	1	3	–	4	**8**	**3**
6.	Skittering Frog	*Euphlyctis cyanophlyctis*	2	35	49	–	**86**	**3**
7.	Swat Green Toad	*Pseudepidalea p. pseudoraddei*	–	1	10	7	**18**	**3**
8.	Rohtas Fort Gecko	*Cyrtopodion rohtasfortai*	–	–	3	10	**13**	**2**
9.	Central Asian Cobra	*Naja oxiana*	–	1	–	1	**2**	**2**
10.	Asian Grass Frog	*Fejervarya limnocharis*	2	–	–	5	**7**	**2**
11.	Indian Rat Snake	*Ptyas mucosus*	–	1	–	1	**2**	**2**
12.	Oriental Garden Lizard	*Calotes versicolor*	–	1	4	–	**5**	**2**
13.	Sochurek's Saw-scaled Viper	*Echis carinatus sochureki*	–	–	–	1	**1**	**1**
14.	Ornamented Pygmy Frog	*Microhyla ornata*	1	–	–	–	**1**	**1**
15.	Yellow-bellied House Gecko	*Hemidactylus flaviviridis*	–	–	–	5	**5**	**1**
16.	Kashmir Torrent Frog	*Allopaa barmoachensis*	–	–	2	–	**2**	**1**
17.	Indian Burrowing Frog	*Sphaerotheca breviceps*	–	–	–	2	**2**	**1**
18.	Braided Snake/Cliff Racer	*Platyceps rhodorachis*	–	–	1	–	**1**	**1**
	Total no. of inividuals observed (Abundance)		36	66	102	84	288	

Exhibit 8.4: Photographs of Common Reptilian Species of the Study Area

a. Striped Grass Skink *Eutropis dissimilis*

b. Punjab Snake-eyed Lacerta *Ophisops jerdonii*

c. Rohtas Fort Gecko *Cyrtopodion rohtasfortai*

d. Bengal Monitor *Varanus bengalensis*

8.1 Overview of Herpeto-fauna Abundance and Diversity

A total of 288 reptile and amphibian specimens belonging to 18 species were observed in the Study Area during the October 2013 survey (**Exhibit 8.2**). The greatest abundance of herpeto-fauna was observed in the Agricultural Fields (13 sightings per sampling point), while the greatest diversity of herpeto-fauna was seen in Scrub Forest where 13 herpeto-faunal species were seen.

Exhibit 8.5 and Exhibit 8.6 show the distribution of the observed abundance and diversity of herpeto-fauna in the Aquatic and Terrestrial Study Area during the October 2013 survey.

The maximum abundance of herpeto-fauna was observed at Sampling Point S13 where 38 specimens of herpeto-fauna were observed. The most abundant amphibian seen here was the Skittering Frog Euphlyctis cyanophlyctis. The second highest abundance was seen at Sampling Point A4 where 23 specimens of herpeto-fauna were observed. The Skittering Frog Euphlyctis cyanophlyctis was also the most abundant herpeto-faunal species seen at this location.

The highest herpeto-faunal diversity was recorded at Sampling Points A3 in River-bank/Riparian habitat and Sampling Point S9 in Scrub Forest as well as during the nocturnal survey at Sampling Point S6. A total of five herpeto-faunal species were observed at each of these locations. The other sampling points were documented by 4, 3 or 2 species at each sampling point, respectively. The least diversity was seen at Sampling Point S3, S4, S14, S15 and S17 where only two species each were observed.

Five herpeto-faunal species were observed during the nocturnal survey at Sampling Point S6. These included Rohtas Fort Gecko Cyrtopodion rohtasfortai, Asian Grass Frog Fejervarya limnocharis, Agror Valley Agama Laudakia agrorensis, Swat Green Toad Pseudepidalea p. pseudoraddei and Indian Burrowing Frog Sphaerotheca breviceps.

Exhibit 8.5: Abundance and Diversity of Herpeto-fauna in the Aquatic Study Area, Survey Conducted October 2013

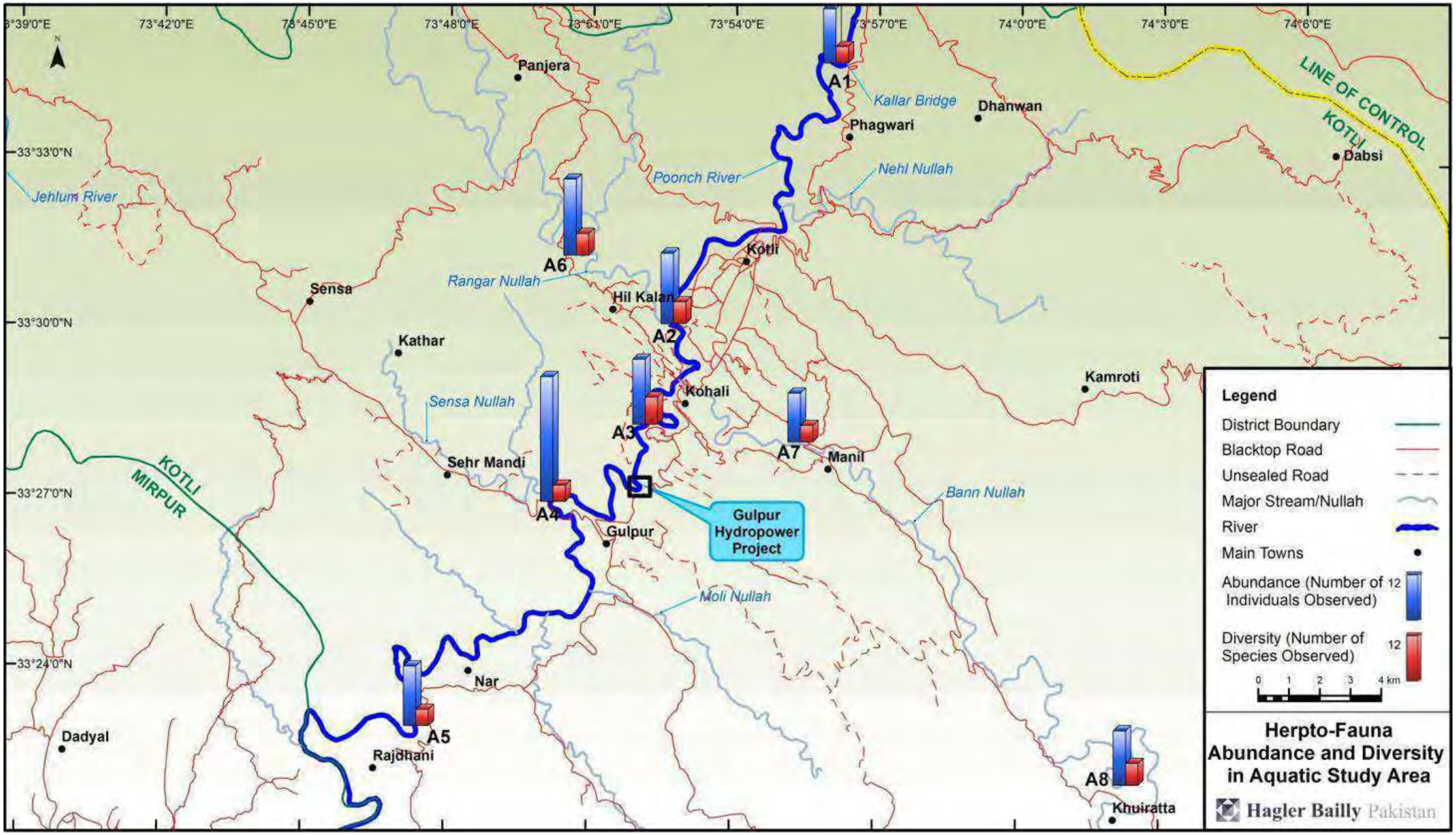


Exhibit 8.6: Abundance and Diversity of Herpeto-fauna in the Terrestrial Study Area, Survey Conducted October 2013

8.1.1 Species Sighted and Habitat Affinities

Exhibit A.5 in **Appendix A** gives the data collected for the herpeto-faunal species observed in the Study Area during the survey of October 2013.

The most abundant herpeto-faunal species observed in the Study Area was Skittering Frog Euphlyctis cyanophlyctis followed by Agror Valley Agama Laudakia agrorensis and Striped Grass Skink Eutropis dissimilis with 86, 68 and 35 specimens seen, respectively. The least abundant species observed only once in the Study Area included Sochurek's Saw-scaled Viper Echis carinatus sochureki, Ornamented Pygmy Frog Microhyla ornata and Braided Snake Platyceps rhodorachis.

Reptiles are highly habitat specific, and therefore, occupy small niches spread all over the Study Area. Unlike birds and mammals that have very wide foraging ranges, reptiles have a restricted home range. Except monitor lizards and large snakes, other species usually stay within an area of one square km for feeding and breeding[94]. Geckos or skinks may occupy microhabitats spread over even smaller areas. The breeding ground for a reptile species cannot be marked at one or two places; these are spread all over the area within suitable habitats at several scattered places, provided other climatic factors remain conducive.

Information from the October 2013 survey was collated to study habitat affinities. Species observed in all four habitats included Striped Grass Skink Eutropis dissimilis, Punjab Snake-eyed Lacerta Ophisops jerdonii, Agror Valley Agama Laudakia agrorensis **(Exhibit 8.3)**. Some species observed in three habitats included Bengal Monitor Varanus bengalensis, Asian Snake-eyed Skink Ablepharus pannonicus, Skittering Frog Euphlyctis cyanophlyctis and Swat Green Toad Pseudepidalea p. pseudoraddei. A few species were observed only in one habitat though the possibility of their presence in other habitats cannot be ruled out. These include the Ornamented Pygmy Frog Microhyla ornata, Yellow-bellied House Gecko Hemidactylus flaviviridis, Kashmir Torrent Frog Allopaa barmoachensis, Braided Snake Platyceps rhodorachis. The distribution of some common herpeto-faunal species in the habitats of the Study Area is shown in **Exhibit 8.7**.

Agricultural Fields

A total of 36 individuals belonging to 8 species were sighted in Agricultural Fields. The most widespread and abundant species of Agricultural Fields was the Agror Valley Agama Laudakia agrorensis followed by Striped Grass Skink Eutropis dissimilis and Punjab Snake-eyed Lacerta Ophisops jerdonii. The species Ornamented Pygmy Frog Microhyla ornata was unique to this habitat (**Exhibit 8.3**).

Pine Forest

A total of 66 reptiles and amphibian belonging to 9 species were seen in the Pine Forest. The most abundant species was the Skittering Frog Euphlyctis cyanophlyctis with a total of 35 individuals seen in this habitat followed by the Agror Valley Agama Laudakia agrorensis and Punjab Snake-eyed Lacerta Ophisops jerdonii (**Exhibit 8.3**).

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[94] Mertens, R. 1969. Die Amphibiens und Reptiliens West Pakistan. Stutt. Beit. *Naturkunde*, 197:1-96.

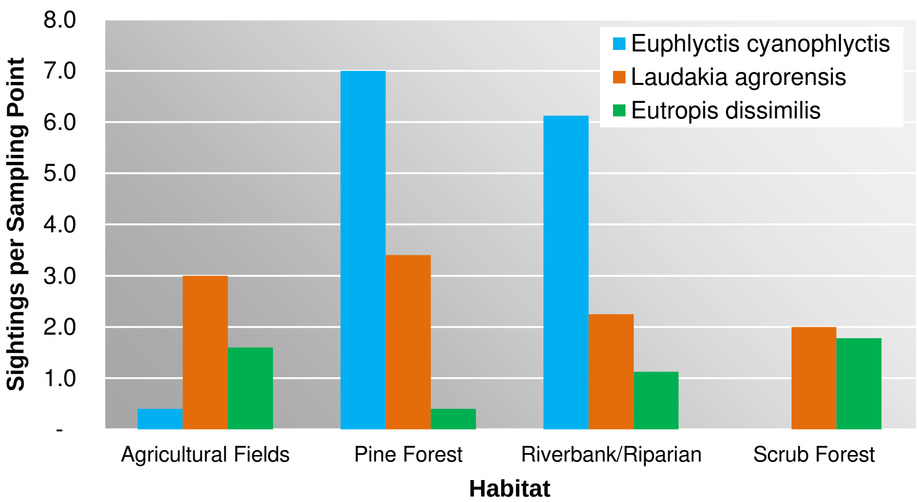
Scrub Forest

A total of 84 individuals belonging to 13 species were sighted in Scrub Forest. The most widespread and abundant species of Scrub Forest was the Agror Valley Agama Laudakia agrorensis followed by Striped Grass Skink Eutropis dissimilis and Punjab Snake-eyed Lacerta Ophisops jerdonii. The species Sochurek's Saw-scaled Viper Echis carinatus sochureki, Yellow-bellied House Gecko Hemidactylus flaviviridis and Indian Burrowing Frog Sphaerotheca breviceps were unique to this habitat (**Exhibit 8.3**).

Riverbank/Riparian

A total of 102 individuals belonging to 10 species were sighted in River-bank/Riparian habitat. The most widespread and abundant species of Riverbank/Riparian was Skittering Frog Euphlyctis cyanophlyctis followed by the Agror Valley Agama Laudakia agrorensis and Swat Green Toad Pseudepidalea p. pseudoraddei. The species Braided Snake Platyceps rhodorachis and Kashmir Torrent Frog Allopaa barmoachensis were unique to this habitat (**Exhibit 8.3**).

Exhibit 8.7: Distribution of Some Common Herpeto-faunal species in Habitat Types in Study Area Survey Conducted October 2013



8.2 Conservation Status

Of the herpeto-fauna species reported from the Study Area, five are endemic to Pakistan. These include Rohtas Fort Gecko Cyrtopodion rohtasfortai, Kashmir Slender Blindsnake Typhlops madgemintonai, Kashmir Blindsnake Typhlops diardi platyventris, Ahsanul's Wormsnake Typhlops ahsanuli and Kashmir Torrent Frog Allopaa barmoachensis. The three species included in CITES Appendix II[95] are Central Asian Cobra Naja oxiana, Indian Rock Python Python molurus and Indian Rat Snake Ptyas mucosus, while Bengal Monitor Varanus bengalensis is included in CITES Appendix I[96]. The only species

[95] UNEP-WCMC. 14 November 2013. UNEP-WCMC Species Database: CITES-Listed Species

[96] UNEP-WCMC. 14 November 2013. UNEP-WCMC Species Database: CITES-Listed Species

included in the IUCN Red List 2013[97] is the Indian Rock Python Python molurus that is listed as Near Threatened.

Rohtas Fort Gecko *Cyrtopodion rohtasfortai*

Rohtas Fort Gecko Cyrtopodion rohtasfortai prefers to live in crevices among rocks and invade houses, where it rests clinging to the walls in dark corners (Khan 2006)[98]. This reptile species is nocturnal and feeds on insects during night. Breeding season extends from May to June. It lays a pair of oblong eggs which are glued to the sides of the crevices and walls in the dark part of buildings. Rohtas Fort Gecko Cyrtopodion rohtasfortai is widely distributed in alpine Punjab and Azad Kashmir. It is endemic to Pakistan. It was observed in the Study Area during the October 2013 survey at Sampling Points A3, S6 and S9 as well as during the nocturnal survey at Sampling Point S6.

Kashmir Torrent Frog *Allopaa barmoachensis*

Kashmir Torrent Frog Allopaa barmoachensis is an amphibian species endemic to Pakistan. It prefers to live in fast running streams (Khan 2006). During strong water currents, tadpoles moves to rock crevices and stick to them with the help of oral discs. Adult frogs also move to spaces below stones which are not under the direct force of the water current. In the dry season they live in the pools formed in the stream and can be seen sitting on the bank of the pool waiting for insects on which they feed. The breeding activity in this frog is observed twice a year: from April to May and July to August. It was observed in the Study Area during the October 2013 survey at Sampling Points S2, S9, S11, S13 and S16.

Indian Rat Snake *Ptyas mucosus*

Indian Rat Snake Ptyas mucosus prefers to live in damp and marshy places along water courses, grasslands, cultivated lands, gardens and forests. It is attracted to human settlements by rodents on which it feeds and often lives in rodents holes (Khan 2006). The breeding season of Indian Rat Snake Ptyas mucosus extends from March through August. During August and September, it lays 6-16 oblong eggs in burrows. The Indian Rat Snake Ptyas mucosus is included in CITES Appendix II. It was observed in the Study Area during the October 2013 survey at Sampling Points S11 and S6.

Central Asian Cobra *Naja oxiana*

Central Asian Cobra Naja oxiana inhibits dry wastelands where it lives in holes and crevices in uneven ground (Khan 2006). In mountains, it lives in caverns, crevices and holes in the rocks. It feeds on rodents, birds, snakes, lizards and often enters inhibited houses attracted by rodents. In Pakistan it is reported from throughout the Khyber Pakhtunkhwa province, north-eastern Baluchistan as well as northwestern Punjab and Kashmir. It is included in CITES Appendix II. It was observed in the Study Area during the October 2013 survey at Sampling Points S9 and S12.

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97 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 11 October 2013

98 Khan, M.S. 2006. Amphibians and Reptiles of Pakistan, Krieger Publishing Company, Malabar, Florida, 2006, 310 pp.

Bengal Monitor *Varanus bengalensis*

Bengal Monitor Varanus bengalensis is large monitor lizard which inhibits moderately dry forests and extends into the cultivated areas where it lives in tracts of barren lands. It lives in burrows and often invades inhibited houses, attracted by poultry and rodents. It is also a good tree climber. During the rainy season it lives in tree holes feeding on birds and eggs. The breeding season of this reptile extends from April to June and it lays 6-12 eggs (Khan 2006). It is included in CITES Appendix I. It was observed in the Study Area during the October 2013 survey at Sampling Points A2, S6, S7 and S8.

Indian Rock Python *Python molurus*

Indian Rock Python Python molurus is a large nonvenomous python species found in many tropic and sub-tropic areas of Southern and Southeast Asia[99]. The skin color pattern is whitish or yellowish with blotched patterns varying from shades of tan to dark brown that vary with terrain and habitat[100]. In Pakistan, Indian Pythons commonly reach a length of 2.4–3 meters (7.9–9.8 feet)[101]. It is listed as Near Threatened in IUCN Red List 2013 and also included in CITES Appendix II. Indian Rock Python Python molurus was notobserved in the Study Area during October 2013 survey.

Kashmir Slender Blindsnake *Typhlops madgemintonai*

Kashmir Slender Blindsnake Typhlops madgemintonai is a small sized snake that is endemic to Pakistan. It inhibits rocky countryside with Pine trees and lush vegetation. Color of this snake is dark brown but the ventral side has lighter brown color (Khan 2006). Kashmir Slender Blindsnake Typhlops madgemintonai was not observed in the Study Area during October 2013 survey.

Kashmir Blindsnake *Typhlops diardi platyventris*

Kashmir Blindsnake Typhlops diardi platyventris is a nocturnal species endemic to Pakistan. It inhibits lowlands, hilly slopes, tropical forests, plantations and wet cultivated areas. This snake spends most of its time underground and is rarely seen above ground[102]. Kashmir Blindsnake Typhlops diardi platyventris was not observed in the Study Area during October 2013 survey.

Ahsanul's Wormsnake *Typhlops ahsanuli*

Ahsanul's Wormsnake Typhlops ahsanuli is a small sized snake. It is 170mm in length. Color of this snake is dark brown to blackish but the ventral side has lighter brown color (Khan 2006). This snake species endemic to Pakistan was not observed in the Study Area during October 2013 survey.

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[99] Wall, F. (1912), "A popular treatise on the common Indian snakes – The Indian Python", *Journal of the Bombay Natural History Society* **21**: 447–476.

[100] Rhomulus Whitaker: "Common Indian Snakes – A Field Guide"; The Macmillan Company of India Limited, 1987; pp. 6-9; SBN 33390-198-3

[101] Minton, S. A. (1966), "A contribution to the herpetology of West Pakistan", *Bulletin of the American Museum of Natural History* **134** (2): 117–118.

[102] Khan, M.S. 1998. Notes on Typhlops Diardi Schlegel, 1839, With Description of a New Subspecies (Squamata, Serpentes, Scolecophidia). Pakistan J. Zoology, 30(3):213-221.

9. Birds

A total of 442 bird species have been reported from AJK (Bird Life International)[103]. These include members of the family Phasianidae, Anatidae, Podicipedidae, Ardeidae, Falconidae, Accipitridae, Cuculidae, Strigidae, Corvidae etc. Most of the bird species are resident. However, some migratory bird species have also been reported from AJK.

A wide variety of water birds have been reported from different water bodies of AJK. These include resident and migratory birds. More than 45 species of water birds have been documented in the valley. Abundant local water birds include the Little Cormorant Phalacrocorax niger, Great Egret Egretta garzetta, Intermediate Egret Mesophoyx intermedia, Black-winged Stilt Himantopus himantopus, Little Grebe Tachybaptus ruficollis and Indian River Tern Sterna aurantia.[104] The migratory birds mostly consist of members of the Family Anatidae, which includes ducks and geese.

At least 15 species of ducks and geese have been reported from the Mangla Reservoir, Tanda dam and Poonch River. These include Common Teal Anas crecca, Common Pochard Aythya ferina, Mallard Anas platyrhynchos, Northern Pintail Anas acuta, Eurasian Wigeon Anas penelope, White-eyed Pochard Aythya nyroca, Common Shelduck Tadorna tadorna, Ruddy Shelduck Tadorna ferruginea and Bar-Headed Goose Anser indicus.

All the ducks are listed as Least Concern in the IUCN Red List while White-eyed Pochard Aythya nyroca is a listed as Near Threatened. This waterfowl has been reported from in and around Poonch River. It is winter visitor and passage migrant and irregular year around visitor. The Bar-headed Goose Anser indicus which is also a rare winter visitor to Pakistan has been reported from Poonch River in good numbers. Common Teal Anas crecca is the most abundant migratory water bird in AJK and more than 10,000 birds annually visit the wetlands of the valley (Azam and Rasool, 2012).

Surveys were conducted in October 2013 and December 2013 to gain information about the bird abundance and diversity in the Study Area.

Sampling points are indicated in **Exhibit 2.2** and **Exhibit 2.3** in the Methodology Section (**Section 2**) of this report.

Data collected during this study is included in **Exhibit A.4** in **Appendix A**.

Exhibit 9.1 provides a summary of sampling points by habitat type, number of sightings, and number of species sighted during the October 2013 and December 2013 surveys. Sampling was conducted at 26 points, of which 5 were in Agricultural Fields, 5 in Pine Forest, 8 in Riverbank/Riparian and 8 in Scrub Forest. On the basis of the topographical features, habitats of the Study Area were divided into four types, i.e. Agricultural Fields, Pine Forest, Riverbank/Riparian and Scrub Forest. In December 2013 Sampling was conducted at 3 sampling points in Scrub Forest.

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[103] Bird Life International website. Accessed on 4 September. http://avibase.bsc-eoc.org/checklist.jsp?region=PKjk&list=howardmoore

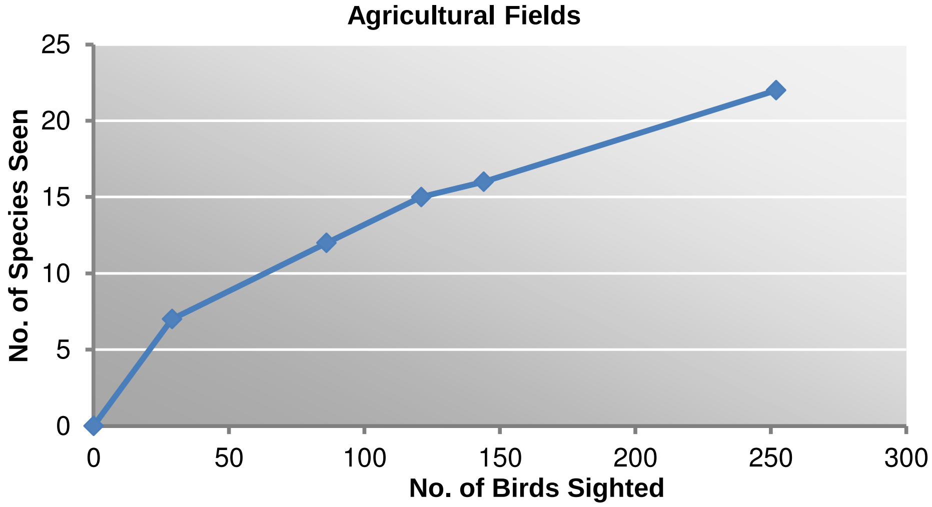
[104] Azam, M.M.and Rasool, G. 2010-2012. Mid-winter Waterfowl Census Report of Mangla Reservoir, Tanda Dam and Poonch River. Unpublished report of WWF-P and ZSD.

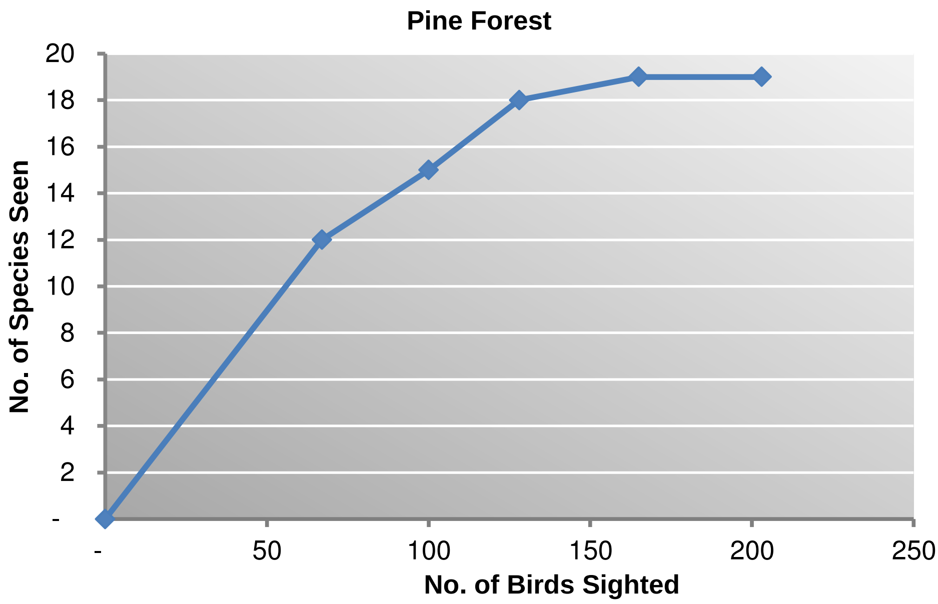
Exhibit 9.2 presents species accumulation curves (SAC) from the October 2013 survey for the four habitat types: Agricultural Fields, Pine Forest, Riverbank/Riparian and Scrub Forest. The curve for Pine Forest and Riverbank/Riparian levelled off and reached saturation indicating adequacy of sampling effort. However, the curves for Agricultural Fields and Scrub Forest did not level off and reach saturation indicating that more sampling was needed in each habitat type. To compensate for any inadequacy in sampling, a literature review of the avi-fauna of the Poonch River basin was completed. Special emphasis was given to the birds of conservation importance.

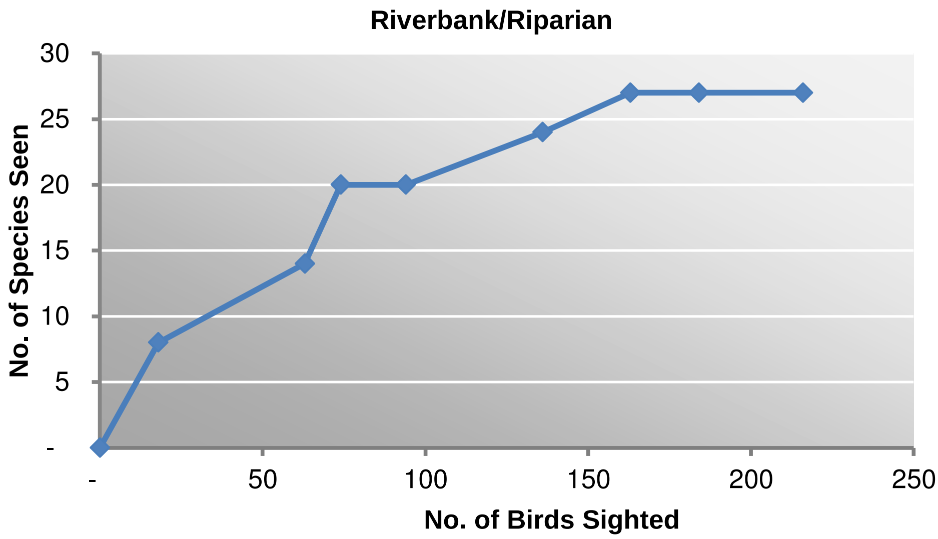
Exhibit 9.1: Bird Abundance and Diversity by Habitat Type
Surveys October 2013 and December 2013

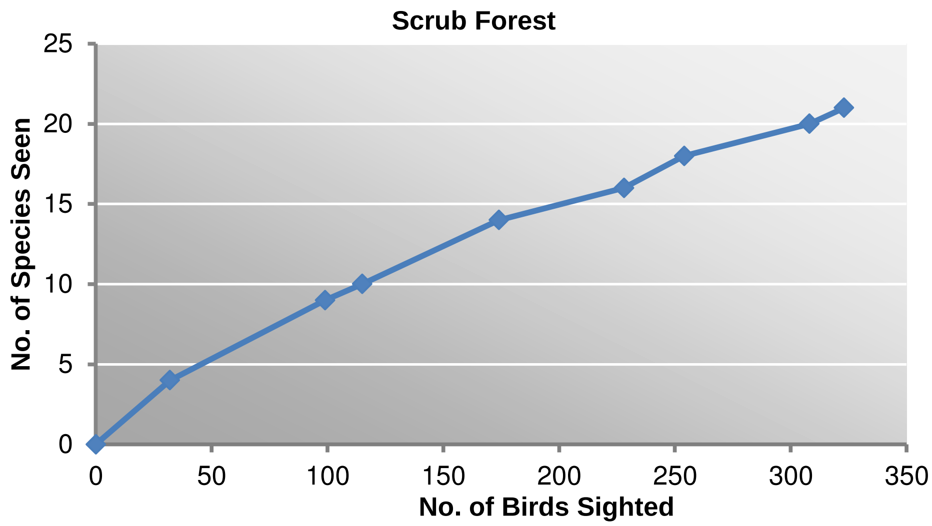
Habitat	*No of. Sampling Points*	*Abundance (Total Sightings)*	*Density (No of Sightings per Sampling Point)*	*Diversity (No. of Species)*
October 2013				
Agricultural Fields	5	252	50.40	22
Pine Forest	5	203	40.60	19
Riverbank/Riparian	8	197	24.63	24
Scrub Forest	8	323	40.38	31
Total	**26**	**975**		
December 2013				
Scrub Forest	3	165	55	23
Total	**3**	**165**	**55**	

Exhibit 9.2: Species Accumulation Curves for October 2013 Survey in Study Area in Habitat Types




Pine Forest
No. of Species Seen
No. of Birds Sighted
20
18
16
14
12
10
8
6
4
2
-
-
50
100
150
200
250


Riverbank/Riparian
No. of Species Seen
No. of Birds Sighted
30
25
20
15
10
5
-
-
50
100
150
200
250



9.1 Results and Discussion

9.1.1 October 2013 Survey

A total of 975 birds belonging to 45 species were observed during the October 2013 ecological survey. Dominant bird species seen in the Study Area included Jungle Babbler Turdoides striata with 177 individuals observed, followed by Common Myna Acridotheres tristis, House Sparrow Passer domesticus and Himalayan Bulbul Pycnonotus leucogenys with 119, 94 and 92 individuals observed respectively.

The spatial distribution of bird abundance and diversity in the Aquatic and Terrestrial Study Area is shown in **Exhibit 9.3** and **Exhibit 9.4** respectively. The highest bird abundance seen during the October 2013 survey was at Sampling Point S10. A total of 108 birds were seen at this sampling point that was located in Agricultural Fields. The presence of adequate food, water and shelter were the likely reasons for the high bird abundance seen here. The Common Myna Acridotheres tristis was the most commonly seen bird at this location. High bird abundance was also seen at some other sampling points during the October 2013 survey including Sampling Point S1, S18 and S16. The least abundance during October 2013 survey was seen at Sampling Point A3 in Riverbank/Riparian where only eleven (11) birds were sighted.

The highest bird diversity seen during the October 2013 survey was at Sampling Point S16 where 16 bird species were observed. The House Crow Corvus splendens was the most commonly observed bird at this location. The second highest bird diversity was observed at Sampling Point S10 where 14 bird species were observed. The Common Myna Acridotheres tristis was the most commonly seen bird at this location. The least diversity observed during the October 2013 survey was at Sampling Points S 18 where only 3 bird species were sighted.

9.1.2 December 2013 survey

During December 2013 survey, 3 locations were sampled in Scrub Forest habitat. A total of 165 birds belonging to 23 species were observed. Maximum bird abundance was seen at Sampling Point D2, while the minimum bird abundance was seen at Sampling Point D3.

Abundant bird species of observed during the December 2013 survey included Jungle Babbler Turdoides striata followed by Common Myna Acridotheres tristis, Himalayan Bulbul Pycnonotus leucogenys Great Tit Parus major and Red-vented Bulbul Pycnonotus cafer.

Exhibit 9.3: Bird Abundance and Diversity in Aquatic Study Area, Survey conducted October 2013

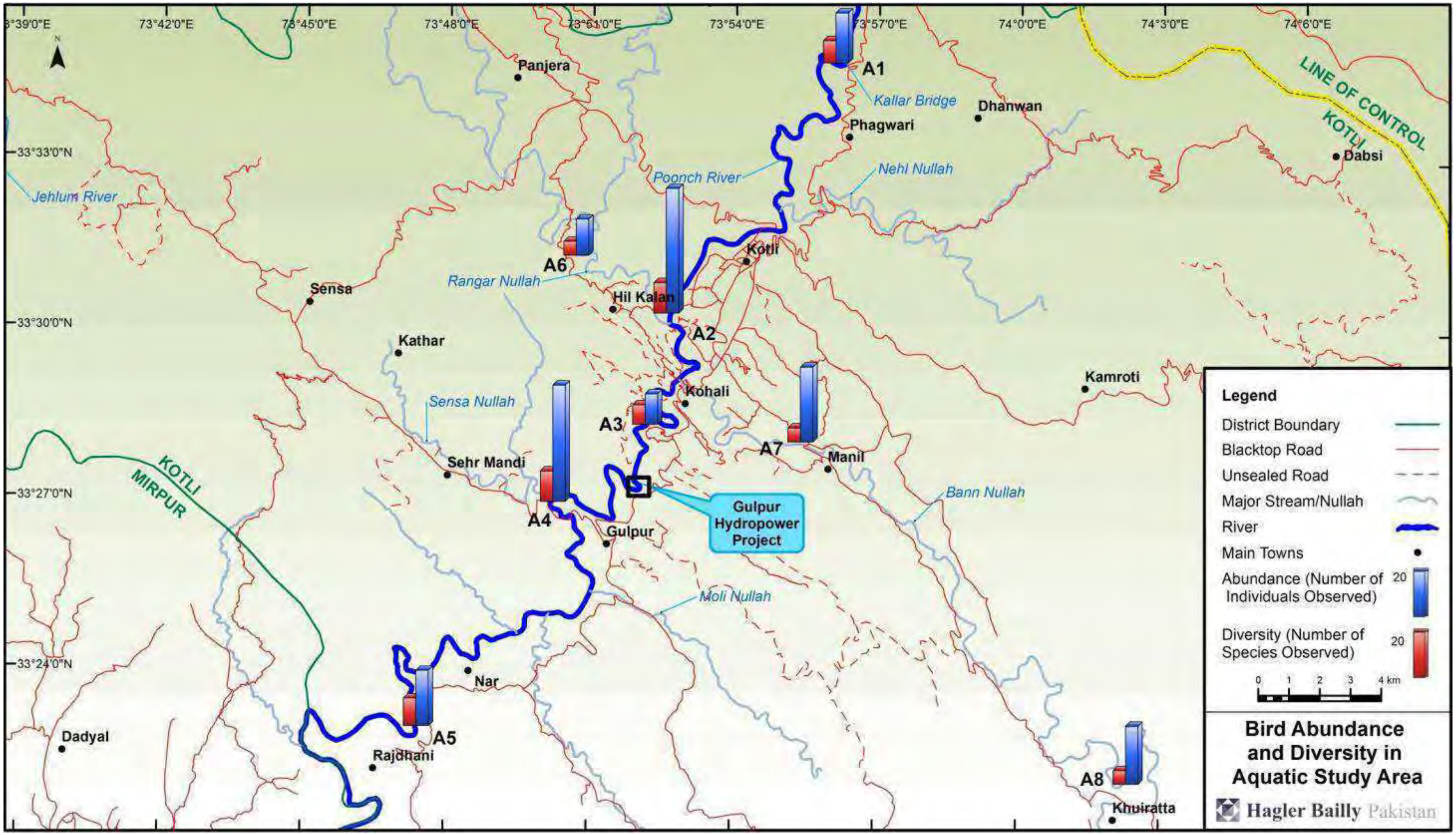


Exhibit 9.4: Bird Abundance and Diversity in Terrestrial Study Area, Survey conducted October 2013

9.2 Species Sighted and Habitat Affinities

Exhibit B.3 in **Appendix B** provides a list of birds observed in the Study Area during the survey of October 2013.

Exhibit 9.5 provides details of the number of birds of each species sighted in each habitat type in the Study Area during October 2013 survey. **Exhibit 9.6** provides details of the number of birds of each species sighted in each habitat type in the Study Area during December 2013 survey

During the October 2013 survey a total of a total of 975 individuals belonging to 45 bird species were observed along 26 sampling points in the four habitat types in the Study Area.

During December 2013 survey, 3 locations were sampled in Scrub Forest habitat. A total of 165 birds belonging to 23 bird species were observed.

Agricultural Fields

During the October 2013 survey, a total of 252 individuals belonging to 22 bird species were observed in the Agricultural Fields (**Exhibit 9.1**). Of the observed species, 4 were unique to the Agricultural Fields and not seen in other habitats. Density observed (50 individuals sighted/sampling point) was more than that seen in all other habitats (**Exhibit 9.1**). The most abundantly seen bird was the Common Myna Acridotheres tristis with a total of 48 individuals seen during October 2013 survey followed by House Sparrow Passer domesticus, Himalayan Bulbul Pycnonotus leucogenys and Jungle Babbler Turdoides striata with counts of 38, 36 and 35 respectively. The species unique to the Agricultural Fields and not observed in other habitats were Barn Swallow Hirundo rustica, Common Tailorbird Orthotomus sutorius, Graceful Prinia Prinia gracilis and Sirkeer Malkoha Phaenicophaeus leschenaultii.

Pine Forest

During the October 2013 survey, a total of 203 individuals belonging to 19 bird species were observed in the Pine Forest (**Exhibit 9.1**). Of the observed species, 4 were unique to the Pine Forest and not seen in other habitats. Density (41 individuals/sampling point) was less than Agricultural Fields but was more than Riverbank/Riparian and Scrub Forest (**Exhibit 9.1**). Jungle Babbler Turdoides striata was the most abundant species with total count of 53 birds in the Pine Forest. This was followed by House Sparrow Passer domesticus and Common Myna Acridotheres tristis with counts 38 and 23, respectively. The species unique to the Pine Forest and not observed in other habitats were Brownish-flanked Bush Warbler Cettia fortipes, Grey-sided Bush Warbler Cettia brunnifrons, Himalayan Woodpecker Dendrocopos himalayensis and Indian Peafowl Pavo cristatus. Asian Koel Eudynamys scolopaceus, Common Hoopoe Upupa epops and Indian Peafowl Pavo cristatus were the least common birds observed only once in the Pine Forest.

Scrub Forest

During the October 2013 survey, a total of 323 individuals belonging to 31 bird species were observed in the Scrub Forest (**Exhibit 9.1**). Of these, eight (08) species were unique to the Scrub Forest. The bird density observed (40 individuals/sampling points) was less than that of seen in Agricultural Fields and Pine Forest but was more than that seen in Riverbank/Riparian (**Exhibit 9.1).** Egyptian Vulture Neophron percnopterus was the most abundant species with total count of 50 birds in the Scrub Forest. This was followed by Jungle Babbler Turdoides striata and Common Myna Acridotheres tristis with counts of 48 and 33 respectively. The species unique to the Scrub Forest and not observed in other habitats were Blue Whistling Thrush Myophonus caeruleus, Eurasian Blackbird Turdus merula, Lesser Whitethroat Sylvia curruca, Long-billed Pipit Anthus similis, Rufous Backed Shrike Lanius schach Scaly-breasted Munia Lonchura punctulata Trumpeter Finch Bucanetes githagineus and White eyed Buzard Butastur teesa. The least common birds observed only once in the Scrub Forest include Asian Koel Eudynamys scolopaceus, Blue Whistling Thrush Myophonus caeruleus, Common Hoopoe Upupa epops, Hill Pigeon Columba rupestris, Rufous backed Shrike Lanius schach, White eyed Buzzard Butastur teesa and White Wagtail Motacilla alba.

During the December 2013 survey, all the three sampling points surveyed were in the Scrub Forest. Abundant bird species of observed during the December 2013 survey included Jungle Babbler Turdoides striata followed by Common Myna Acridotheres tristis, Himalayan Bulbul Pycnonotus leucogenys Great Tit Parus major and Red-vented Bulbul Pycnonotus cafer.

Riverbank/Riparian

During the October 2013 survey, a total of 197 individuals belonging to 24 bird species were observed in the Riverbank/Riparian (**Exhibit 9.1**). Of these, four (04) species were unique to the Riverbank/Riparian. The bird density observed (25 individuals/sampling points) was less than that seen in all other habitats of the Study Area (**Exhibit 9.1).** Jungle Babbler Turdoides striata was the most abundant species with total count of 41 birds in the Riverbank/Riparian. This was followed by Jungle Crow Corvus macrorhynchos and Himalayan Bulbul Pycnonotus leucogenys with count 18 each. The species unique to the Riverbank/Riparian and not observed in other habitats were Black Redstart Phoenicurus ochruros, Indian Robin Saxicoloides fulicatus, Isabelline Wheatear Oenanthe isabellina and White-capped Redstart Chaimarrornis leucocephalus. White-rumped Vulture Gyps bengalensis was the least common bird observed only once in the Riverbank/Riparian.

Exhibit 9.5: Number of Birds of each Species Sighted by Habitat Type in the Study Area. Survey Conducted October 2013

No	*Common Names*	*Scientific Names*	*Habitat*				
			Agricultural Fields	*Pine Forest*	*Riverbank/ Riparian*	*Scrub Forest*	***Total***
1.	Asian House Martin	*Delichon dasypus*	1	–	–	3	4
2.	Asian Koel	*Eudynamys scolopaceus*	–	1	–	1	2
3.	Barn Swallow	*Hirundo rustica*	5	–	–	–	5
4.	Black Drongo	*Dicrurus macrocercus*	3	–	3	3	9
5.	Black Kite	*Milvus migrans*	8	6	8	11	33
6.	Black Redstart	*Phoenicurus ochruros*	–	–	3	–	3

No	Common Names	Scientific Names	Habitat				
			Agricultural Fields	Pine Forest	Riverbank/ Riparian	Scrub Forest	**Total**
7.	Blue Whistling Thrush	*Myophonus caeruleus*	–	–	–	1	1
8.	Brownish-flanked Bush Warbler	*Cettia fortipes*	–	2	–	–	2
9.	Common Chiffchaff	*Phylloscopus collybita*	3	22	6	5	36
10.	Common Hoopoe	*Upupa epops*	1	1	3	1	6
11.	Common Myna	*Acridotheres tristis*	48	23	15	33	119
12.	Common Tailorbird	*Orthotomus sutorius*	2	–	–	–	2
13.	Egyptian Vulture	*Neophron percnopterus*	–	3	12	50	65
14.	Eurasian Blackbird	*Turdus merula*	–	–	–	2	2
15.	Graceful Prinia	*Prinia gracilis*	3	–	–	–	3
16.	Great Tit	*Parus major*	–	–	6	12	18
17.	Grey-sided Bush Warbler	*Cettia brunnifrons*	–	2	–	–	2
18.	Hill Pigeon	*Columba rupestris*	–	–	2	1	3
19.	Himalayan bulbul	*Pycnonotus leucogenys*	36	17	18	21	92
20.	Himalayan Woodpecker	*Dendrocopos himalayensis*	–	4	–	–	4
21.	House Crow	*Corvus splendens*	10	6	2	27	45
22.	House Sparrow	*Passer domesticus*	38	38	–	18	94
23.	Indian Peafowl	*Pavo cristatus*	–	1	–	–	1
24.	Indian Robin	*Saxicoloides fulicatus*	–	–	4	–	4
25.	Indian Roller	*Coracias benghalensis*	4	–	–	3	7
26.	Isabelline Wheatear	*Oenanthe isabellina*	–	–	4	–	4
27.	Jungle Babbler	*Turdoides striata*	35	53	41	48	177
28.	Jungle Crow	*Corvus macrorhynchos*	25	13	18	30	86
29.	Laughing Dove	*Spilopelia senegalensis*	7	5	8	4	24
30.	Lesser Whitethroat	*Sylvia curruca*	–	–	–	2	2
31.	Little green bee eater	*Merops orientalis*	2	–	5	3	10
32.	Long-billed Pipit	*Anthus similis*	–	–	–	3	3
33.	Pied Bush Chat	*Saxicola caprata*	–	2	10	2	14
34.	Red-vented Bulbul	*Pycnonotus cafer*	10	2	–	3	15
35.	Rock Bunting	*Emberiza cia*	–	–	6	5	11

No	Common Names	Scientific Names	Habitat				
			Agricultural Fields	Pine Forest	Riverbank/ Riparian	Scrub Forest	**Total**
36.	Rufous backed shrike	*Lanius schach*	–	–	–	1	1
37.	Rufous Treepie	*Dendrocitta vagabunda*	3	2	3	–	8
38.	Scaly-breasted Munia	*Lonchura punctulata*	–	–	–	10	10
39.	Sirkeer Malkoha	*Phaenicophaeus leschenaultii*	3	–	–	–	3
40.	Stone Chat	*Saxicola rubicola*	3	–	2	–	5
41.	Trumpeter Finch	*Bucanetes githagineus*	–	–	–	2	2
42.	White eyed Buzard	*Butastur teesa*	–	–	–	1	1
43.	White Wagtail	*Motacilla alba*	2	–	2	1	5
44.	White-backed Vulture	*Gyps bengalensis*	–	–	1	16	17
45.	White-capped Redstart	*Chaimarrornis leucocephalus*	–	–	15	–	15
	Total		**252**	**203**	**197**	**323**	**975**

Exhibit 9.6: Number of Birds of each Species Sighted by Habitat Type in the Study Area. Survey Conducted December 2013

No	Scientific Name	Common Name	Scrub Forest	Total
1.	*Delichon dasypus*	Asian House Martin	5	5
2.	*Milvus migrans*	Black Kite	10	10
3.	*Prunella fulvescens*	Brown Accentor	6	6
4.	*Falco tinnunculus*	Common Kestrel	3	3
5.	*Acridotheres tristis*	Common Myna	24	24
6.	*Neophron percnopterus*	Egyptian Vulture	5	5
7.	*Turdus merula*	Eurasian Blackbird	2	2
8.	*Prinia gracilis*	Graceful Prinia	2	2
9.	*Grandala coelicolor*	Grandala	1	1
10.	*Parus major*	Great Tit	15	15
11.	*Pycnonotus leucogenys*	Himalayan bulbul	17	17
12.	*Passer domesticus*	House Sparrow	10	10
13.	*Luscinia brunnea*	Indian blue Robin	1	1
14.	*Turdoides striata*	Jungle Babbler	32	32
15.	*Corvus macrorhynchos*	Jungle Crow	6	6

No	Scientific Name	Common Name	Scrub Forest	Total
16.	*Phalacrocorax sulcirostris*	Little Black Cormorant	2	2
17.	*Falco columbarius*	Merlin	1	1
18.	*Falco peregrinus*	Peregrine Falcon	1	1
19.	*Prinia inornata*	Plain prinia	2	2
20.	*Pycnonotus cafer*	Red-vented Bulbul	14	14
21.	*Lanius schach*	Rufous backed shrike	1	1
22.	*Dendrocitta vagabunda*	Rufous Treepie	4	4
23.	*Aquila nipalensis*	Steppe eagle	1	1
		Total	**165**	**165**

9.3 Important Bird Areas

The Important Bird Areas (IBAs)[105] are designated by Birdlife International in different countries of the world and are key sites for conservation – small enough to be conserved in their entirety and often already part of a protected-area network. They do one (or more) of three things:

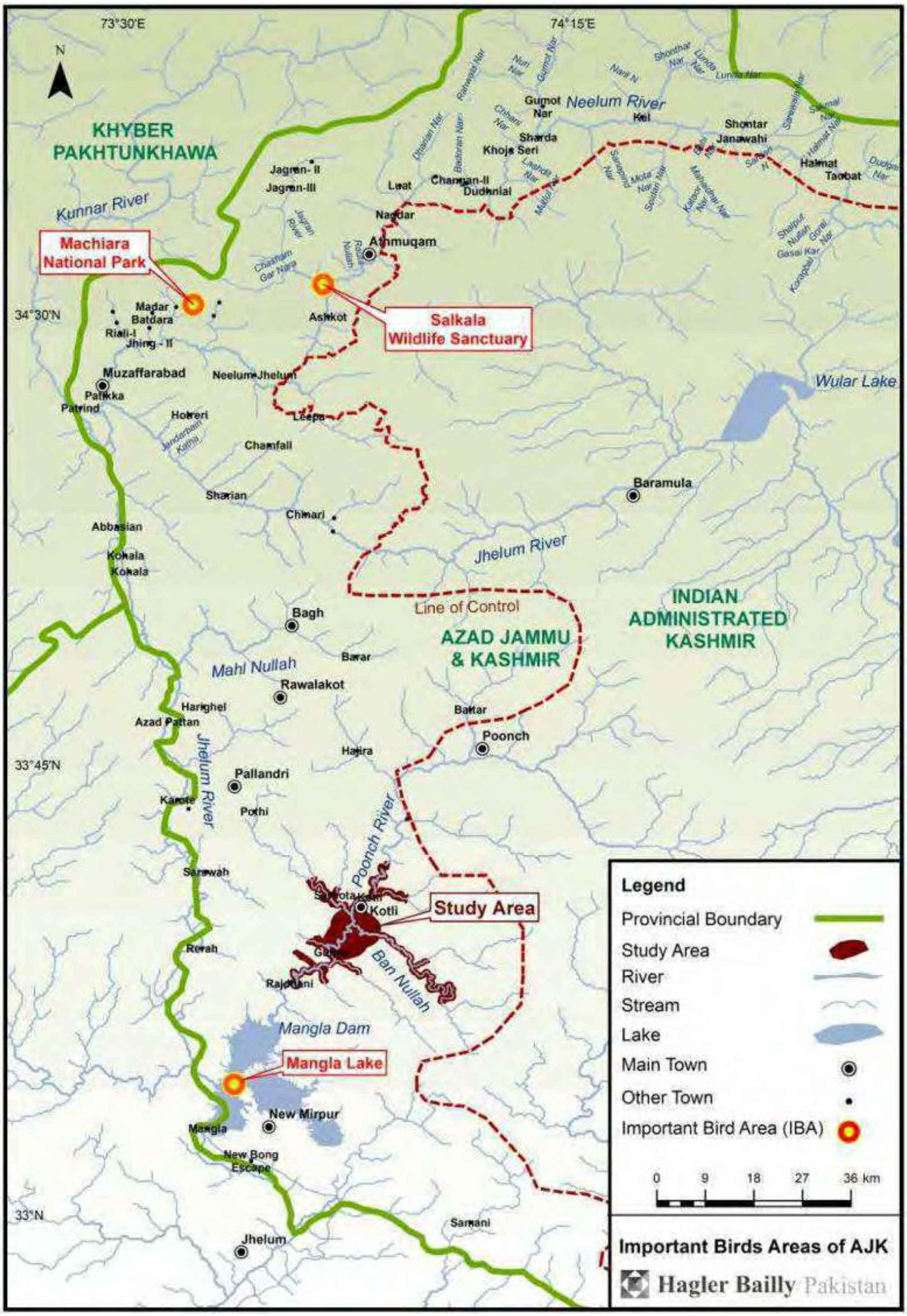
- Hold significant numbers of one or more globally threatened species
- Are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species
- Have exceptionally large numbers of migratory or congregatory species

The location of some of the IBAs identified in AJK[106] are indicated on a map in **Exhibit 9.7**. The only IBA in the vicinity of the Study Area is the Mangla Lake. This wetland comprising an area of 26,500 hectares is located in the Mirpur district of AJK. The congregatory water birds found here include Mallard Anas platyrhynchos, Common Teal Anas crecca, Common Pochard Aythya ferina and Tufted Duck Aythya fuligula. The species included in the IUCN Red List 2013 is the Marbled Teal Marmaronetta angustirostris that is listed as Vulnerable (Birdlife International 2013).

[105] Birdlife International official website. http://www.birdlife.org/action/science/sites/index.html. Downloaded on 5 December 2012.

[106] Birdlife International Official Website http://www.birdlife.org/datazone/userfiles/file/IBAs/AsiaCntryPDFs/Pakistan.pdf

Exhibit 9.7: Location of some of the Important Bird Areas in AJK



Source: Map adapted from Birdlife International Official Website
http://www.birdlife.org/datazone/userfiles/file/IBAs/AsiaCntryPDFs/Pakistan.pdf

9.4 Importance of Study Area for Migratory Birds

Pakistan gets a large number of guest birds from Europe, Central Asian States and India every year. These birds that originally reside in the northern states spend winters in various wetlands and deserts of Pakistan from the high Himalayas to coastal mangroves and mud flats in the Indus delta. After the winter season, they go back to their native habitats.

This famous route from Siberia to various destinations in Pakistan over Karakorum, Hindu Kush, and Suleiman Ranges along Indus River down to the delta is known as International Migratory Bird Route Number 4. It is also called the Green Route or more commonly the Indus Flyway, one of the important migratory routes in the Central Asian - Indian Flyway[107] (**Exhibit 9.8**). The birds start on this route in November. February is the peak time and by March they start flying back home. These periods may vary depending upon weather conditions in Siberia and/or Pakistan. As per an estimate based on regular counts at different Pakistani wetlands, between 700,000 and 1,200,000 birds arrive in Pakistan through Indus Flyway every year.[108] Some of these birds stay in the lakes but majority migrate to coastal areas.

Even though there are some migratory birds reported from the Study Area, the major staging ground for these birds is the Mangla Lake or Mangla Reservoir. According to preliminary investigations undertaken during the October 2013 survey, most of the migratory birds do not use the Study Area as a breeding and nesting area but merely as a resting ground on their way to the Mangla Lake where greater food and habitat is available.

[107] Convention on the Conservation of Migratory Species. 1 February 2006. Central Asian Flyway Action Plan for the Conservation of Migratory Waterbirds and their Habitats. New Delhi, 10-12 June 2005: UNEP/CMS Secretariat.

[108] Pakistan Wetlands Programme. 2012. Migratory Birds Census Report.

Exhibit 9.8: Asian Migratory Bird Flyways

Source: http://alaska.fws.gov/media/avian_influenza/ak-flyway2.gif U.S. Fish and Wildlife Service/Alaska] |Author=U.S. Fish and Wildlife Service |Date=2008

9.5 Birds of Conservation Importance

Two of the bird species reported from the Study Area are included in the IUCN Red List 2013[109]. These are the White-backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus listed as Critically Endangered and Endangered respectively. Two bird species, Black Kite Milvus migrans and White eyed Buzzard Butastur teesa are included in CITES Appendix II.

Vultures have suffered a rapid population decline in India and Pakistan resulting from poisoning by the veterinary drug Diclofenac combined with several long-term declines in Europe and West Africa (BirdLife International 2011)[110].

During the October 2013 surveys, vultures were seen concentrated near Kotli city's waste dumping site and the waste outlet of Kotli slaughter house, both of which are located near Sampling Point S18. According to information collected during the October 2013 survey, the breeding area for most of the vulture population is inside the Pir Lasura National Park located about 12 km from the Study Area. However, many of them feed and rest in the hills in the vicinity of the Study Area particularly near Sampling Point S18, at the confluence of Poonch River and Ban Nullah (**Exhibit 9.9)**.

A total of two (02) vulture nests were found in the Study Area at Sampling Point S1 and S18. The spatial distribution of these nests is shown in **Exhibit 9.9**.

Photographs of vultures and their nests seen in the Study Area are shown in **Exhibit 9.10.**

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[109] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 11 October 2013

[110] BirdLife International and Durham University (2011) Species factsheet: *Neophron percnopterus*. Downloaded from http://www.birdlife.org on 18th October 2011.

Oriental White-backed Vulture or White-rumped Vulture *Gyps bengalensis*

This is the smallest of the Gyps vultures found in Pakistan and AJK. Its population has been decimated by the widespread use of the anti-inflammatory drug Diclofenac on livestock which if scavenged causes renal failure in the vultures (Grimmett 2008)[111]. It is now an uncommon resident in the plains and is close to extirpation in Pakistan and AJK. It is therefore listed as Critically Endangered in the IUCN Red List 2013 and placed in Appendix II of the CITES Species List[112]. A total of 17 specimens of the White-backed Vulture Gyps bengalensis were seen in the Study Area at Sampling Points A2, S17 and S18. It was not seen during December 2013 survey.

Egyptian Vultures *Neophron percnopterus*

This is a small vulture with long, pointed wings, small and pointed head, and wedge shaped tail (Grimmett 2008). The Egyptian Vulture Neophron percnopterus is distributed over south-western Europe and northern Africa to southern Asia, but is rapidly declining in large parts of it range. In the case of southern Asia, this has been attributed to the widespread use of Diclofenac in veterinary medicine. Diclofenac enters the food chain of the vulture when it scavenges on treated livestock. As a result, the birds die of renal failure (Oaks et al 2004)[113]. It is listed as Endangered in the IUCN Red List 2013 and placed in Appendix II of the CITES Species List. 65 specimens of the Egyptian Vulture Neophron percnopterus were seen in the Study Area during the October 2013survey at Sampling Points A2, A3, A5, A4, A7, A8, S1, S12, S15, S16, S 17 and S18, while it was seen at Sampling Points D-1, D-2 and D-3 during December 2013 survey.

Black Kite *Milvus migrans*

Adults of this species have a pale band across the upper wings while juvenile birds have broad whitish streaking on the head and under-parts. (Grimmett 2008). Black Kite Milvus migrans is included in Appendix II of the CITES Species List. During the October 2013 survey, it was seen at Sampling Points S1, S2, S4, S6, S9, S11, S12, S16, S17, A1, A3, A5, A7 and A8 during the October 2013 survey. It was seen at all three (3) sampling points - D1, D2 and D3, during the December 2013 Survey.

White eyed Buzzard *Butastur teesa*

The species has long and slim wings and an elongated tail. It becomes very noisy during the breeding season (Grimmett 2008). White eyed Buzzard Butastur teesa is included in Appendix II of the CITES Species List. It was seen at Sampling Point S16 during October 2013 survey but was not observed during the December 2013 survey.

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[111] Grimmett, R., Roberts, T., and Inskipp, T. 2008. Birds of Pakistan, Yale University Press.

[112] UNEP-WCMC. 20 October, 2013. UNEP-WCMC Species Database: CITES-Listed Species

[113] Oaks, J. L., Gilbert, M., Virani, M. Z., Watson, R. T., Meteyer, C. U., Rideout, B.A., Shivaprasad, H. L., Ahmad, S., Chaudhry, M. J. I., Arshad, M., Mahmood, S., Ali, A. and Khan, A. A. (2004) Diclofenac residues as the cause of population decline of White-backed Vultures in Pakistan. *Nature* 427: 630-633.

Exhibit 9.9: Spatial Distribution of Vultures in the Study Area, Survey Conducted October 2013

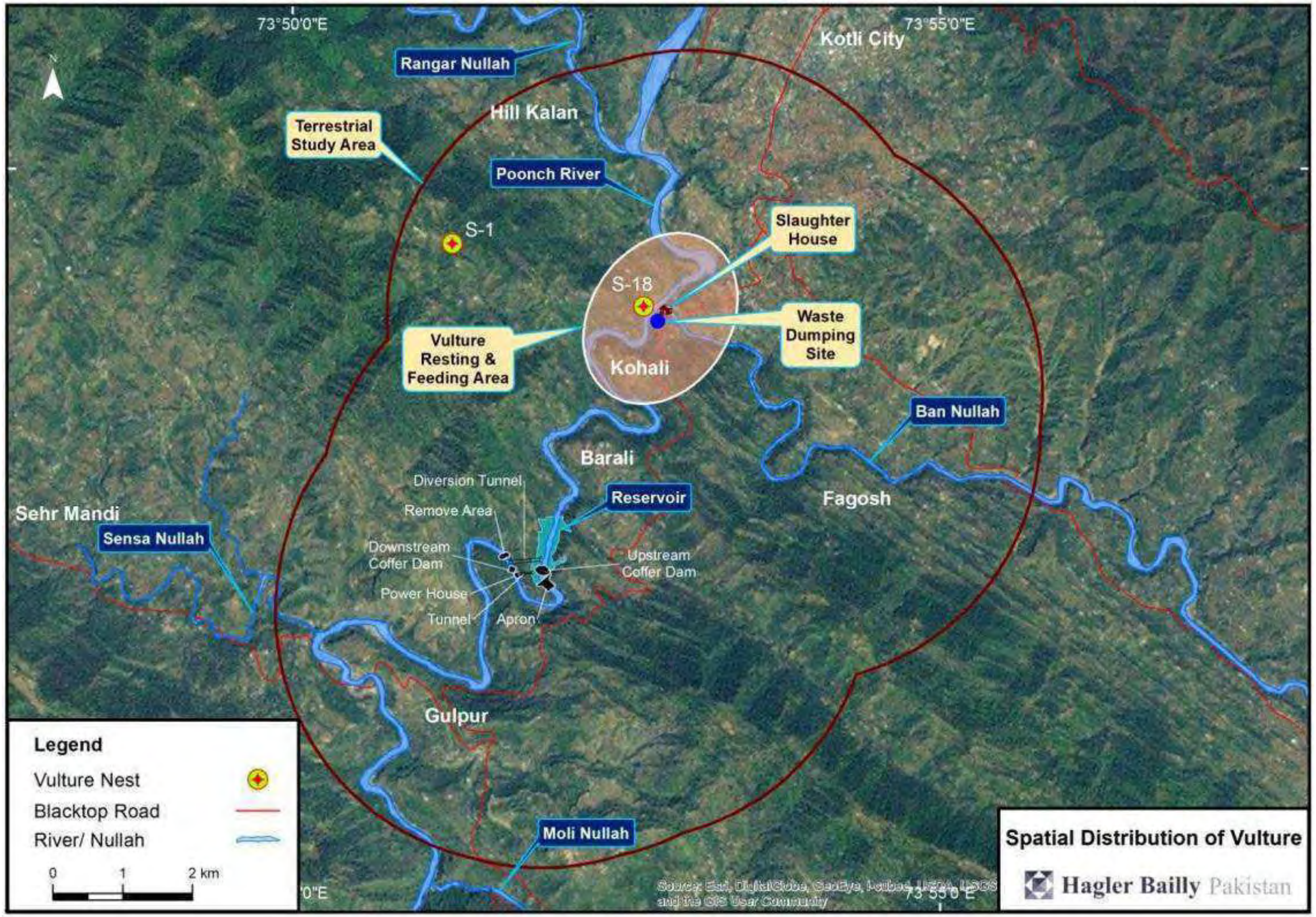

Exhibit 9.10: Photographs of Vultures and Vulture Nests in the Study Area
Survey Conducted October 2013

Vulture Nest on a Pine Tree at Sampling point S1

Egyptian Vulture Neophron percnopterus at Sampling Point S18

Egyptian Vulture Neophron percnopterus at the Garbage dumping site near S18

White-backed Vulture Gyps bengalensis near Sampling point S17

10. Conclusion

The Gulpur Hydropower Project with design capacity of 100 MW will use the water resources of the Poonch River for power generation. The Project site is located in Kotli District, Azad Jammu and Kashmir. The Project's major components include weir, intake structure and power house. All the project structures will be located near Barali on the Poonch River at about 11 km downstream of Kotli Town and about 6 km downstream of the confluence of Ban Nullah with the Poonch River. A low flow section of a length of about 700m will be created downstream of the weir to the outlet of the powerhouse.

The Study Area for sampling the aquatic resources consists of the stretch of Poonch River from Kallar Bridge to just downstream Rajhdani as well as the main tributaries of the River including Ban Nullah, Rangar Nullah and Nehl Nullah. The Study Area for sampling of the terrestrial ecological resources consists of the Project facilities such as power house, weir, camping sites etc. as well as a 3 km potential impact zone around each facility that may be impacted by Project related activities such as habitat loss, sound, vibrations etc. The term 'Ecological Study Area' or simply 'Study Area' is used to jointly refer to both the Aquatic and Terrestrial Study Areas

Sampling points in each habitat type for the terrestrial surveys conducted are listed in **Exhibit 10.1**. Habitats were classified depending upon the vegetation type (and other abiotic) characteristics. Biotic factors (both flora and fauna), within habitats, were assessed to determine baseline biodiversity information and to describe the ecological conditions, as well as, to determine if there were any critical habitat, threatened species, and/or species with conservation importance. There are four habitats in the Terrestrial Study Area. They are Agricultural Fields, Pine Forest, Scrub Forest and Riverbank/Riparian. During the October 2013 survey, sampling was carried out in all four habitats while during the December 2013 survey, sampling was only carried out in the Scrub Forest. During May 2014 survey sampling was carried out only for vegetation at three locations in the Scrub Forest (same locations as December 2014 survey).

Sampling points for the aquatic resources of the Study Area are listed in the **Exhibit 10.2.** During the October 2013 survey, sampling was conducted at eight locations for fish and macro-invertebrates. During the December 2013 survey, sampling for Otter sightings and signs was conducted at six locations and sampling for fish was conducted at 4 locations. During the May 2014 survey, fish sampling was carried out at nine sampling locations, five sites that were sampled in the October 2013 survey and four additional sites.

Exhibit 10.1: Terrestrial Sampling Points for Each Habitat Type, Surveys Conducted October 2013, December 2013 and May 2014

Habitat	*Vegetation*	*Mammals*	*Birds*	*Reptiles*	*Small Mammals*
October 2013					
Agricultural Fields	5	5	5	5	2
Pine Forest	5	5	5	5	2
Scrub Forest	8	8	8	9	2
Riverbank/Riparian	8	8	**8**	8	1
Total	**26**	**26**	**26**	**27**	**7**
December 2013					
Scrub Forest	3	3	**3**	–	1
Total	**3**	**3**	**3**	**–**	**1**
May 2014					
Scrub Forest	3	–	–	–	–
Total	**3**	**–**	**–**	**–**	**–**

Exhibit 10.2: Aquatic Sampling Points for Surveys Conducted in October 2013, December 2014 and May 2014

Species	*Fish*	*Otter*	*Macro-invertebrate*
October 2013	8	–	8
December 2013	4	6	–
May 2014	9	–	–

10.1 Habitat Types and Ecological Characteristics

Agricultural Fields

Agriculture Fields are the most dominant habitat, constituting 35% of the habitat of the Study Area (**Exhibit 6.2**). The agricultural fields mostly lie in the plains. The range of vegetation cover in this habitat during October 2013 survey was from 0.5% to 16.5%, while average plant count was 33. The floral diversity and density observed in this habitat are higher than recorded in Riverbank/Riparian but lower than that observed in Scrub Forest and Pine Forest. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The dominant plant species in this habitat as reflected by the Importance Value Index were Broussonetia papyrifera, Parthenium hysterophorus, Dalbergia sissoo and Malvastrum coromandelianum **(Exhibit 6.6)**.

During the October 2013 Survey Common Red Fox Vulpes vulpes was the only large mammal species observed in Agriculture Fields. Signs of this species were also seen in this habitat (**Exhibit 7.4)**. Of the small mammals, the Indian Grey Mongoose, Herpestes edwardsii was the only species observed in Agriculture Fields. Signs of this species were also seen in this habitat. The small mammal trapping revealed that rodents are abundant in Agriculture Fields. A total of four (04) rodent species were trapped during the October 2013 survey and three (03) of these were trapped in Agriculture Fields. Indian Field Mouse Mus Booduga was the most abundantly trapped rodent species.

During the October 2013 Survey a total of 36 herpeto-faunal individuals belonging to 8 species were sighted in Agricultural Fields. The most widespread and abundant species of Agricultural Fields was the Agror Valley Agama Laudakia agrorensis followed by Striped Grass Skink Eutropis dissimilis and Punjab Snake-eyed Lacerta Ophisops jerdonii. The species Ornamented Pygmy Frog Microhyla ornata was unique to this habitat (**Exhibit 8.3**).

During October 2013 Survey a total of 252 bird individuals belonging to 22 species were observed in the Agricultural Fields. Of the observed species, 4 were unique to the Agricultural Fields and not seen in other habitats. Bird density observed (50 individuals sighted/sampling point) was more than that seen in all other habitats (**Exhibit 9.1**). The most abundantly seen bird was the Common Myna Acridotheres tristis followed by House Sparrow Passer domesticus, Himalayan Bulbul Pycnonotus leucogenys and Jungle Babbler Turdoides striata. The species unique to the Agricultural Fields and not observed in other habitats were Barn Swallow Hirundo rustica, Common Tailorbird Orthotomus sutorius, Graceful Prinia Prinia gracilis and Sirkeer Malkoha Phaenicophaeus leschenaultii.

Pine Forest

Pine Forest is the second most abundant habitat, constituting 30% of the total habitat of the Study Area (**Exhibit 6.2**). This habitat is characterized by vegetation dominated by Pine trees. The range of vegetation cover in this habitat during October 2013 survey was from 1.9% to 25.9% while average plant count was 199. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The floral diversity and density observed in this habitat was highest among all habitats of the Study Area. The dominant plant species in this habitat as reflected by the Importance Value Index were Imperata cylindrical, Pinus roxburghii, Dalbergia sissoo and Dodonaea viscosa 5.61
(Exhibit 6.6).

Among large and medium sized mammals, the Common Red Fox Vulpes vulpes was observed in Pine Forest during October 2013 Survey. Signs of Asiatic Jackal Canis aureus and Common Red Fox Vulpes vulpes were also seen in this habitat. The Common Red Fox Vulpes vulpes was most abundant species seen in Pine Forest (**Exhibit 7.4)**. Among the small mammals, the Indian Grey Mongoose, Herpestes edwardsii was seen in Pine Forest. Signs of Indian Grey Mongoose, Herpestes edwardsii and Indian Crested Porcupine Hystrix indica were also seen in this habitat. Three rodent species were captured from this habitat. These were House Mouse Mus Musculus House Shrew Suncus Murinus and Indian Field Mouse Mus Booduga.

During October 2013 Survey a total of 66 reptiles and amphibian individuals belonging to 9 species were seen in the Pine Forest. The most abundant species was the Skittering Frog Euphlyctis cyanophlyctis with a total of 35 individuals seen in this habitat followed by the Agror Valley Agama Laudakia agrorensis and Punjab Snake-eyed Lacerta Ophisops jerdonii (**Exhibit 8.3**).

A total of 203 bird individuals belonging to 19 species were observed in the Pine Forest during the October 2013 Survey (**Exhibit 9.1**). Of the observed species, 4 were unique to the Pine Forest and not seen in other habitats. Bird density (41 individuals/sampling point) was less than Agricultural Fields but was more than Riverbank/Riparian and Scrub Forest (**Exhibit 9.1**). Jungle Babbler Turdoides striata was the most abundant bird species Pine Forest followed by House Sparrow Passer domesticus and Common Myna Acridotheres tristis. The species unique to the Pine Forest and not observed in other habitats were Brownish-flanked Bush Warbler Cettia fortipes, Grey-sided Bush Warbler Cettia brunnifrons, Himalayan Woodpecker Dendrocopos himalayensis and Indian Peafowl Pavo cristatus. The least common birds observed only once in the Pine Forest included Asian Koel Eudynamys scolopaceus, Common Hoopoe Upupa epops and Indian Peafowl Pavo cristatus.

Scrub Forest

Scrub Forest constitutes 28% of the total habitat of the Study Area (**Exhibit 6.2**). This habitat is characterized by vegetation dominated by shrubs with some trees, grasses and herbs. The range of vegetation cover in this habitat during October 2013 survey was from 0.4% to 15% while average plant count wass 43. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 6.5**). The floral diversity and density observed in this habitat was higher than that recorded in Riverbank/Riparian and Agriculture Fields but lower than that observed in Pine Forest. The dominant plant species in this habitat as reflected by the Importance Value Index were Ziziphus mauritiana, Dalbergia sissoo, Parthenium hysterophorus 13.91 and Imperata cylindrical **(Exhibit 6.6)**. During the December 2013 survey, three locations in Scrub Forest were sampled. A total of 13 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 1.5% to 4.3% while average count was 36. The floral diversity in this habitat was 4 species per sampling point. The dominant plant species of this habitat include Dalbergia sissoo, Dodonaea viscosa and Acacia Modesta (**Exhibit 6.5**). During May 2014 survey a total 9 plant species were observed in Scrub Forest. The range of vegetation cover in this habitat during the survey was from 3.9% to 10.1% while the average count was 50. The floral diversity in this habitat was 3 species per sampling point **(Exhibit 6.5).** The dominant plant species in this habitat as reflected by the Important Value Index were dalbergia sisso 34.5, Dodonea viscosa 19.5 and Nerium oleander 13.1 (**Exhibit 6.8**).

During the October 2013 Survey Common Red Fox Vulpes vulpes was the only large mammal species seen in Scrub Forest. Signs of this species were also seen in this habitat (**Exhibit 7.4)**. Of the small mammals, the Indian Grey Mongoose, Herpestes edwardsii was the only species seen in Scrub Forest. Signs of this species were also seen in this habitat. Three rodent species were captured from this habitat. These were House Mouse Mus Musculus House Shrew Suncus Murinus and Indian Field Mouse Mus Booduga. During the December 2013 survey, one specimen each of the Indian Grey Mongoose Herpestes edwardsii and Asiatic Jackal Canis aureus were sighted. Signs of Asiatic Jackal Canis aureus, Fox Vulpes sp.and Indian Grey Mongoose Herpestes edwardsii were observed in this habitat (**Exhibit 7.4).** Among small mammals, two specimens of House Shrew Suncus Murinus were trapped in this habitat.

A total of 84 herpeto-faunal individuals belonging to 13 species were sighted in Scrub Forest during the October 2013 survey. The most widespread and abundant species of Scrub Forest was the Agror Valley Agama Laudakia agrorensis followed by Striped Grass Skink Eutropis dissimilis and Punjab Snake-eyed Lacerta Ophisops jerdonii. The species Sochurek's Saw-scaled Viper Echis carinatus sochureki, Yellow-bellied House Gecko Hemidactylus flaviviridis and Indian Burrowing Frog Sphaerotheca breviceps were unique to this habitat (**Exhibit 8.3**). Since the herpeto-fauna hibernate in the winter months, reptile and amphibian sampling was not conducted during the December 2013 survey.

A total of 323 bird individuals belonging to 31 species were observed in the Scrub Forest during the October 2013 survey. (Of these, eight (08) species were unique to the Scrub Forest. The bird density observed (40 individuals/sampling points) was less than that seen in Agricultural Fields and Pine Forest but was more than that seen in Riverbank/Riparian (**Exhibit 9.1).** Egyptian Vulture Neophron percnopterus was the most abundant species in the Scrub Forest. This was followed by Jungle Babbler Turdoides striata and Common Myna Acridotheres tristis. The bird species unique to the Scrub Forest and not observed in other habitats were Blue Whistling Thrush Myophonus caeruleus, Eurasian Blackbird Turdus merula, Lesser Whitethroat Sylvia curruca, Long-billed Pipit Anthus similis, Rufous Backed Shrike Lanius schach Scaly-breasted Munia Lonchura punctulata Trumpeter Finch Bucanetes githagineus and White eyed Buzard Butastur teesa. The least common birds observed only once in the Scrub Forest include Asian Koel Eudynamys scolopaceus, Blue Whistling Thrush Myophonus caeruleus, Common Hoopoe Upupa epops, Hill Pigeon Columba rupestris, Rufous Backed Shrike Lanius schach, White eyed Buzzard Butastur teesa and White Wagtail Motacilla alba. During the December 2013 survey, 165 birds belonging to 23 bird species were observed in the Scrub Forest (**Exhibit 9.1).** Abundant bird species observed in this habitat included Jungle Babbler Turdoides striata followed by Common Myna Acridotheres tristis, Himalayan Bulbul Pycnonotus leucogenys, Great Tit Parus major and Red–vented Bulbul Pycnonotus cafer.

Riverbank/Riparian

Riverbank/Riparian constitutes 3% of the habitat of the Study Area (**Exhibit 6.2**). The range of vegetation cover observed in this habitat during October 2013 survey was from 0.5% to 10.9% while average count was 25. The floral diversity in this habitat was 2 species per sampling point[114] (**Exhibit 6.5**). The floral diversity and density observed in this habitat was lowest among all habitats of the Study Area. The dominant plant species in this habitat as reflected by the Importance Value Index were Dalbergia sissoo, Parthenium hysterophorus, Saccharum sp and Dodonaea viscosa **(Exhibit 6.6)**.

During the October 2013 Survey signs of Rhesus Monkey Macaca mulatta and Common Red Fox Vulpes vulpes were observed in the Riverbank/Riparian habitat. Signs of Common Red Fox Vulpes vulpes and Cat Felis sp. were also seen in this habitat. The Rhesus Monkey Macaca mulatta was most abundant mammal species seen in

[114] As explained in Section 2, Methodology, the area was sampled by the quadrate method, taking 3 quadrates of 5m x 5m at each sampling site. The first quadrate was taken at the beginning of the quadrate, the second at 250 meters and the third at 500 m.

Riverbank/Riparian (**Exhibit 7.4)**. Among the small mammals, specimens of the Indian Grey Mongoose, Herpestes edwardsii were seen in Riverbank/Riparian. Signs of Indian Grey Mongoose, Herpestes edwardsii and Indian Crested Porcupine Hystrix indica were also seen in this habitat. Two rodent species were captured from this habitat. These were House Mouse Mus Musculus and House Rat Rattus rattus.

During the October 2013 Survey total of 102 individuals belonging to 10 herpeto-faunal species were sighted in River-bank/Riparian habitat. The most abundant species of this habitat was Skittering Frog Euphlyctis cyanophlyctis followed by the Agror Valley Agama Laudakia agrorensis and Swat Green Toad Pseudepidalea p. pseudoraddei. The species BraidedSnake Platyceps rhodorachis and Kashmir Torrent Frog Allopaa barmoachensis were unique to this habitat (**Exhibit 8.3**).

A total of 197 individuals belonging to 24 bird species were observed in the Riverbank/Riparian. Of these, four (04) species were unique to this habitat. The bird density observed (25 individuals/sampling points) was less than that seen in all other habitats of the Study Area (**Exhibit 9.1).** Jungle Babbler Turdoides striata was the most abundant species with total count of 41 birds in the Riverbank/Riparian. This was followed by Jungle Crow Corvus macrorhynchos and Himalayan Bulbul Pycnonotus leucogenys. The species unique to the Riverbank/Riparian and not observed in other habitats were Black Redstart Phoenicurus ochruros, Indian Robin Saxicoloides fulicatus, Isabelline Wheatear Oenanthe isabellina and White-capped Redstart Chaimarrornis leucocephalus. White-rumped Vulture Gyps bengalensis was the least common bird observed only once in the Riverbank/Riparian.

10.2 Fish Fauna

- A total of 37 fish species have been recorded from the Poonch River (**Exhibit 4.1)**[115 116]. The diversity is higher in the area where the River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer.

During the October 2013 survey, a total of 253 fish specimens belonging to 27 fish species were collected. Maximum abundance was observed at Sampling Point A3 where 57 fish specimens were collected followed by A5 where 45 specimens were collected Gangetic Latia Crossocheilus latius was the most abundant fish species collected during October 2013 survey followed by Mahaseer Tor putitora followed by Pakistani Baril Barilius pakistanicus.

During the December 2013 survey fish were not observed in the main river. However, deep pools ranging from 10–20 m were sampled using the gill nets and some large sized fish species were collected including Pakistani Labeo Labeo dyocheilus and Mahaseer Tor putitora.

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115 Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

116 HBP, November 2013, Draft Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

During the May 2014 survey a total of 302 fish specimens belonging to 21 species were collected. Maximum abundance was seen at Sampling Point A11 where 41 fish specimens were collected followed by A5 where 39 fish specimens were collected. Mahaseer Tor putitora was the most abundant species collected during the May 2014 survey. The second most abundant fish was Pakistan Labeo Labeo dyocheilus followed by Gangetic latia Crossocheilus latius.

10.3 Macro-Invertebrates

A total of 37 macro-invertebrate taxa were identified in the Study Area during the October 2013 survey. Some of these were identified up to the genus level while others could only be identified up to family / sub-family level. Abundant macro-invertebrate taxa observed included Chironimidae Choroterpes sp., Stenonema sp. and Chematopsyche sp. The least abundant taxa seen during October 2013 belonged to Family Culicidae and Scirtidae.

10.4 Endangered and Threatened Species

Exhibit 10.3 lists the species with conservation status observed or likely to occur in the Study Area, locations where these species were sighted, and the habitats in which they were sighted.

Vegetation

No threatened plant was determined to be present in the Study Area.

Large Mammals

Two large mammal species of the Study Area that are included in the IUCN Red List 2013[117] are the Common Leopard Panthera pardus and the Common Otter Lutra lutra.

The Common Leopard Panthera pardus is listed as Near Threatened in the IUCN Red List 2013. It is also listed as Critically Endangered in the Pakistan's Mammals National Red List 2006[118], and included in CITES Appendix 1[119]. It was neither seen nor were signs of this species observed in the Study Area during October 2013 survey or December 2013surveys.

The Common Otter Lutra lutra is listed as Near Threatened in the IUCN Red List 2013. It is also listed as Near Threatened in the Pakistan's Mammals National Red List 2006 and included in CITES Appendix I. It was not seen in the Study Area during October 2013 survey. During the December 2013 survey, signs of Otter were observed at the following sampling locations: A1, A3, A4 and Nar area. Otter signs were absent at D1 (Project location) and Sampling Point A5. Three Otters were sighted on 17 February,

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117 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 18 November 2013.

118 Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan

119 UNEP-WCMC. 14 November 2013. UNEP-WCMC Species Database: CITES-Listed Species

2014 by Hagler Bailly's Socio-economic survey team, about 1 km upstream of Sampling Point A4. The otters were sitting on a rock in the River about 3 meters from the left bank.

The mammals of the Study Area included in the Pakistan's Mammals National Red List 2006 include the Common Red Fox Vulpes vulpes. The Common Red Fox was sighted at four sampling points including Sampling Points S10, S1, A7 and S15 during the October 2013 surveys. During the December 2013 survey, signs of Common Red Fox Vulpes vulpes were observed at Sampling Points D-1, D-2 and D-3.

Another member of Family Canidae known to occur in the Study Area is the Asiatic Jackal Canis aureus that is listed as Near Threatened in the Pakistan's Mammals National Red List 2006. It was sighted in the Study Area at Sampling Point S1 during October 2013 survey. During December 2013 survey, it was seen at Sampling Point D-3 as well as sign of this species were seen at Sampling Points D-1, D-2 and D-3.

The Rhesus Monkey Macaca mulatta is listed as Near Threatened in the Pakistan's Mammals National Red List 2006. The Rhesus Monkey was seen at Sampling Point A5 during October 2013 survey but was not observed during the December 2013 survey.

Determination: Two large mammals reported from the Study Area are listed in IUCN Red List 2013. There are some species that are included in the CITES Species List and in the Pakistan Mammals National Red List 2006. However, none of the mammal species observed or reported from the Study Area are endemic, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Small Mammals

None of the small mammals observed or reported from the Study Area are included in the IUCN Red List 2013. The Indian Crested Porcupine Hystrix indica is listed as Near Threatened in the Pakistan's Mammals National Red List. This animal was seen during the October 2013 surveys at Sampling Points S1 and A1 but was not observed during the December 2013 survey.

The Gray Mongoose Herpestes edwardsii is included in Appendix III of the CITES Species List. It was seen during the October 2013 survey at Sampling Points S2, S4, S5, S10, S14, S15 and A3. During December 2013 survey, Gray Mongoose was observed at Sampling Points D-1 and D-3 while signs of this species were observed at Sampling Point D-1.

Determination: No threatened small mammals or endemics were determined to be resident on the Study Area. There are some species of limited conservation concern, but their distribution is widespread.

Herpetofauna

One of the reptile species recorded from Study Area is included in the IUCN Red List 2013. This is the Indian Rock Python Python molurus that is listed as Near Threatened. It is also included in CITES Appendix II. Indian Rock Python Python molurus was not seen during October 2013 survey.

Bengal Monitor Varanus bengalensis is included in CITES Appendix I. It was observed in the Study Area during the October 2013 survey at Sampling Points A2, S6, S7 and S8.

Indian Rat Snake Ptyas mucosus is included in CITES Appendix II. It was observed in the Study Area during the October 2013 survey at Sampling Points S11 and S6.

Central Asian Cobra Naja oxiana is included in CITES Appendix II. It was observed in the Study Area during the October 2013 survey at Sampling Points S9 and S12.

The endemic reptiles and amphibians found in the area include Common Asian Toad Duttaphrynus m. melanostictus, Kashmir Torrent Frog Allopaa barmoachensis, Rohtas Fort Thin-toed Gecko Cyrtopodion rohtasfortai, Kashmir Slender Blindsnake Typhlops madgemintonai, Ahsanul's Wormsnake Typhlops ahsanuli and Kashmir Blindsnake Typhlops diardi platyventris. Of these, only two species were seen during October 2013 survey. Kashmir Torrent Frog Allopaa barmoachensis was seen at Sampling Point A8 and Rohtas Fort Thin-toed Gecko Cyrtopodion rohtasfortai was seen at Sampling Points A3, S6 and S9 during October 2013 survey.

Determination: One herpeto-faunal species is listed in IUCN Red List 2013. There are some CITES listed species and a few endemic species found in the Study Area. However, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Birds

Two bird species found in the Study Area are included in the IUCN Red List 2013. These include the Oriental White-backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus. Two bird species, Black Kite Milvus migrans and White eyed Buzzard Butastur teesa are included in CITES Appendix II.

The Oriental White-backed Vulture Gyps bengalensis is listed as Critically Endangered in the IUCN Red List and placed in Appendix II of the CITES Species List**.** Specimens of this bird were seen in the Study Area during the October 2013 survey at Sampling Points A2, S17 and S18. It was not seen during December 2013 survey.

Egyptian Vulture Neophron percnopterus is listed as Endangered in the IUCN Red List 2013 and placed in Appendix II of the CITES Species List. It was seen in the Study Area at Sampling Points A2, A3, A5, A4, A7, A8, S1, S12, S15, S16, S17 and S18 during October 2013 survey. During December 2013 Survey it was seen at Sampling Points D-1, D-2 and D-3.

Black Kite Milvus migrans is included in Appendix II of the CITES Species List. It was observed at Sampling Points S1, S2, S4, S6, S9, S11, S12, S16, S17, A1, A3, A5, A7 and A8 during October 2013 survey. It was seen at all three (3) sampling points including D1, D2 and D3 during the December 2013 Survey.

White eyed Buzzard Butastur teesa is included in Appendix II of the CITES Species List. It was seen at Sampling Point S16 during October 2013 survey. It was not seen during the December 2013 Survey.

Determination: Two vulture species have been observed in the Study Area. These include the Oriental White-backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus. The vultures observed during the ecological surveys were concentrated near Kotli city's waste dumping site and the waste outlet of Kotli slaughter house, both of which are located near Sampling Point S18. However, these vulture feeding and resting areas are located at least two (2) km from the area where the Project facilities will be constructed. According to preliminary investigations, most of the vultures breed in the Pir Lasura National Park located about 12 km from the Terrestrial

Study Area. Therefore, the Study Area is not critical to the survival of these vulture species.

Fish

Seven (7) fish species observed in the Study Area are listed in IUCN Red List. In addition, there are three (3) species that are endemic to Pakistan besides Kashmir Catfish Glyptothorax kashmirensis that is both endemic and included in the IUCN Red List.[120]

Kashmir Catfish Glyptothorax kashmirensis is listed as Critically Endangered in IUCN Red List and is also endemic to Pakistan. This fish species was seen for the first time in the Poonch River during October 2013 survey at Sampling Points A1 and A3. During May 2014 survey the fish was collected at Sampling Point A4 and A5.

Mahaseer Tor putitora is listed as Endangered in IUCN Red List. Poonch River and its tributaries are important breeding grounds for this species. It was seen at Sampling Points A1, A2, A3, A4, A5, A6, A7 and A8 during October 2013 survey. During the May 2014 survey this species was collected at Sampling Point A12, A11, A10, A-3b, A10, A1, A9, A4 and A5.

Pabdah Catfish Ompok pabda is listed as Near Threatened in IUCN Red List. It was collected at Sampling Points A2 and A8 during October 2013 survey. It was not collected during the May 2014 survey

Butter Catfish Ompok bimaculatus is listed as Near Threatened in IUCN Red List. It was collected at Sampling Point A5 during October 2013 survey. It was not collected during the May 2014 survey.

Common Carp Cyprinus carpio, Snow Trout Schizothorax plagiostomus and Twin-banded Loach Botia rostrata are listed as Vulnerable in IUCN Red List. Common Carp Cyprinus carpio was seen at Sampling Point A5, while Twin-banded Loach Botia rostrata was seen at Sampling Points A1, A2, A3, A4, A5 and A6 during October 2013 survey. The Snow Trout Schizothorax plagiostomus was not observed during the October 2013 survey but was caught in the main river channel during the December 2013 survey. It was not collected during the May 2014 survey

Pakistani Baril Barilius pakistanicus, Punjab Loach Schistura punjabensis and Nazir's Catfish Glyptothorax naziri are fish species endemic to Pakistan. During October 2013 survey, Pakistani Baril Barilius pakistanicus was seen at Sampling Points A2, A3, A4, A5, A6, A7 and A8, Punjab Loach Schistura punjabensis was seen at Sampling Point A1 and Nazir's Catfish Glyptothorax naziri was seen at Sampling Point A3. Neither of these fish were collected from the main River during the December 2013 survey. During the May 2014 survey, Pakistani Baril Barilius pakistanicus was collected at Sampling Point A11, A10, A-3b, A1, A-3b and A4, Punjab Loach Schistura punjabensis was not collected during the May 2014 survey while the Nazir's Catfish Glyptothorax naziri was collected at Sampling Point,A3-a during the May 2014 survey.

[120] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 18 November 2013

Determination: The Study Area provides habitat for the Kashmir Catfish Glyptothorax kashmirensis listed as Critically Endangered and Mahaseer Tor putitora listed as Endangered in IUCN Red List in addition to three endemic fish species.

10.4.1 Critical Habitat Assessment

The Critical Habitat Assessment of the Project was completed in September 2013[121]. Given below is a brief summary of this Critical Habitat Assessment.

Critical habitat is described as having a high biodiversity value, as defined by:

- Areas protected by the International Union for Conservation of Nature (Categories I-VI);122
- wetlands of international importance (according to the Ramsar convention);123
- important bird areas (defined by Birdlife International);124 and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;125
- The following additional characteristics are used in Critical Habitat Assessment.
- Habitat of significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted–range species;
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision would be evaluated on a case–by–case basis.

Aquatic Study Area

The Project Site for the Gulpur Hydropower Project is located on the Poonch River and the Aquatic Study Area was determined to be located in a Critical Habitat on the basis of two criterion outlined in the Performance Standard 6.

Criterion 1: Habitat of significant importance to Critically Endangered and/or Endangered species

[121] HBP, January 2014, Critical Habitat Assessment of Gulpur Hydropower Project, Hagler Bailly Pakistan.

[122] IUCN. 1994. *Guidelines for Protected Areas Management Categories. IUCN*, Cambridge, UK.

[123] Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

[124] Birdlife International, UK

[125] Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

The Poonch River provide habitat for two fish species: Kashmir Catfish Glyptothorax kashmirensis listed as Critically Endangered and Mahaseer Tor putitora listed as Endangered in IUCN Red List.

In addition, fish species Common Carp Cyprinus carpio, Snow Carp Schizothorax plagiostomus (richardsonii) and Twin–banded Loach Botia rostrata listed as Vulnerable in the IUCN Red List have also been observed in the Poonch River.

According to IFC's Guidance Note 6, Tier 1 sub-criteria for Criterion 1 are defined as follows[126]:

- Habitat required to sustain ≥ 10 percent of the global population of an IUCN Red-listed CR or EN species where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species.
- Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.

Tier 2 sub-criteria for Criterion 1 are defined as follows:

- Habitat that supports the regular occurrence of a single individual of an IUCN Red-listed CR species and/or habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species.
- Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species.
- As appropriate, habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent national/regional listing.

Concerning the Endangered Mahaseer Tor putitora, the Poonch River triggers Critical Habitat based on the first and third criterion of the Criterion 1, Tier 2 i.e. "habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species; and habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent *national/regional listing."* This is because the largest population of Mahaseer fish Tor putitora, in Pakistan is found in the Poonch River and the Poonch River and its tributaries serve as an important breeding ground for this fish species.[127] However, the Mahaseer Tor putitora does not fulfill the second criterion in Criterion 1, Tier 2 i.e. habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. This is because according to

[126] Guidance Note 6, January 2012, Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group

[127] Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

the IUCN Red List,[128] Tor putitora is a widely distributed species in south and south-east Asia, with a restricted area of occupancy. The species has been reported from across the Himalayan region and elsewhere in south Asia and south-east Asia,
ranging from Afghanistan, Pakistan, India (Darjeeling to Kashmir), Nepal, Bangladesh, Bhutan, Sri Lanka, Myanmar, western Iran to eastern Thailand. Moreover, the Mahaseer Tor putitora does not trigger Critical Habitat based on Criterion 1 Tier 1 since according to information available, it is widely distributed in south and south-east Asia even though the area of occupancy is limited (IUCN Red List) and more than 10% of the global population of this species is not found in the Poonch River.

Kashmir Catfish Glyptothorax kashmirensis is a rare and Critically Endangered (IUCN Red List 2013) fish. According to IUCN Red List it is reported only from the Jhelum River. However, specimens of this fish species have been caught from the Poonch River during the October 2013 survey (**Section 5.2.4**). It triggers Critical Habitat based on Criterion 1 Tier 1. This is because the fish has a very restricted range of occupancy (Jhelum and Poonch River) and is endemic to Kashmir. Keeping in view the predominantly riffle habitat of the Poonch River, which are the preferred habitat of this fish as well as the shallow waters particularly in the winter season, it is likely that more than 10% of the population of Kashmir Catfish Glyptothorax kashmirensis is found in the Poonch River. In addition, there are fewer than 10 management sites of this species globally. Thus it fulfills the requirements of Criterion 1 Tier 1. In addition, the Kashmir Catfish Glyptothorax kashmirensis also fulfills all three requirements to trigger Criterion 1 Tier 2 of Critical habitat since the Poonch River provides habitat containing regionally important concentrations of this Critically Endangered fish and loss of such a habitat could potentially impact the long term survivability of the species.

The other species of special importance are listed in **Table 5-17**. None of these species are listed as Endangered or Critically Endangered in the IUCN Red List 2013. The six indicator fish species selected to study the impact of Project impacts on the aquatic resources of the Poonch River are listed in **Section 5.2.4**. Details of expected impacts and mitigation measures are outlined in **Section 6, Environmental Flow Assessment**.

Criterion 2: Areas that meet the criteria of the IUCN's Protected Area Management Categories Ia, Ib and II, although areas that meet criteria for Management Categories III–VI may also qualify depending on the biodiversity values inherent to those sites[129]

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[128] Jha, B.R. & Rayamajhi, A. 2010. *Tor putitora*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **08 April 2014**.

[129] IUCN Protected Areas Categories System

IUCN protected area management categories classify protected areas according to their management objectives. The categories are recognized by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

Ia Strict Nature Reserve

Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring

Ib Wilderness Area

The entire length of the Poonch River was designated by the AJK Government as River Poonch Mahaseer National Park vie a notification of the Secretariat Forests/AKLASC/Wildlife and Fisheries) in December 2010. Even though the official notification does not specify the basis for the designation, the objective for declaring the Poonch River as a national park was to protect the aquatic ecological resources of the Poonch River. The ecological and socio-economic significance of the Poonch River is outlined in the Ecological Baseline Study of the Poonch River[130] and summarized in **Appendix B,** Draft Biodiversity Baseline.

The Poonch River was declared a National Park based on the definitions given in the AJK Wildlife Act 2010[131]. It has not been designated any official protected area category by IUCN. However, it also seems to fit the IUCN category II definition which is "Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor *opportunities."*

It was therefore concluded that the Aquatic Study Area of the Project lies in a Critical Habitat as designated by IFC's Performance Standard 6.

Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park

Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

III Natural Monument or Feature

Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area

Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape

A protected area where the interaction of people and nature over time has produced an area of distinct charcter with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources

Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

[130] Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

[131] Azad Jammu and Kashmir Wildlife (Protection, Preservation and Management) Act 2010.

Determination: The Aquatic Study Area lies in a Critical Habitat.

Terrestrial Study Area

The Terrestrial Study Area does not meet any of the following criteria of a Critical Habitat.

- Areas protected by the International Union for Conservation of Nature (Categories I-VI);[132]
- wetlands of international importance (according to the Ramsar convention);[133]
- important bird areas (defined by Birdlife International);[134] and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;[135]

The following additional characteristics were used in the Critical Habitat Assessment

Habitat integral to the survival of critically endangered or endangered species: Two of the bird species recorded from the Ecological Study Area are included in the IUCN Red List 2013. These are the White–backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus listed as Critically Endangered and Endangered respectively. Even though these birds use the Terrestrial Study Area for feeding and resting, their main breeding areas are at least 10 km away from the Project site. There is nothing in the literature reviewed nor in the information gathered that would imply that the Study Area habitat is integral to the survival of these vulture species;

A list of the species of conservation importance reported from the Study Area and the locations where sighted is included in the Biodiversity Baseline of Gulpur Hydropower Project.[136]

Areas having special significance for endemic or restricted-range species: The habitats found on Study Area are homogenous and widespread. Even though some endemic herpeto-faunal species have been reported from the Terrestrial Study Area, their distribution is not limited to any specific site or habitat type, and their distribution is widespread. Therefore, the Study Area does not hold any significance for the survival of endemic or restricted range species; or

Areas critical for the survival of migratory species: Even though there are some migratory birds reported from the Study Area, the major staging ground for these birds is the Mangla Lake or Mangla Reservoir. According to investigations, most of the migratory birds do not use the Study Area as a breeding and nesting area but merely as a resting ground on their way to the Mangla Lake where greater food and habitat is available. Moreover, no mammal species depends on the area for its migration.

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[132] IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.

[133] Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

[134] Birdlife International, UK

[135] Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

[136] Hagler Bailly Pakistan (HBP 2014), Biodiversity Baseline, Final Report, Gulpur Hydropower project,

Areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services. This situation is not present on the Study Area. While all species are functioning components of ecosystems, there are no unique assemblages of species or association of key evolutionary processes in the Terrestrial Study Area; or

Areas having biodiversity of significant social, economic or cultural importance to local communities. Although the area is of importance to residents in terms of ecosystem services (such as water, vegetation for grazing and fuel wood), it has no unique biodiversity value of social, economic or cultural importance to the community.

Determination: The Terrestrial Study Area does not lie in a Critical Habitat.

Exhibit 10.3: List of Species with Conservation Status Observed or Likely to Occur in the Study Area
Surveys conducted October 2013 (Oct 2013) and Decemer 2013 (Dec 2013)

Mammals

No.	*Scientific Names*	*Common Names*	*IUCN Status*	*National Mammals Red List*	*CITES*	*Location of Sightings / Signs at Sampling Points*
	Canidae					
1	*Canis aureus*	Asiatic Jackal	Least Concern	Near Threatened	III	Oct 2013 - S1 Dec 2013 – D1, D2, D3
2	*Vulpes vulpes*	Common Red Fox	Least Concern	Near Threatened	III	Oct 2013 - S1, S2, S5, S6, S9, S10, S13, S14, S15, A1, A2, A3, A5, A7 and A8 Dec 2013 – D1, D2, D3
	Felidae					Oct 2013 – Not Seen
3	*Panthera pardus*	Common Leopard	Near Threatened	Critically Endangered	I	Dec 2013 - Not seen
	HERPESTIDAE					
4	*Herpestes edwardsii*	Indian Grey Mongoose	Least Concern	Least Concern	III	Oct 2013 - S2, S4, S5, S10, S14, S15 and A3 Dec 2013 – D1, D3
	HYSTRICIDAE					
5	*Hystrix indica*	Indian Crested Porcupine	Least Concern	Near Threatened		Oct 2013 - S1 and A1 Dec 2013 – Not Seen
	MUSTELIDAE					
6	*Lutra lutra*	The Common Otter	Near Threatened	Near Threatened	I	Oct 2013 - Not surveyed Dec 2013 – Signs at A1, A3, A4, Narr. Sighted upstream A4.
	CERCOPITHECIDAE					Oct 2013 - A5
7	*Macaca mulatta*	Rhesus Monkey	Least Concern	Near Threatened	II	Dec 2013 – Not Seen
	CERVIDAE					Oct 2013 – Not Seen
8	*Muntiacus muntjak*	Barking Deer	Least Concern	Endangered		Dec 2013 - Not seen

Birds

No.	*Scientific Names*	*Common Names*	*IUCN Status*	*CITES*	*Location of Sightings / Signs(Sampling Point)*
	Accipitridae				
1	*Milvus migrans*	Black Kite	Least Concern	II	Oct 2013 - S1, S2, S4, S6, S9, S11, S12, S16, S17, A1, A3, A5, A7 and A8 Dec 2013 – D1, D2, D3
2	*Neophron percnopterus*	Egyptian Vulture	**Endangered**	II	Oct 2013 - A2, A3, A5, A4, A7, A8, S1, S12, S15, S16, S17 and S18. Dec 2013 – D1, D2, D3
3	*Butastur teesa*	White eyed Buzzard	Least Concern	II	Oct 2013 - S16 Dec 2013 – Not Seen
4	*Gyps bengalensis*	White-backed Vulture	**Critically Endangered**	II	Oct 2013 - A2, S17 and S18 Dec 2013 – Not Seen

Herpetofuana

No	*Scientific Name*	*Common Name*	*IUCN Status*	*CITES*	*Endemism*	*Location of Sightings / Signs (Sampling point)*
	AMPHIBIANS					
	Family Dicroglossidae					
1.	*Allopaa barmoachensis*	Kashmir Torrent Frog	Not Evaluated		Endemic	Oct 2013 - A8
	REPTILES					
	Family Gekkonidae					
2.	*Cyrtopodion rohtasfortai*	Rohtas Fort Thin-toed Gecko	Not Evaluated		Endemic	Oct 2013 - A3, N2, S6 and S9
	Family Varanidae					
3.	*Varanus bengalensis*	Bengal Monitor	Least Concern	I		Oct 2013 -, S6, S7 and S8
	Family Pythonidae					
4.	*Python molurus*	Indian Rock Python	Near Threatened	II		Oct 2013 - Not seen
5.	*Ptyas mucosus*	Dhaman or Rat Snake	Not Evaluated	II		Oct 2013 - S6 and S11
6.	*Xenochrophis piscator*	Checkered Keelback	Not Evaluated	III		Oct 2013 - Not seen
	Family Elapidae					
7.	*Naja oxiana*	Central Asia Cobra	Data Deficient	II		Oct 2013 - S9 and S12
	Family Typhlopidae					
8.	*Typhlops madgemintonai*	Kashmir Slender Blindsnake	Not Evaluated		Endemic	Oct 2013 - Not seen
9.	*Typhlops ahsanuli*	Ahsanul's Wormsnake	Not Evaluated		Endemic	Oct 2013 - Not seen
10.	*Typhlops diardi platyventris*	Kashmir Blindsnake	Not Evaluated		Endemic	Oct 2013 - Not seen
	Family Viperidae					
11.	*Daboia russelii*	Russell's Chain Viper	Not Evaluated	III		Oct 2013 - Not seen

Fish

No.	Scientific Names	Common Name	Endemism	IUCN Status	Commercial Value	Location of Sightings / Signs(Sampling Point)
	Cobitidae					
1.	*Botia rostrata*	Twin-banded Loach		**Vulnerable**	Low	Oct 2013 - A1, A2, A3, A4, A5 and A6 Dec 2013.-.not collected May 2014 - A12, A11, A10, A-3a, A-3b, A1, A9, A4, A5
	Cyprinidae					
2.	*Barilius pakistanicus*	Pakistani Baril	Endemic	Not Evaluated	Low	Oct 2013 - A2, A3, A4, A5, A6, A7 and A8 Dec 2013.-.not collected May 2014 - A11, A10, A-3b, A1, A-3a, A4
3.	*Cyprinus carpio*	Common Carp		**Vulnerable**	High	Oct 2013 - Sampling Point A5
4.	*Tor putitora*	Mahaseer		**Endangered**	Very High	Oct 2013 - A1, A2, A3, A4, A5, A6, A7 and A8 Dec 2013 – Pools in Poonch River May 2014 - A12, A11, A10, A-3b, A1, A9, A4, A5
5.	*Schizothorax plagiostomus (richardsonii)*	Snow Trout		Vulnerable	High	Oct 2013 – Not collected Dec 2013 – collected from main River channel May 2014 - not colleceted
	Nemacheilidae					
6.	*Schistura punjabensis*	Punjab Loach	Endemic	Not Evaluated	Low	Oct 2013 - A1 Dec 2013.-.not collected May 2014 - not colleceted
	Siluridae					
7.	*Ompok bimaculatus*	Butter Catfish		**Near Threatened**	Low	Oct 2013 - A5 Dec 2013.-.not collected May 2014 - not colleceted

No.	Scientific Names	Common Name	Endemism	IUCN Status	Commercial Value	Location of Sightings / Signs(Sampling Point)
8.	*Ompok pabda*	Pabdah Catfish		**Near Threatened**	Low	Oct 2013 - A2 and A8 Dec 2013.-.not collected May 2014 - not colleceted
	Sisoridae		Endemic			
9.	*Glyptothorax kashmirensis*	Kashmir Catfish		**Critically Endangered**	Low	Oct 2013- A1 and A3 Dec 2013.-.not collected May 2014 -.A4, A5
10.	*Glyptothorax naziri*	Nazir's Catfish	Endemic	Not Evaluated	Low	Oct 2013 - A3 Dec 2013.-.not collected May 2014 - A-3a

Appendix A: Survey Field Data

Exhibit A.1: Vegetation Field Data, Survey Conducted October 2013, December 2013 and May 2014

October 2013

ID	Coordinates		Habitat	*Acacia modesta*		*Achyranthes aspera*		*Berberis sp.*		*Broussonetia papyrifera*		*Carissa opaca*		*Chenopodium album*		*Conyza canadensis*		*Dalbergia sissoo*	
	Latitude (N)	Longitude (E)		Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count
A1	33 34 44.20	73 56 05.40	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	7.81	19
A2	33 30 07.20	73 52 43.70	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	10.66	12
A3	33 28 20.64	73 52 09.24	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	5.04	17
A4	33 26 58.10	73 50 14.10	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	2.01	13
A5	33 22 59.70	73 47 24.90	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A6	33 31 18.34	73 50 40.42	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.39	6
A7	34 29 18.70	73 49 43.20	Riverbank/Riparian	1.66	1	0.00	–	0.03	1	0.00	–	0.00	–	0.00	–	0.00	–	0.13	3
A8	33 22 04.70	74 02 18.90	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.57	9
S1	33 29 32.40	73 51 19.18	Pine Forest	0.00	–	0.00	–	0.06	3	0.00	–	0.00	2	0.00	–	0.00	–	0.91	11
S2	33 29 41.70	73 52 19.70	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	1.91	11
S3	33 29 57.90	73 53 32.50	Agricultural Fields	0.00	–	0.00	–	0.00	–	10.25	5	0.00	–	0.00	–	0.00	–	0.00	–
S4	33 29 49.00	73 55 09.90	Agricultural Fields	2.49	1	0.00	–	0.00	–	9.97	6	0.00	–	0.00	–	0.00	–	0.46	3
S5	33 29 09.10	73 55 44.50	Scrub Forest	0.00	–	0.00	–	0.03	2	0.00	–	0.00	–	0.05	7	0.02	3	0.13	4
S6	33 28 33.20	73 53 59.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.32	6
S7	33 28 40.70	73 51 59.10	Scrub Forest	0.00	–	0.00	–	0.02	1	0.00	–	0.08	3	0.00	–	0.00	–	0.00	–
S8	33 28 54.86	73 50 57.14	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.02	6	0.00	–	0.00	–	0.00	–	0.35	9
S9	33 27 06.40	73 51 10.20	Scrub Forest	4.30	1	0.02	3	0.00	–	1.91	3	0.00	–	0.00	–	0.00	–	0.84	8
S10	33 27 21.60	73 52 27.10	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.16	4
S11	33 27 45.80	73 53 45.90	Pine Forest	0.00	–	0.00	–	0.09	4	0.00	–	0.00	–	0.07	12	0.01	3	0.00	–
S12	33 27 42.90	73 54 23.10	Pine Forest	0.00	–	0.00	–	0.15	11	0.00	–	0.00	–	0.00	–	0.00	–	6.38	7
S13	33 26 55.20	73 53 41.90	Pine Forest	0.00	–	0.00	–	0.05	3	0.00	–	0.00	–	0.00	–	0.00	–	0.34	8
S14	33 27 04.15	73 51 58.62	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.23	2
S15	33 26 36.80	73 51 03.60	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	1	0.26	2
S16	33 25 44.70	73 52 13.10	Scrub Forest	0.00	–	0.00	–	0.09	1	0.32	3	0.00	–	0.02	2	0.00	1	1.35	8
S17	33 28 56.90	73 53 11.90	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	1.05	8
S18	33 29 04.80	73 52 51.50	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	1.85	9
				8.44	**3**	**0.02**	**3**	**0.52**	**26**	**22.49**	**23**	**0.09**	**5**	**0.13**	**21**	**0.04**	**8**	**43.17**	**179**

ID	Coordinates		Habitat 1	Dodonaea viscosa		Euphorbia hirta		Ficus carica		Imperata cylindrica		Ipomea carnea		Juglans regia		Lantana camara		Malvastrum coromandelianum	
	Latitude (N)	Longitude (E)		Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count
A1	33 34 44.20	73 56 05.40	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A2	33 30 07.20	73 52 43.70	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.03	2	0.00	2
A3	33 28 20.64	73 52 09.24	Riverbank/Riparian	0.03	3	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A4	33 26 58.10	73 50 14.10	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A5	33 22 59.70	73 47 24.90	Riverbank/Riparian	0.09	10	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A6	33 31 18.34	73 50 40.42	Riverbank/Riparian	0.01	1	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A7	34 29 18.70	73 49 43.20	Riverbank/Riparian	0.01	3	0.01	2	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.02	6
A8	33 22 04.70	74 02 18.90	Riverbank/Riparian	0.12	6	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S1	33 29 32.40	73 51 19.18	Pine Forest	0.04	10	0.00	–	0.00	–	13.87	800	0.12	4	0.00	–	0.00	–	0.00	–
S2	33 29 41.70	73 52 19.70	Agricultural Fields	0.08	8	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.01	4
S3	33 29 57.90	73 53 32.50	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.02	7
S4	33 29 49.00	73 55 09.90	Agricultural Fields	0.00	–	0.01	2	0.00	–	0.00	–	0.00	–	0.00	–	0.34	10	0.04	3
S5	33 29 09.10	73 55 44.50	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S6	33 28 33.20	73 53 59.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S7	33 28 40.70	73 51 59.10	Scrub Forest	0.08	10	0.00	–	0.00	–	0.00	–	0.05	2	0.00	–	0.00	–	0.00	–
S8	33 28 54.86	73 50 57.14	Agricultural Fields	0.07	3	0.00	1	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S9	33 27 06.40	73 51 10.20	Scrub Forest	0.03	2	0.01	2	0.00	–	0.00	–	0.00	–	0.13	1	0.00	–	0.01	3
S10	33 27 21.60	73 52 27.10	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.02	6
S11	33 27 45.80	73 53 45.90	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S12	33 27 42.90	73 54 23.10	Pine Forest	0.05	3	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S13	33 26 55.20	73 53 41.90	Pine Forest	0.05	6	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	2.92	5
S14	33 27 04.15	73 51 58.62	Pine Forest	0.13	12	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S15	33 26 36.80	73 51 03.60	Scrub Forest	0.13	10	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.25	4	0.00	–
S16	33 25 44.70	73 52 13.10	Scrub Forest	0.01	6	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S17	33 28 56.90	73 53 11.90	Scrub Forest	0.03	3	0.03	4	4.16	2	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S18	33 29 04.80	73 52 51.50	Scrub Forest	0.12	7	0.00	–	1.89	1	0.31	100	0.00	–	0.00	–	0.00	–	0.00	–
				1.08	**103**	**0.05**	**11**	**6.05**	**3**	**14.18**	**900**	**0.17**	**6**	**0.13**	**1**	**0.62**	**16**	**3.05**	**36**

ID	Coordinates		Habitat 1	Melia azedarach		Morus nigra		Nerium oleander		Olea ferruginea		Parthenium hysterophorus		Pinus roxburghii		Populus mexicana		Ricinus communis	
	Latitude (N)	Longitude €		Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count
A1	33 34 44.20	73 56 05.40	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.03	4	0.00	–	0.00	–	0.00	–
A2	33 30 07.20	73 52 43.70	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.03	9	0.00	–	0.00	–	0.00	–
A3	33 28 20.64	73 52 09.24	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
A4	33 26 58.10	73 50 14.10	Riverbank/Riparian	0.00	–	0.00	–	0.50	3	0.00	–	0.00	–	0.00	–	0.00	–	0.09	1
A5	33 22 59.70	73 47 24.90	Riverbank/Riparian	0.00	–	0.00	–	0.20	2	0.00	–	0.02	3	0.00	–	0.00	–	0.00	–
A6	33 31 18.34	73 50 40.42	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.07	10	0.00	–	0.00	–	0.00	–
A7	34 29 18.70	73 49 43.20	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.06	9	0.00	–	0.00	–	0.00	–
A8	33 22 04.70	74 02 18.90	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.09	8	0.00	–	0.00	–	0.00	–
S1	33 29 32.40	73 51 19.18	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	3	10.79	6	0.00	–	0.00	–
S2	33 29 41.70	73 52 19.70	Agricultural Fields	0.00	–	0.00	–	0.00	–	5.77	5	0.07	14	0.00	–	0.00	–	0.86	1
S3	33 29 57.90	73 53 32.50	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.06	5	0.00	–	0.00	–	0.00	–
S4	33 29 49.00	73 55 09.90	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.11	11	0.00	–	0.00	–	0.00	–
S5	33 29 09.10	73 55 44.50	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.10	14	0.00	–	0.00	–	0.00	–
S6	33 28 33.20	73 53 59.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.10	11	0.00	–	0.00	–	0.00	–
S7	33 28 40.70	73 51 59.10	Scrub Forest	0.00	–	0.00	–	0.00	–	5.31	2	0.02	4	0.00	–	0.00	–	0.00	–
S8	33 28 54.86	73 50 57.14	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	1	0.00	–	0.00	–	5.21	4	0.00	–
S9	33 27 06.40	73 51 10.20	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–
S10	33 27 21.60	73 52 27.10	Agricultural Fields	0.12	1	0.00	–	0.00	–	0.00	–	0.06	13	0.00	–	0.00	–	0.00	–
S11	33 27 45.80	73 53 45.90	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	15.36	12	0.00	–	0.00	–
S12	33 27 42.90	73 54 23.10	Pine Forest	0.00	–	0.00	–	0.00	–	0.62	2	0.00	–	12.43	12	0.00	–	0.00	–
S13	33 26 55.20	73 53 41.90	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.06	13	1.28	6	0.00	–	0.00	–
S14	33 27 04.15	73 51 58.62	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.09	11	1.14	9	0.00	–	0.00	–
S15	33 26 36.80	73 51 03.60	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.08	11	0.00	–	0.00	–	0.00	–
S16	33 25 44.70	73 52 13.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.10	14	0.00	–	0.00	–	0.00	–
S17	33 28 56.90	73 53 11.90	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.07	6	0.00	–	0.00	–	0.00	–
S18	33 29 04.80	73 52 51.50	Scrub Forest	2.50	1	1.71	1	0.00	–	0.00	–	0.11	10	0.00	–	0.00	–	0.00	–
				2.62	**2**	**1.71**	**1**	**0.70**	**5**	**11.70**	**10**	**1.32**	**183**	**41.00**	**45**	**5.21**	**4**	**0.95**	**2**

ID	Coordinates		Habitat 1	Saccharum sp.		Solanum nigrum		Solanum surrattense		Traxicum sp.		Xanthium strumarium		Ziziphus mauritiana		**Total**	
	Latitude (N)	Longitude (E)		Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	**Cover %**	**Count**
A1	33 34 44.20	73 56 05.40	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**7.84**	**23**
A2	33 30 07.20	73 52 43.70	Riverbank/Riparian	0.12	1	0.00	–	0.00	–	0.00	–	0.07	3	0.00	–	**10.90**	**29**
A3	33 28 20.64	73 52 09.24	Riverbank/Riparian	0.04	2	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**5.12**	**22**
A4	33 26 58.10	73 50 14.10	Riverbank/Riparian	0.24	8	0.00	–	0.00	–	0.00	–	0.06	3	0.00	–	**2.91**	**28**
A5	33 22 59.70	73 47 24.90	Riverbank/Riparian	3.94	13	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**4.25**	**28**
A6	33 31 18.34	73 50 40.42	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**0.47**	**17**
A7	34 29 18.70	73 49 43.20	Riverbank/Riparian	0.07	3	0.00	–	0.00	1	0.00	–	0.01	1	0.00	–	**2.01**	**30**
A8	33 22 04.70	74 2 18.90	Riverbank/Riparian	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**0.78**	**23**
S1	33 29 32.40	73 51 19.18	Pine Forest	0.07	3	0.00	–	0.00	–	0.00	–	0.00	–	0.06	2	**25.93**	**844**
S2	33 29 41.70	73 52 19.70	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.01	2	0.04	4	**8.75**	**49**
S3	33 29 57.90	73 53 32.50	Agricultural Fields	0.51	6	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**10.83**	**23**
S4	33 29 49.00	73 55 09.90	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.06	3	3.05	1	**16.54**	**40**
S5	33 29 09.10	73 55 44.50	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.03	3	0.02	2	**0.39**	**35**
S6	33 28 33.20	73 53 59.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.84	7	**1.26**	**24**
S7	33 28 40.70	73 51 59.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	9.46	6	**15.02**	**28**
S8	33 28 54.86	73 50 57.14	Agricultural Fields	0.00	1	0.00	–	0.00	–	0.00	–	0.00	–	0.00	2	**5.67**	**27**
S9	33 27 06.40	73 51 10.20	Scrub Forest	0.00	–	0.01	1	0.00	–	0.00	–	0.00	–	2.68	1	**9.94**	**25**
S10	33 27 21.60	73 52 27.10	Agricultural Fields	0.00	–	0.00	–	0.00	–	0.00	–	0.08	3	0.00	–	**0.45**	**27**
S11	33 27 45.80	73 53 45.90	Pine Forest	0.00	–	0.00	–	0.00	–	0.01	4	0.00	–	0.00	–	**15.55**	**35**
S12	33 27 42.90	73 54 23.10	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.01	2	**19.64**	**37**
S13	33 26 55.20	73 53 41.90	Pine Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**4.70**	**41**
S14	33 27 04.15	73 51 58.62	Pine Forest	0.27	3	0.00	1	0.00	–	0.00	–	0.00	–	0.00	–	**1.86**	**38**
S15	33 26 36.80	73 51 03.60	Scrub Forest	0.40	3	0.00	–	0.00	–	0.00	–	0.03	3	0.00	–	**1.15**	**34**
S16	33 25 44.70	73 52 13.10	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.06	3	0.08	2	**2.04**	**40**
S17	33 28 56.90	73 53 11.90	Scrub Forest	0.00	–	0.00	–	0.01	1	0.00	–	0.08	2	0.00	–	**5.42**	**26**
S18	33 29 04.80	73 52 51.50	Scrub Forest	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	0.00	–	**8.49**	**129**
				5.66	**43**	**0.02**	**2**	**0.02**	**2**	**0.01**	**4**	**0.49**	**26**	**16.25**	**29**	**187.9**	**1,702**

December 2013

ID	Coordinates		Habitat 1	*Acacia modesta*		*Berberis sp.*		*Broussonetia papyrifera*		*Carissa opaca*		*Cassia fistula*		*Dalbergia sissoo*		*Dodonaea viscosa*		*Ipomea carnea*		*Lantana camara*		*Nerium oleander*		*Olea ferruginea*		*Saccharum sp.*		*Ziziphus mauritiana*		**Total**		**Species Count**
	Lat	Long		Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	Cover %	Count	**Cover %**	**Count**	
D-1	33 27 23.1	73 51 56.6	Scrub Forest	0.82	3.00	0.00	–	0.07	2	0.00	–	0.00	–	0.45	5	0.05	5	0.00	–	0.00	–	0.12	5	0.00	–	0.08	4	0.16	4	**1.75**	**28**	**7**
D-2	33 27 20.8	73 51 41.6	Scrub Forest	1.14	5.00	0.17	5.00	0.00	–	0.25	7	0.00	–	1.24	6	0.22	15	0.32	5	0.13	3	0.00	–	0.88	3	0.00	–	0.00	–	**4.34**	**49**	**8**
D-3	33 27 18.9	73 51 51.6	Scrub Forest	0.00	–	0.29	7.00	0.00	–	0.00	–	0.57	1	0.41	6	0.17	12	0.00	–	0.00	–	0.00	–	0.00	–	0.05	4	0.00	–	**1.49**	**30**	**5**
				1.96	**8**	**0.46**	**12**	**0.07**	**2**	**0.25**	**7**	**0.57**	**1**	**2.11**	**17**	**0.44**	**32**	**0.32**	**5**	**0.13**	**3**	**0.12**	**5**	**0.88**	**3**	**0.13**	**8**	**0.16**	**4**	**7.6**	**107**	**13**

May 2014

ID	Coordinates		Habitat 1	*Berberis sp.*		*Cassia fistula*		*Dalbergia sissoo*		*Dodonaea viscosa*		*Mentha longifolia*		*Monotheca buxifolia*		*Nerium oleander*		*Saccharum sp.*		*Traxicum sp.*		***Total***		***Species Count***
	Latitude (N)	Longitude €		Cover	Count	Cover	Count	Cover	Count	Cover	Count	Cover	Count	Cover	Count	Cover	Count	Cover	Count	Cover	Count	***Cover***	***Count***	
D-1	33 27 22.30	73 51 57.00	Scrub Forest	0.00%	-	0.00%	-	2.55%	16	0.27%	15	0.00%	-	0.00%	-	0.95%	10	0.19%	9	0.00%	-	**3.95%**	**50**	**4**
D-2	33 27 19.80	73 51 43.30	Scrub Forest	0.10%	3.00	0.00%	-	3.61%	21	0.34%	16	0.01%	1	0.00%	-	0.45%	13	0.15%	3	0.01%	1	**4.66%**	**58**	**7**
D-3	33 27 16.30	73 51 54.70	Scrub Forest	0.17%	8.00	5.59%	5	3.45%	8	0.32%	12	0.00%	-	0.42%	1	0.00%	-	0.17%	8	0.00%	-	**10.11%**	**42**	**6**
			Total	**0.27%**	**11**	**5.59%**	**5**	**9.61%**	**45**	**0.93%**	**43**	**0.01%**	**1**	**0.42%**	**1**	**1.40%**	**23**	**0.50%**	**20**	**0.01%**	**1**	**18.7%**	**150**	**9**

Exhibit A.2: Mammals Field Data, Survey Conducted October and December 2013

October 2013

ID	*Date*	*Coordinates*		*Habitat*	*Canis aureus*			*Felis sp.*			*Herpestes edwardsii*			*Hystrix indica*			*Macaca mulatta*			*Vulpes vulpes*			***Sightings***		***Signs***	
		Latitude (N)	*Longitude (E)*		*Sighting*	*Signs*	***Total***	*Sighting*	*Signs*	***Total***	*Sighting*	*Signs*	***Total***	*Sighting*	*Signs*	***Total***	*Sighting*	*Signs*	***Total***	*Sighting*	*Signs*	***Total***	***Total***	***Species Count***	***Total***	***Species Count***
S2	09/28/13	33 29 41.70	73 52 19.70	Agricultural Fields	–	–	–	–	–	–	1	1	2	–	–	–	–	–	–	–	3	3	**1**	**1**	**4**	**2**
S8	09/29/13	33 28 54.86	73 50 57.14	Agricultural Fields	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S3	09/29/13	33 29 57.90	73 53 32.50	Agricultural Fields	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S4	10/02/13	33 29 49.00	73 55 09.90	Agricultural Fields	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	**1**	**1**	**–**	**–**
S10	10/02/13	33 27 21.60	73 52 27.10	Agricultural Fields	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	1	2	3	**2**	**2**	**2**	**1**
S1	09/28/13	33 29 32.40	73 51 19.18	Pine Forest	–	1	1	–	–	–	–	–	–	–	1	1	–	–	–	1	2	3	**1**	**1**	**4**	**3**
S12	10/01/13	33 27 42.90	73 54 23.10	Pine Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S11	10/01/13	33 27 45.80	73 53 45.90	Pine Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S13	10/01/13	33 26 55.20	73 53 41.90	Pine Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	5	**–**	**–**	**5**	**1**
S14	10/01/13	33 27 04.15	73 51 58.62	Pine Forest	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	3	3	**1**	**1**	**3**	**1**
A6	09/28/13	33 31 18.34	73 50 40.42	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
A1	09/28/13	33 34 44.20	73 56 05.40	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	2	2	–	–	–	–	2	2	**–**	**–**	**4**	**2**
A3	09/29/13	33 28 20.64	73 52 09.24	Riverbank/Riparian	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	1	1	**1**	**1**	**1**	**1**
A2	09/29/13	33 30 07.20	73 52 43.70	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	**–**	**–**	**2**	**1**
A5	09/30/13	33 22 59.70	73 47 24.90	Riverbank/Riparian	–	–	–	–	1	1	–	–	–	–	–	–	50	–	50	–	7	7	**50**	**1**	**8**	**2**
A4	09/30/13	33 26 58.10	73 50 14.10	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
A7	10/01/13	33 28 03.70	73 55 25.30	Riverbank/Riparian	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	1	3	4	**1**	**1**	**4**	**2**
A8	10/01/13	33 22 04.70	74 2 18.90	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S17	09/29/13	33 28 56.90	73 53 11.90	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S18	09/29/13	33 29 04.80	73 52 51.50	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S7	09/29/13	33 28 40.70	73 51 59.10	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S16	09/30/13	33 25 44.70	73 52 13.10	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**	**–**	**–**	**–**
S15	09/30/13	33 26 36.80	73 51 03.60	Scrub Forest	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	1	2	3	**2**	**2**	**2**	**1**
S5	10/02/13	33 29 09.10	73 55 44.50	Scrub Forest	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	2	2	**1**	**1**	**2**	**1**
S9	10/02/13	33 27 06.40	73 51 10.20	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3	**–**	**–**	**3**	**1**
S6	10/03/13	33 28 33.20	73 53 59.10	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	**–**	**–**	**1**	**1**
																							61	**10**	**45**	**14**

December 2013

ID	Date	Coordinates		Habitat	Asiatic Jackal *Canis aureus*			Indian grey mongoose *Herpestes edwardsii*			Fox *Vulpes*			**Sightings**		**Signs**	
		Latitude (N)	Longitude (E)		Sighting	Signs	Total	Sighting	Signs	Total	Sighting	Signs	Total	**Total**	**Species Count**	**Total**	**Species Count**
D-1	12/25/13	33 27 23.10	73 51 56.60	Scrub Forest	–	3	3	1	2	3	–	2	2	**1**	**1**	**7**	**3**
D-2	12/25/13	33 27 20.80	73 51 41.60	Scrub Forest	–	1	1	–	–	–	–	3	3	**–**	**0**	**4**	**2**
D-3	12/28/13	33 27 18.90	73 51 51.90	Scrub Forest	1	1	2	1	–	1	–	1	1	**2**	**2**	**2**	**2**
														3	**2**	**13**	**3**

Exhibit A.3: Small Mammals Trapping Data, Survey Conducted October 2013

ID	*Trap Set Date*	*Latitude*	*Longitude*	*Habitat*	*Wind*	*Cloud %*	*Mus Booduga*	*Mus Musculus*	*Rattus rattus*	*Suncus Murinus*	***Total***	***No of Species***	***Traps***
T3	01/10/13	33 28 22.35	73 53 39.58	Agricultural Fields		10%	2	–	–	–	**2**	**1**	40
T5	03/10/13	33 27 24.89	73 52 10.82	Agricultural Fields		10%	1	1	1	–	**3**	**3**	40
T7	02/10/13	33 28 18.41	73 52 14.25	Riverbank/Riparian	Light	10%	–	2	2	–	**4**	**2**	40
T6	30/09/13	33 27 06.50	73 51 51.78	Pine Forest		0%	–	1	–	1	**2**	**2**	40
T4	30/09/13	33 27 14.90	73 52 29.30	Pine Forest		0%	1	–	–	1	**2**	**2**	40
T1	02/10/13	33 29 01.30	73 53 01.60	Scrub Forest		10%	1	–	–	2	**3**	**2**	40
T2	29/09/13	33 28 33.47	73 53 52.00	Scrub Forest		0%	–	2	–	–	**2**	**1**	40
							5	**6**	**3**	**4**	**18**	**4**	**280**

Exhibit A.4: Birds Field Data, Survey Conducted October and December 2013

October 2013

ID	*Date*	*Longitude*	*Latitude*	*Habitat*	*Delichon dasypus*	*Eudynamys scolopaceus*	*Hirundo rustica*	*Dicrurus macrocercus*	*Milvus migrans*	*Phoenicurus ochruros*	*Myophonus caeruleus*	*Cettia fortipes*	*Phylloscopus collybita*	*Upupa epops*	*Acridotheres tristis*	*Orthotomus sutorius*	*Neophron percnopterus*	*Turdus merula*	*Prinia gracilis*	*Parus major*	*Cettia brunnifrons*	*Columba rupestris*	*Pycnonotus leucogenys*	*Dendrocopos himalayensis*	*Corvus splendens*	*Passer domesticus*	*Pavo cristatus*
S2	09/28/13	33 29 41.70	73 52 18.70	Agricultural Fields	–	–	–	2	5	–	–	–	3	–	–	–	–	–	–	–	–	–	–	-	-	-	-
S8	09/29/13	33 28 54.86	73 50 57.14	Agricultural Fields	–	–	–	–	–	–	–	–	–	–	10	–	–	–	–	–	–	–	–	-	10	20	-
S3	09/29/13	33 29 57.90	73 53 32.50	Agricultural Fields	–	–	–	1	–	–	–	–	–	1	8	–	–	–	–	–	–	–	6	-	-	-	-
S4	10/02/13	33 29 50.29	73 54 49.51	Agricultural Fields	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	5	-	-	3	-
S10	10/02/13	33 27 21.60	73 52 27.10	Agricultural Fields	1	–	5	–	–	–	–	–	–	–	30	2	–	–	3	–	–	–	25	-	-	15	-
S1	09/28/13	33 29 32.40	73 51 19.18	Pine Forest	–	–	–	–	3	–	–	2	16	–	–	–	1	–	–	–	2	–	–	1	-	20	1
S14	09/30/13	33 27 04.15	73 51 58.62	Pine Forest	–	–	–	–	–	–	–	–	4	1	10	–	–	–	–	–	–	–	–	-	3	-	-
S12	10/01/13	33 27 42.90	73 54 23.10	Pine Forest	–	–	–	–	2	–	–	–	–	–	5	–	2	–	–	–	–	–	7	2	-	-	-
S11	10/01/13	33 27 45.80	73 53 45.60	Pine Forest	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	10	1	3	3	-
S13	10/01/13	33 26 55.20	73 53 41.90	Pine Forest	–	–	–	–	–	–	–	–	2	–	8	–	–	–	–	–	–	–	–	-	-	15	-
A6	09/28/13	33 31 18.34	73 50 40.42	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	-	-	-	-
A1	09/28/13	33 34 44.20	73 56 05.40	Riverbank/Riparian	–	–	–	1	2	3	–	–	2	–	–	–	–	–	–	–	–	–	–	-	-	-	-
A2	09/29/13	33 30 07.20	73 52 43.70	Riverbank/Riparian	–	–	–	2	–	–	–	–	2	1	2	–	7	–	–	–	–	–	10	-	-	-	-
A3	09/29/13	33 28 20.64	73 52 09.24	Riverbank/Riparian	–	–	–	–	1	–	–	–	2	–	–	–	1	–	–	–	–	–	–	-	-	-	-
A5	09/30/13	33 22 59.70	73 47 24.90	Riverbank/Riparian	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	2	–	-	-	-	-
A4	09/30/13	33 26 58.10	73 50 14.10	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	3	–	1	–	–	6	–	–	–	-	2	-	-
A7	10/01/13	33 28 03.70	73 55 25.30	Riverbank/Riparian	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	-	-	-	-
A8	10/01/13	33 22 04.70	74 02 18.90	Riverbank/Riparian	–	–	–	–	3	–	–	–	–	2	10	–	1	–	–	–	–	–	5	-	-	-	-
S17	09/29/13	33 28 56.90	73 53 11.90	Scrub Forest	–	–	–	–	8	–	–	–	–	–	–	–	6	–	–	–	–	–	–	-	-	-	-
S18	09/29/13	33 29 04.80	73 52 51.50	Scrub Forest	–	–	–	–	–	–	–	–	–	–	–	–	41	–	–	–	–	–	–	-	-	-	-
S7	09/29/13	33 28 40.70	73 51 59.10	Scrub Forest	–	–	–	–	–	–	–	–	2	–	–	–	–	1	–	4	–	–	5	-	-	-	-
S16	09/30/13	33 25 44.70	73 52 13.00	Scrub Forest	–	1	–	3	1	–	1	–	–	1	10	–	2	–	–	3	–	1	–	-	15	-	-
S15	09/30/13	33 26 36.80	73 51 03.60	Scrub Forest	–	–	–	–	–	–	–	–	3	–	10	–	1	1	–	5	–	–	–	-	12	-	-
S5	10/02/13	33 29 14.52	73 55 18.63	Scrub Forest	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	5	-	-	3	-
S9	10/02/13	33 27 06.40	73 51 10.20	Scrub Forest	3	–	–	–	1	–	–	–	–	–	10	–	–	–	–	–	–	–	3	-	-	15	-
S6	10/03/13	33 28 33.20	73 53 59.10	Scrub Forest	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	8	-	-	-	-
				Total	**4**	**2**	**5**	**9**	**33**	**3**	**1**	**2**	**36**	**6**	**119**	**2**	**65**	**2**	**3**	**18**	**2**	**3**	**92**	**4**	**45**	**94**	**1**

ID	*Date*	*Longitude*	*Latitude*	*Habitat*	*Saxicoloides fulicatus*	*Coracias benghalensis*	*Oenanthe isabellina*	*Turdoides striata*	*Corvus macrorhynchos*	*Spilopelia senegalensis*	*Sylvia curruca*	*Merops orientalis*	*Anthus similis*	*Saxicola caprata*	*Pycnonotus cafer*	*Emberiza cia*	*Lanius schach*	*Dendrocitta vagabunda*	*Lonchura punctulata*	*Phaenicophaeus leschenaultii*	*Saxicola rubicola*	*Bucanetes githagineus*	*Butastur teesa*	*Motacilla alba*	*Gyps bengalensis*	*Chaimarrornis leucocephalus*	***Total***	***Species Count***
S2	09/28/13	33 29 41.70	73 52 18.70	Agricultural Fields	–	–	–	–	10	3	–	–	–	–	–	–	–	3	–	3	–	–	–	–	–	–	**29**	**7**
S8	09/29/13	33 28 54.86	73 50 57.14	Agricultural Fields	–	2	–	13	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**57**	**6**
S3	09/29/13	33 29 57.90	73 53 32.50	Agricultural Fields	–	–	–	7	10	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**35**	**7**
S4	10/02/13	33 29 50.29	73 54 49.51	Agricultural Fields	–	–	–	10	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	**23**	**5**
S10	10/02/13	33 27 21.60	73 52 27.10	Agricultural Fields	–	2	–	5	5	2	–	–	–	–	8	–	–	–	–	–	3	–	–	2	–	–	**108**	**14**
S1	09/28/13	33 29 32.40	73 51 19.18	Pine Forest	–	–	–	10	7	–	–	–	–	2	–	–	–	2	–	–	–	–	–	–	–	–	**67**	**12**
S14	09/30/13	33 27 04.15	73 51 58.62	Pine Forest	–	–	–	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**33**	**5**
S12	10/01/13	33 27 42.90	73 54 23.10	Pine Forest	–	–	–	–	3	5	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	**28**	**8**
S11	10/01/13	33 27 45.80	73 53 45.60	Pine Forest	–	–	–	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**37**	**7**
S13	10/01/13	33 26 55.20	73 53 41.90	Pine Forest	–	–	–	10	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**38**	**5**
A6	09/28/13	33 31 18.34	73 50 40.42	Riverbank/Riparian	–	–	–	3	–	–	–	–	–	2	–	–	–	–	–	–	2	–	–	–	–	3	**13**	**5**
A1	09/28/13	33 34 44.20	73 56 05.40	Riverbank/Riparian	2	–	–	–	3	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	4	**18**	**8**
A2	09/29/13	33 30 07.20	73 52 43.70	Riverbank/Riparian	–	–	–	3	10	5	–	–	–	–	–	–	–	2	–	–	–	–	–	–	1	–	**45**	**11**
A3	09/29/13	33 28 20.64	73 52 09.24	Riverbank/Riparian	2	–	–	–	2	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	1	**11**	**7**
A5	09/30/13	33 22 59.70	73 47 24.90	Riverbank/Riparian	–	–	3	–	–	3	–	1	–	2	–	–	–	1	–	–	–	–	–	1	–	5	**20**	**10**
A4	09/30/13	33 26 58.10	73 50 14.10	Riverbank/Riparian	–	–	1	15	–	–	–	2	–	3	–	6	–	–	–	–	–	–	–	1	–	2	**42**	**11**
A7	10/01/13	33 28 03.70	73 55 25.30	Riverbank/Riparian	–	–	–	20	3	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**27**	**5**
A8	10/01/13	33 22 04.70	74 02 18.90	Riverbank/Riparian	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**21**	**5**
S17	09/29/13	33 28 56.90	73 53 11.90	Scrub Forest	–	–	–	–	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	**32**	**4**
S18	09/29/13	33 29 04.80	73 52 51.50	Scrub Forest	–	–	–	–	13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	–	**67**	**3**
S7	09/29/13	33 28 40.70	73 51 59.10	Scrub Forest	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**16**	**6**
S16	09/30/13	33 25 44.70	73 52 13.00	Scrub Forest	–	3	–	10	–	–	2	2	–	–	–	3	–	–	–	–	–	–	1	–	–	–	**59**	**16**
S15	09/30/13	33 26 36.80	73 51 03.60	Scrub Forest	–	–	–	20	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	**54**	**9**
S5	10/02/13	33 29 14.52	73 55 18.63	Scrub Forest	–	–	–	–	–	–	–	–	3	2	–	–	–	–	10	–	–	–	–	-	-	-	**26**	**6**
S9	10/02/13	33 27 06.40	73 51 10.20	Scrub Forest	–	–	–	15	–	2	–	–	–	–	–	2	1	–	–	–	–	2	–	-	-	-	**54**	**10**
S6	10/03/13	33 28 33.20	73 53 59.10	Scrub Forest	–	–	–	3	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	-	-	-	**15**	**4**
				Total	**4**	**7**	**4**	**177**	**86**	**24**	**2**	**10**	**3**	**14**	**15**	**11**	**1**	**8**	**10**	**3**	**5**	**2**	**1**	**5**	**17**	**15**	**975**	**45**

December 2013

ID	*Date*	*Coordiantes*		*Habitat 1*	*Delichon dasypus*	*Milvus migrans*	*Prunella fulvescens*	*Falco tinnunculus*	*Acridotheres tristis*	*Neophron percnopterus*	*Turdus merula*	*Prinia gracilis*	*Grandala coelicolor*	*Parus major*	*Pycnonotus leucogenys*	*Passer domesticus*	*Luscinia brunnea*	*Turdoides striata*	*Corvus macrorhynchos*	*Phalacrocorax sulcirostris*	*Falco columbarius*	*Falco peregrinus*	*Prinia inornata*	*Pycnonotus cafer*	*Lanius schach*	*Dendrocitta vagabunda*	*Aquila nipalensis*	***Total***	***Species Count***
		Lat	*Long*																										
D-1	12/25/13	33 27 23.1	73 51 56.6	Scrub Forest	5	3	–	–	10	2	1	2	1	15	–	–	–	–	3	–	–	–	2	–	–	–	–	**44**	**10**
D-2	12/25/13	33 27 20.8	73 51 41.6	Scrub Forest	–	5	6	1	8	2	1	–	–	–	7	10	1	24	–	2	–	1	–	10	1	2	1	**82**	**16**
D-3	12/25/13	33 27 18.9	73 51 51.6	Scrub Forest	–	2	–	2	6	1	–	–	–	–	10	–	–	8	3	–	1	–	–	4	–	2	–	**39**	**10**
					5	**10**	**6**	**3**	**24**	**5**	**2**	**2**	**1**	**15**	**17**	**10**	**1**	**32**	**6**	**2**	**1**	**1**	**2**	**14**	**1**	**4**	**1**	**165**	**23**

Exhibit A.5: Herpeto-fauna Field Data, Survey Conducted October 2013

ID	*Date*	*Latitutde*	*Longitude*	*Habitat*	*Ablepharus pannonicus*	*Calotes versicolor*	*Cyrtopodion rohtasfortai*	*Echis carinatus sochureki*	*Euphlyctis cyanophlyctis*	*Eutropis dissimilis*	*Fejervarya limnocharis*	*Hemidactylus flaviviridis*	*Laudakia agrorensis*	*Microhyla ornata*	*Naja oxiana*	*Ophisops jerdonii*	*Platyceps rhodorachis*	*Pseudepidalea p. pseudoraddei*	*Ptyas mucosus*	*Allopaa barmoachensis*	*Sphaerotheca breviceps*	*Varanus bengalensis*	***Total***	***Species Count***
S2	9/28/13	33 29 41.70	73 52 19.70	Agricultural Fields	1	–	–	–	–	1	–	–	3	1	–	–	–	–	–	–	–	–	**6**	**4**
S8	9/29/13	33 28 54.86	73 50 57.14	Agricultural Fields	–	–	–	–	2	–	2	–	–	–	–	5	–	–	–	–	–	1	**10**	**4**
S3	9/29/13	33 29 57.90	73 53 32.50	Agricultural Fields	–	–	–	–	–	3	–	–	5	–	–	–	–	–	–	–	–	–	**8**	**2**
S4	10/2/13	33 29 50.29	73 54 49.51	Agricultural Fields	–	–	–	–	–	2	–	–	4	–	–	–	–	–	–	–	–	–	**6**	**2**
S10	10/2/13	33 27 21.60	73 52 27.10	Agricultural Fields	–	–	–	–	–	2	–	–	3	–	–	1	–	–	–	–	–	–	**6**	**3**
S1	9/28/13	33 29 32.40	73 51 19.18	Pine Forest	–	–	–	–	–	–	–	–	2	–	–	3	–	1	–	–	–	–	**6**	**3**
S14	9/30/13	33 27 04.15	73 51 58.62	Pine Forest	–	–	–	–	–	2	–	–	5	–	–	–	–	–	–	–	–	–	**7**	**2**
S12	10/1/13	33 27 42.90	73 54 23.10	Pine Forest	–	1	–	–	–	–	–	–	5	–	1	2	–	–	–	–	–	–	**9**	**4**
S11	10/1/13	33 27 45.80	73 53 45.60	Pine Forest	2	–	–	–	–	–	–	–	3	–	–	–	–	–	1	–	–	–	**6**	**3**
S13	10/1/13	33 26 55.20	73 53 41.90	Pine Forest	1	–	–	–	35	–	–	–	2	–	–	–	–	–	–	–	–	–	**38**	**3**
A6	9/28/13	33 28 33.20	73 53 59.10	Riverbank/Riparian	–	–	–	–	3	3	–	–	1	–	–	–	–	7	–	–	–	–	**14**	**4**
A1	9/28/13	33 34 44.20	73 56 05.40	Riverbank/Riparian	–	–	–	–	7	1	–	–	–	–	–	–	–	2	–	–	–	–	**10**	**3**
A3	9/29/13	33 28 20.64	73 52 09.24	Riverbank/Riparian	–	1	3	–	–	–	–	–	5	–	–	2	1	–	–	–	–	–	**12**	**5**
A2	9/29/13	33 30 07.20	73 52 43.70	Riverbank/Riparian	–	–	–	–	7	–	–	–	4	–	–	–	–	1	–	–	–	1	**13**	**4**
A5	9/30/13	33 22 59.70	73 47 24.90	Riverbank/Riparian	–	–	–	–	7	–	–	–	3	–	–	1	–	–	–	–	–	–	**11**	**3**
A4	9/30/13	33 26 58.10	73 50 14.10	Riverbank/Riparian	–	–	–	–	16	4	–	–	3	–	–	–	–	–	–	–	–	–	**23**	**3**
A7	10/1/13	33 28 03.70	73 55 25.30	Riverbank/Riparian	–	–	–	–	5	–	–	–	2	–	–	2	–	–	–	–	–	–	**9**	**3**
A8	10/1/13	33 22 04.70	74 02 18.90	Riverbank/Riparian	–	3	–	–	4	1	–	–	–	–	–	–	–	–	–	2	–	–	**10**	**4**
S17	9/29/13	33 28 56.90	73 53 11.90	Scrub Forest	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	**2**	**2**
S18	9/29/13	33 29 04.80	73 52 51.50	Scrub Forest	–	–	–	–	–	–	–	5	3	–	–	1	–	–	–	–	–	–	**9**	**3**
S7	9/29/13	33 28 40.70	73 51 59.10	Scrub Forest	–	–	–	–	–	3	–	–	–	–	–	2	–	–	–	–	–	1	**6**	**3**
N2	9/29/13	33 28 30.70	73 53 59.10	Scrub Forest	–	–	5	–	–	–	5	–	3	–	–	–	–	7	–	–	2	–	**22**	**5**
S16	9/30/13	33 25 44.70	73 52 13.10	Scrub Forest	2	–	–	–	–	2	–	–	5	–	–	–	–	–	–	–	–	–	**9**	**3**
S15	9/30/13	33 26 36.80	73 51 03.60	Scrub Forest	–	–	–	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	**3**	**2**
S5	10/2/13	33 29 14.52	73 55 18.63	Scrub Forest	–	–	–	1	–	11	–	–	–	–	–	3	–	–	–	–	–	–	**15**	**3**
S6	10/2/13	33 28 33.20	73 53 59.10	Scrub Forest	–	–	3	–	–	–	–	–	3	–	–	–	–	–	1	–	–	1	**8**	**4**
S9	10/2/13	33 27 06.40	73 51 10.20	Scrub Forest	2	–	2	–	–	–	–	–	1	–	1	4	–	–	–	–	–	–	**10**	**5**
					8	**5**	**13**	**1**	**86**	**35**	**7**	**5**	**68**	**1**	**2**	**28**	**1**	**18**	**2**	**2**	**2**	**4**	**288**	**8**

Exhibit A.6: Fish Data, Survey Conducted October 2013 and May 2014

Site A1 (River at Kallar Bridge)

Dated: 28-09-2013 Time: 4:30-6:00 pm

Latitude: 33°34'44.20"N Longitude: 73°56'5.40"E

Specimens collected by casting 20 Cast Nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	3	2	1	**6**	Endangered	Very high
Labeo dyocheilus	Pakistani Labeo	-	1	1	**2**	Least Concern	Very high
Crossocheilus latius	Gangetic Latia	1	3	1	**5**	Least Concern	Low
Garra gotyla	Sucker Head	2	–	–	**2**	Least Concern	Low
Schistura punjabensis	Punjab Loach	3	–	–	**3**	Least Concern/ Endemic	Low
Botia rostrata	Twin-banded Loach	1	–	–	**1**	Vulnerable	Aquarium fish
Botia almorhae	Pakistani Loach	2	–	–	**2**	Least Concern	Aquarium fish
Glyptothorax pectinopterus	Flat Head Catfish	1	–	–	**1**	Least Concern	Low
Glyptothorax kashmirensis		2	–	–	**2**	Critically Endangered	Low
Glyptothorax cavia	Heart Throat Catfish	3	–	–	**3**	Least Concern	Low
Mastacembelus armatus	Tire-track Spiny Eel	1	–	–	**1**	Least Concern	Medium

Site A2 (River at Confluence with Rangar Nullah)

Dated: 29-09-2013 Time: 03:40-05:00 pm

Latitude: 33°30'7.20"N Longitude: 73°52'43.70"E

Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	2	2	–	**4**	Endangered	Very high
Labeo dyocheilus	Pakistani Labeo	2	1	–	**3**	Least Concern	Very high
Crossocheilus latius	Gangetic Latia	1	3	1	**5**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	2	–	–	**2**	Endemic	Low
Garra gotyla	Sucker Head	1	–	–	**1**	Least Concern	Low
Acanthocobitis botia	Mottled Loach	2	–	–	**2**	Least Concern	Low
Botia rostrata	Twin-banded Loach	1	–	–	**1**	Vulnerable	Aquarium fish
Ompok pabda	Pabdah Catfish	–	1	–	**1**	Near Threatened	Low
Glyptothorax pectinopterus	Flat Head Catfish	1	–	–	**1**	Least Concern	Low
Glyptothorax cavia	Heart Throat Catfish	2	–	–	**2**	Least Concern	Low
Mastacembelus armatus	Tire-track Spiny Eel	1	–	–	**1**	Least Concern	Medium
Channa gachua	Dwarf Snakehead	–	1	–	**1**	Least Concern	Low

Site A3 (River at Borali Bridge)

Dated: 29-09-2013 Time: 10:00-11:30 am

Latitude: 33 28 20.64 Longitude 73 52 09.24

Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	3	3	–	**6**	Endangered	Very high
Labeo dyocheilus	Pakistani Labeo	1	2	–	**3**	Least Concern	Very high
Labeo dero	Kalbans	1	1	–	**2**	Least Concern	High
Crossocheilus latius	Gangetic Latia	2	4	4	**10**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	2	1	–	**3**	Endemic	Low
Garra gotyla	Sucker Head	2	–	–	**2**	Least Concern	Low
Schistura punjabensis	Punjab Loach	1	–	–	**1**	Least Concern/ Endemic	Low
Botia rostrata	Twin-banded Loach	5	–	–	**5**	Vulnerable	Aquarium fish
Botia almorhae	Pakistani Loach	3	–	–	**3**	Least Concern	Aquarium fish
Glyptothorax pectinopterus	Flat head Catfish	3	–	–	**3**	Least Concern	Low
Glyptothorax kashmirensis		2	–	–	**2**	Critically Endangered	Low
Glyptothorax cavia	Heart Throat Catfish	5	–	–	**5**	Least Concern	Low
Glyptothorax naziri	Nazir's Catfish	3	–	–	**3**	Not Evaluated/Endemic	Low
Gagata cenia	Clown Catfish	5	–	–	**5**	Least Concern	Low
Clupisoma garua	Garua Bachwa	2	–	–	**2**		Very high

Mastacembelus armatus	Tire-track Spiny Eel	2	–	–	**2**	Least Concern	Medium

Site A4 (River at Gulpur Bridge)

Dated: 30-09-2013 Time: 4:00-5:30 pm

Latitude: 33°26'58.10"N Longitude 73°50'14.10"E

Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	2	2	–	**4**	Endangered	Very high
Labeo dero	Kalbans	–	1	–	**1**	Least Concern	Very high
Crossocheilus latius	Gangetic Latia	3	2	–	**5**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	1	–	–	**1**	Endemic	Low
Salmophasia bacaila	Large Razorbelly Minnow	1	–	–	**1**	Least Concern	Low
Garra gotyla	Sucker Head	1	–	–	**1**	Least Concern	Low
Botia rostrata	Twin-banded Loach	2	–	–	**2**	Vulnerable	Aquarium fish
Botia almorhae	Pakistani Loach	1	–	–	**1**	Least Concern	Aquarium fish
Glyptothorax cavia	Heart Throat Catfish	2	–	–	**2**	Least Concern	Low

Site A5 (River at Billiporian Bridge near Rajdhani)

Dated: 30-09-2013 Time: 11:30-12:30 am

Latitude: 33°22'59.70"N Longitude 73°47'24.90"E

Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	3	1	2	**6**	Endangered	Very high
Labeo dyocheilus	Pakistani Labeo	1	2	–	**4**	Least Concern	Very high
Cyprinus carpio	Common Carp	–	–	1	**1**	Vulnerable	High
Crossocheilus latius	Gangetic Latia	2	5	2	**9**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	3	–	–	**3**	Endemic	Low
Aspidoparia morar	Chilwa	–	2	–	**2**	Least Concern	Low
Salmophasia bacaila	Large Razorbelly Minnow	1	–	–	**1**	Least Concern	Low
Securicula gora	Gora Chela	3	–	–	**3**	Least Concern	Low
Garra gotyla	Sucker Head	1	–	–	**1**	Least Concern	Low
Parambassis ranga	Glassy Fish	3	–	–	**3**		
Chanda nama	Elongate Glassy Perchlet	1	–	–	**1**	Least Concern	Low
Acanthocobitis botia	Mottled Loach	1	–	–	**1**	Least Concern	Low
Botia rostrata	Twin-banded Loach	1	–	–	**1**	Vulnerable	Aquarium fish
Botia almorhae	Pakistani Loach	2	–	–	**2**	Least Concern	Aquarium fish
Ompok bimaculatus	Butter Catfish	–	1	–	**1**	Least Concern	Low
Glyptothorax cavia	Heart Throat Catfish	3	–	–	**3**	Least Concern	Low
Mastacembelus armatus	Tire-track Spiny Eel	2	–	–	**2**	Least Concern	Medium

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Clupisoma garua	Garua Bachwa	–	1	–	**1**		High

Site A6 (Rangar Nullah)

Dated: 28-09-2013 Time: 10:10-12:15 am

Latitude: 33°31'18.34"N Longitude 73°50'40.42"E

Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	3	5	3	**11**	Endangered	Very high
Labeo dyocheilus	Pakistani Labeo	–	1	–	**1**	Least Concern	Very high
Crossocheilus latius	Gangetic Latia	2	6	3	**11**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	4	2	–	**6**	Endemic	Low
Salmophasia bacaila	Large Razorbelly Minnow	–	2	1	**3**	Least Concern	Low
Garra gotyla	Sucker Head	1	–	–	**1**	Least Concern	Low
Schistura punjabensis	Punjab Loach	3	–	–	**3**	Endemic	Low
Botia rostrata	Twin-banded Loach	1	–	–	**1**	Vulnerable	Aquarium fish
Glyptothorax pectinopterus	Flat Head Catfish	1	–	–	**1**	Least Concern	Low
Mastacembelus armatus	Tire-track Spiny Eel	1	–	–	**1**	Least Concern	Medium

Site A7 (Ban Nullah)

Dated: 01-10-2013 Time: 2:30-04:00 pm

Latitude: 33°28'3.70"N Longitude 73°55'25.30"E

Table 1: Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	2	1	–	**3**	Endangered	Very high
Crossocheilus latius	Gangetic Latia	3	4	–	**7**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	2	–	–	**2**	Endemic	Low
Garra gotyla	Sucker Head	2	–	–	**2**	Least Concern	Low

Site A8 (Ban Nullah)

Dated: 01-10-2013 Time: 10:15-11:30 am

Latitude: 33°22'4.70"N Longitude 74° 2'18.90"E

Specimens collected by casting 20 cast nets

Scientific Name	*English Name*	*Specific habitat*				*IUCN Status/ Endemism*	*Commercial value*
		Riffles (0.3-0.5m)	*Pools (1-1.5 m)*	*Backwater (1-1.5 m)*	***Total***		
Tor putitora	Mahaseer	1	1	–	**2**	Endangered	Very high
Crossocheilus latius	Gangetic Latia	4	7	–	**11**	Least Concern	Low
Barilius pakistanicus	Pakistani Baril	4	–	–	**4**	Endemic	Low
Salmophasia bacaila	Large Razorbelly Minnow	3	–	–	**3**	Least Concern	Low
Garra gotyla	Sucker Head	6	–	–	**6**	Least Concern	Low
Ompok pabda	Pabdah Catfish	–	2	–	**2**	Near Threatened	Low

Fish Data December 2014

S.No	*Scientific Name*	*Common Name*	*Habitat*	*E Flow Site/ Corresponding Sampling Point*			
				E-Flow site 1 (A-1)	*E-flow site 2 (A-3b)*	*E Flow site 3 (A-4)*	*E Flow site 4 (A-5)*
				Co-ordinates			
				33°34'44.20"N	*33°27'18.05"N*	*33°26'58.10"N*	*33°22'59.70"N*
				73°56'5.40"E	*73°52'1.17"E*	*73°50'14.10"E*	*73°47'24.90"E*
1	*Schizothorax plagiostomus*	Snow Carp	Pools	2	0	0	0
2	*Tor putitora*	Mahaseer	Pools	2	3	5	7
3	*Labeo dyocheilus*	Pakistani Labeo	Pools	4	6	4	3

Fish Data May 2014

No			Sampling Locations																																				
		Sampling Location	A-12				A-11				A-10				A-3b				A-1				A-9				A-3a				A-4				A-5				
		CoordinatesLong Lat	73°57'11.28"E 33°42'15.20"N				73°58'39.20"E 33°39'18.18"N				73°55'42.95"E 33°36'31.36"N				73°52'1.17"E 33°27'18.05"N				73°56'5.40"E 33°34'44.20"N				73°54'23.16"E 33°31'47.09"N				73°52'9.24"E 33°28'20.64"N				73°50'14.10"E 33°26'58.10"N				73°47'24.90"E 33°22'59.70"N				
		EF – Sites													EFlow Site 2				EFlow Site 1												EFlow Site 3				EFlow Site 4				
		Location	Sehra Dam Site				Meander Nullah				Sehra Hydropower Project Site				Gulpur Hydropower Project Site				(Kotli Dam Site)				Kotli Hydropower Project Site (Kotli)				River at Barali Bridge				River at Gulpur Bridge				River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,				
		Biotopes	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	
	Scientific Name	Common Name																																					
1.	*Aspidoparia morar*	Chilwa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	
2.	*Barilius pakistanicus*	Pakistani Baril	–	–	–	–	2	4	2	8	1	2	3	6	1	–	1	2	2	3	1	6	–	–	–	–	–	–	1	1	2	2	–	4	–	–	–	-	
3.	*Botia almorhae*	Pakistani Loach	4	–	–	4	3	–	–	3	2	–	–	2	1	–	–	1	1	1	–	2	3	–	–	3	3	–	–	3	3	1	–	4	2	–	–	2	
4.	*Botia rostrata*	Twin–banded Loach	5	–	–	5	4	–	–	4	4	–	–	4	4	–	–	4	3	–	–	3	3	1	–	4	1	1	–	2	2	2	–	4	2	–	–	2	
5.	*Chanda nama*	Elongate glass–perchlet	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3	
6.	*Clupisoma garua*	Garua bachwaa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	–	2	–	2	1	1	–	2	
7.	*Crossocheilus latius*	Gangetic latia	1	3	1	5	2	3	1	6	–	1	2	3	1	3	1	5	2	1	2	5	2	2	–	4	1	1	–	2	–	1	–	1	–	1	2	3	
8.	*Gagata cenia*	Clown Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	3	–	9	–	–	–	–	–	–	–	-	
9.	*Garra gotyla*	Sucker Head	6	–	–	6	5	–	–	5	4	–	–	4	2	2	–	4	2	1	–	3	3	1	–	4	3	–	–	3	2	–	–	2	1	–	–	1	
10.	*Glyptothorax cavia*	Heart Throat Catfish	–	–	–	–	2	–	–	2	3	–	–	3	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-	
11.	*Glyptothorax kashmirensis*	Kashmir Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	3	–	–	3	
12.	*Glyptothorax naziri*	Nazirs' Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	-	
13.	*Glyptothorax pectinopterus*	Flat head Catfish	–	–	–	–	3	–	–	3	1	–	–	1	–	–	–	–	2	–	–	2	4	–	–	4	–	–	–	–	–	–	–	–	–	–	–	-	
14.	*Labeo dero*	Kalbans	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	-	
15.	*Labeo dyocheilus*	Pakistani Labeo	2	3	–	5	3	1	–	4	1	2	–	3	2	2	1	5	–	3	–	3	2	4	–	6	2	2	–	4	2	2	1	5	2	1	1	4	
16.	*Mastacembelus armatus*	Tire–track spiny eel	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	2	–	–	2	1	–	–	1	–	–	–	–	1	1	–	2	1	–	–	1	
17.	*Parambassis ranga*	Indian glassy fish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	4	
18.	*Salmophasia bacaila*	Large razorbelly minnow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	3	
19.	*Schizothorax plagiostomus*	Snow Carp	2	2	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-	
20.	*Securicula gora*	Gora Chela	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	4	
21.	*Tor putitora*	Mahaseer	3	2	1	6	3	3	–	6	2	2	–	4	3	1	–	4	1	2	–	3	2	1	1	4	3	1	–	4	3	1	–	4	3	2	–	5	
	Total					**35**				**41**				**30**				**31**				**29**				**30**				**36**				**31**				**39**	**302**

Exhibit A.7: Benthic Macro-invertebrates Field Data, Surveys Conducted October, 2013

				Abundance/ meter^2 at Sampling Points														Feeding Habit	HKH Bios pollution tolerance values
			Sampling Points	A1	A2		A3		A4	A5			A6	A7		A8			
			Latitude	33°34'44.20" N	33°30'7.20"N		33 28 20.64		33 26 58.10	33 22 59.70			33 28 33.20	33 28 33.20		33 22 04.70			
			Longitude	73°56'5.40"E	73°52'43.70"E		73 52 09.24		73°50'14 .10"E	73°47'24.90 "E			73 53 59.10	73 53 59.10		74° 2'18.90"E			
			Habitats	Riffle	Riffle	Pool	Riffle	Pool	Riffle	Riffle	Glides	Pool	Riffle	Riffle	Pool	Riffle	Pool		
No	Group Idicators	Taxa (Family)	Genus																
1	EPT	Perlidae	Neoperla	–	3	–	–	–	–	–	–	5	8	9	–	4	12	Predator	8
2	EPT	Baetidae	Acentrella	11	19	4	17		54		22	10	6	–	–	–	–	Collector gatherer	8
3	EPT	Baetidae	Baetis	18	25	–	13	40	12	40		87	21	–	23	27	44	Collector gatherer	–
4	EPT	Baetidae	Baetiella	–	–	–	3	–	9	–	–	–	–	–	7	–	–	Collector gatherer	8
5	EPT	Baetidae	Centroptilum	–	–	–	–	–	–	–	–	–	–	–	–	–	25	Collector gatherer	–
6	EPT	Caenidae	Caenis	6	4	–	–	–	2	15	25	37	19	6	–	–	26	Collector gatherer	7
7	EPT	Caenidae	Brachycerus	–	–	–	–	–	–	–	–	–	–	24	–	–	–	Collector gatherer	–
8	EPT	Heptageniidae	Stenonema	24	23	–	37	–	19	35	190	50	64	17	–	–	–	Scraper	8
9	EPT	Heptageniidae	Rhithrogena	5	5	–	9	–	7		19	–	–	–	–	–	–	Scraper	9
10	EPT	Leptophebiidae	Choroterpes	13	7	–	12	–	17	20	206	72	94	49	3	146	35	Collector gatherer	7
11	EPT	Ephemerellidae	–	–	–	–	–	–	2	–	–	–	5	–	–	–	–	Collector gatherer	7
12	EPT	Hydropsychidae	Hydropsyche	43	–	–	–	–	–	–	–	–	–	–	–	–	–	Collector filterer	7
13	EPT	Hydropsychidae	Chematopsyche	22	16	–	1	–	17	26	131	–	15	109	–	57	–	Collector filterer	7
14	EPT	Hydroptilidae	–	–	–	–	–	–	–	–	–	–	–	–	–	11	15	Unknown	7
15	EPT	Philopotamidae	Chimarra	–	12	–	3	–	8	–	175		8	82	–	3	–	Collector filterer	7
16	Other flies & Midges	Chironimidae	–	53	64	–	80	20	50	–	–	–	107	90	–	129	200	Unknown	1
17	Other flies & Midges	Tipulidae	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	Collector gatherer	7
18	Other flies & Midges	Athericidae	Atherix	10	10	–	2	–	14	–	17	–	–	6	–	–	–	Predator	9
19	Other flies & Midges	Culicidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	Unknown	2
20	Other flies & Midges	Tabanidae	Tabanus	–	–	–	–	2	–	–	–	–	3	6	–	2	2	Predator	6
21	Other flies & Midges	Psychodidae	Psychoda	1	–	–	–	–	–	–	–	–	4	–	–	–	–	Collector gatherer	6
22	Simulidae	Simulidae	–	–	8	–	–	–	23	–	–	–	–	–	–	–	–	Collector filterer	7
23	Other Taxa	Elmidae	–	–	16	–	42	24	10	17	27	45	–	2	–	2	–	Scraper	8
24	Other Taxa	Scirtidae	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	Unknown	8
25	Other Taxa	Gyrinidae	–	–	–	–	–	–	–	–	–	–	2	–	–	–	4	Predator	6
26	Other Taxa	Psephenidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	Screper	8
27	Other Taxa	Aphelocheiridae	Aphelocheirus	–	4	–	1	–	5	15	9	12	–	4	–	–	–	Predator	7

				Abundance/ meter^2 at Sampling Points														*Feeding Habit*	*HKH Bios pollution tolerance values*
			Sampling Points	*A1*	*A2*		*A3*		*A4*	*A5*			*A6*	*A7*		*A8*			
			Latitude	*33°34'44.20" N*	33°30'7.20"N		*33 28 20.64*		*33 26 58.10*	*33 22 59.70*			*33 28 33.20*	*33 28 33.20*		*33 22 04.70*			
			Longitude	*73°56'5.40"E*	73°52'43.70"E		*73 52 09.24*		73°50'14 .10"E	73°47'24.90 "E			*73 53 59.10*	*73 53 59.10*		74° 2'18.90"E			
			Habitats	*Riffle*	*Riffle*	*Pool*	*Riffle*	*Pool*	*Riffle*	*Riffle*	*Glides*	*Pool*	*Riffle*	*Riffle*	*Pool*	*Riffle*	*Pool*		
No	*Group Idicators*	*Taxa (Family)*	*Genus*																
28	Other Taxa	Corixidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	Predator	6
29	Other Taxa	Gerridae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	Predator	–
30	Other Taxa	Corydalidae	Corydalus	–	1	–	–	–	–	–	1	–	2	4	–	1	–	Predator	7
31	Other Taxa	Gomphidae	–	1	–	–	–	–	–	–	–	15	–	–	2	–	15	Predator	–
32	Other Taxa	Libellulidae	–	1	–	–	–	–	–	–	–	–	–	–	–	–	6	Predator	6
33	Other Taxa	Cordulidae	–	–	–	–	–	2	–	–	–	–	–	–	–	–	2	Predator	5
34	Other Taxa	Potamidae	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	Collector gatherer	7
35	Other Taxa	Unionidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16	Collector filterer	6
36	Other Taxa	Enchyrtraeidae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	44	Collector gatherer	–
37	Other Taxa	Tubificidae	–	2	–	1	1	–	–	–	–	–	–	–	–	–	–	Collector gatherer	1
Total Abundance/m^2				**210**	**218**	**7**	**221**	**88**	**249**	**168**	**823**	**333**	**358**	**409**	**192**	**382**	**462**		
Diversity				**14**	**16**	**4**	**13**	**5**	**15**	**7**	**12**	**9**	**14**	**14**	**5**	**10**	**18**		

Appendix B: Species List

Exhibit B.1: List of Reptile and Amphibian Species in the Study Area

No	Scientific Name	Common Name	IUCN Status	CITES	Endemism
	AMPHIBIANS				
	Family Bufonidae				
1.	*Duttaphrynus m. melanostictus*	Common Asian Toad	Least Concern		
2.	*Duttaphrynus stomaticus*	Marbled Toad or Indus Valley Toad	Least Concern		
3.	*Pseudepidalea p. pseudoraddei*	Mertens's Green Toad or Swat Green Toad	Least Concern		
	Family Dicroglossidae				
4.	*Allopaa barmoachensis*	Kashmir Torrent Frog	Not Evaluated		Endemic
5.	*Euphlyctis cyanophlyctis*	Common Skittering Frog	Least Concern		
6.	*Fejervarya limnocharis*	Indian Cricekt Frof or Paddy Frog	Least Concern		
7.	*Sphaerotheca breviceps*	Indian Burrowing Frog	Least Concern		
	Family Microhylidae				
8.	*Microhyla ornata*	Ornate Narrow-mouthed frog	Least Concern		
9.	*Uperodon systoma*	Marbled Baloon Frog	Least Concern		
	REPTILES				
	Family Agamidae				
10.	*Calotes versicolor*	Asian Garden Lizard	Not Evaluated		
11.	*Laudakia agrorensis*	Agrore Valley Rock Agama	Not Evaluated		
	Family Gekkonidae				
12.	*Cyrtopodion rohtasfortai*	Rohtas Fort Thin-toed Gecko	Not Evaluated		Endemic
13.	*Hemidactylus flaviviridis*	Yellow-bellied House Gecko	Not Evaluated		
14.	*Hemidactylus brookii*	Spotted House Gecko	Not Evaluated		
	Family Lacertidae				
15.	*Ophisops jerdonii*	Punjab Snake-eyed Lacerta	Least Concern		
	Family Scincidae				
16.	*Ablepharus pannonicus*	Asian Snake-eyed Skink	Not Evaluated		
17.	*Eutropis dissimilis*	Striped Grass Skink	Not Evaluated		

No	Scientific Name	Common Name	IUCN Status	CITES	Endemism
	Family Varanidae				
18.	*Varanus bengalensis*	Bengal Monitor	Least Concern	I	
	Family Pythonidae				
19.	*Python molurus*	Indian Rock Python	Near Threatened	II	
	Family Colubridae				
20.	*Amphiesma stolatum*	Buff-striped Keelback	Not Evaluated		
21.	*Lycodon aulicus*	Common Wolfsnake	Not Evaluated		
22.	*Oligodon arnensis*	Russet Kukri Snake	Not Evaluated		
23.	*Platyceps rhodorachis*	Jan's Cliff Racer	Not Evaluated		
24.	*Ptyas mucosus*	Dhaman or Rat Snake	Not Evaluated	II	
25.	*Sibynophis sagittarius*	Cantor's Black-headed Snake	Not Evaluated		
26.	*Spalerosophis atriceps*	Black-headed Royal Snake	Not Evaluated		
27.	*Xenochrophis piscator*	Checkered Keelback	Not Evaluated	III	
	Family Elapidae				
28.	*Bungarus caeruleus*	Indian Krait	Not Evaluated		
29.	*Naja oxiana*	Central Asia Cobra	Data Deficient	II	
	Family Typhlopidae				
30.	*Typhlops madgemintonai*	Kashmir Slender Blindsnake	Not Evaluated		Endemic
31.	*Typhlops ahsanuli*	Ahsanul;s Wormsnake	Not Evaluated		Endemic
32.	*Typhlops diardi platyventris*	Kashmir Blindsnake	Not Evaluated		Endemic
	Family Viperidae				
33.	*Gloydius himalayanus*	Himalayan Pitviper	Not Evaluated		
34.	*Daboia russelii*	Russell's Chain Viper	Not Evaluated	III	
35.	*Echis carinatus sochureki*	Sochurek's Saw-scaled Viper	Not Evaluated		

Exhibit B.2: List of the Mammal Species in the Study Area

No.	*Scientific Names*	*Common Names*	*IUCN Status*	*CITES*	*National Mammals Red List*
1.	*Canis aureus*	Asiatic Jackal	Least Concern	III	**Near Threatened**
2.	*Felis sp*	Cat			
3.	*Herpestes edwardsii*	Indian Grey Mongoose	Least Concern		Least Concern
4.	*Hystrix indica*	Indian Crested Porcupine	Least Concern		**Near Threatened**
5.	*Lutra lutra*	The Common Otter	**Near Threatened**	I	**Near Threatened**
6.	*Macaca mulatta*	Rhesus Monkey	Least Concern	II	**Near Threatened**
7.	*Muntiacus muntjak*	Barking Deer	Least Concern		**Endangered**
8.	*Mus Booduga*	Indian Field Mouse	Least Concern		Least Concern
9.	*Mus Musculus*	House Mouse	Least Concern		Least Concern
10.	*Panthera pardus*	Common Leopard	**Near Threatened**	I	**Critically Endangered**
11.	*Rattus rattus*	House Rat	Least Concern		Least Concern
12.	*Suncus Murinus*	House Shrew	Least Concern		Least Concern
13.	*Vulpes vulpes*	Common Red Fox	Least Concern	III	**Near Threatened**

Exhibit B.3: List of Bird Species in the Study Area

No.	Scientific Names	Common Names	IUCN Status	CITES
1.	*Acridotheres tristis*	Common Myna	Least Concern	
2.	*Anthus similis*	Long-billed Pipit	Least Concern	
3.	*Bucanetes githagineus*	Trumpeter Finch	Least Concern	
4.	*Butastur teesa*	White eyed Buzard	Least Concern	II
5.	*Cettia brunnifrons*	Grey-sided Bush Warbler	Least Concern	
6.	*Cettia fortipes*	Brownish-flanked Bush Warbler	Least Concern	
7.	*Chaimarrornis leucocephalus*	White-capped Redstart	Least Concern	
8.	*Columba rupestris*	Hill Pigeon	Least Concern	
9.	*Coracias benghalensis*	Indian Roller	Least Concern	
10.	*Corvus macrorhynchos*	Jungle Crow	Least Concern	
11.	*Corvus splendens*	House Crow	Least Concern	
12.	*Delichon dasypus*	Asian House Martin	Least Concern	
13.	*Dendrocitta vagabunda*	Rufous Treepie	Least Concern	
14.	*Dendrocopos himalayensis*	Himalayan Woodpecker	Least Concern	
15.	*Dicrurus macrocercus*	Black Drongo	Least Concern	
16.	*Emberiza cia*	Rock Bunting	Least Concern	
17.	*Eudynamys scolopaceus*	Asian Koel	Least Concern	
18.	*Gyps bengalensis*	White-rumped Vulture	**Critically Endangered**	II
19.	*Hirundo rustica*	Barn Swallow	Least Concern	
20.	*Lanius schach*	Rufous backed shrike	Least Concern	
21.	*Lonchura punctulata*	Scaly-breasted Munia	*Least Concern*	
22.	*Merops orientalis*	Little Green Bee- eater	Least Concern	
23.	*Milvus migrans*	Black Kite	Least Concern	II
24.	*Motacilla alba*	White Wagtail	Least Concern	
25.	*Myophonus caeruleus*	Blue Whistling Thrush	Least Concern	
26.	*Neophron percnopterus*	Egyptian Vulture	**Endangered**	II
27.	*Oenanthe isabellina*	Isabelline Wheatear	Least Concern	
28.	*Orthotomus sutorius*	Common Tailorbird	Least Concern	

No.	Scientific Names	Common Names	IUCN Status	CITES
29.	*Parus major*	Great Tit	Least Concern	
30.	*Passer domesticus*	House Sparrow	Least Concern	
31.	*Pavo cristatus*	Indian Peafowl	Least Concern	
32.	*Phaenicophaeus leschenaultii*	Sirkeer Malkoha	Least Concern	
33.	*Phoenicurus ochruros*	Black Redstart	Least Concern	
34.	*Phylloscopus collybita*	Common Chiffchaff	Least Concern	
35.	*Prinia gracilis*	Graceful Prinia	Least Concern	
36.	*Pycnonotus cafer*	Red-vented Bulbul	Least Concern	
37.	*Pycnonotus leucogenys*	Himalayan bulbul	Least Concern	
38.	*Saxicola caprata*	Pied Bush Chat	Least Concern	
39.	*Saxicola rubicola*	Stone Chat	Least Concern	
40.	*Saxicoloides fulicatus*	Indian Robin	Least Concern	
41.	*Stigmatopelia senegalensis*	Laughing Dove	Least Concern	
42.	*Sylvia curruca*	Lesser Whitethroat	Least Concern	
43.	*Turdoides striata*	Jungle Babbler	Least Concern	
44.	*Turdus merula*	Eurasian Blackbird	Least Concern	
45.	*Upupa epops*	Common Hoopoe	Least Concern	
46.	*Falco columbarius*	Merlin	Least Concern	II
47.	*Falco peregrinus*	Peregrine Falcon	Least Concern	I
48.	*Falco tinnunculus*	Common Kestrel	Least Concern	II
49.	*Grandala coelicolor*	Grandala	Least Concern	
50.	*Luscinia brunnea*	Indian Blue Robin	Least Concern	
51.	*Aquila nipalensis*	Steppe Eagle	Least Concern	II
52.	*Phalacrocorax sulcirostris*	Little Black Cormorant	Least Concern	
53.	*Prinia inornata*	Plain Prinia	Least Concern	
54.	*Prunella fulvescens*	Brown Accentor	Least Concern	

Exhibit B.4: List of Fish Species in the Study Area

No	Scientific Name	English Name	Distributional Status	IUCN Status	Commercial Value
	Cyprinidae				
1.	*Chela cachius*	Silver hatchet chela	Wide	Least concerned (LC)	Low
2.	*Salmophasia bacaila*	Large razorbelly minnow	Wide	LC	Low
3.	*Aspidoparia morar*	Aspidoparia	Wide	LC	Low
4.	*Barilius pakistanicus*	Pakistani baril	Endemic	Not determined (ND)	Low
5.	*Esomus danricus*	Flying barb	Wide	LC	Low
6.	*Cirrhinus reba*	Reba carp	Wide	LC	Fairly good
7.	*Cyprinion watsoni*	Cyprinion	Wide	ND	Low
8.	*Labeo dero*	Kalbans	Wide	LC	Fairly good
9.	*Labeo dyocheilus*	Pakistani Labeo	Wide	LC	High
10.	*Osteobrama cotio*	Cotio	Wide	LC	Low
11.	*Puntius chola*	Swamp Barb	Wide	LC	Low
12.	*Puntius sophore*	Spotfin Swamp Barb	Wide	LC	Low
13.	*Puntius ticto*	Two spot Barb	Wide	LC	Low
14.	*Tor putitora*	Mahaseer	Wide	Endangered	Very high
15.	*Crossocheilus latius*	Gangetic latia	Wide	LC	Low
16.	*Garra gotyla*	Sucker head	Wide	LC	Low
17.	*Schizothorax plagiostomus (richardsonii)*	Snow carp	Wide	Vulnerable	High

No	Scientific Name	English Name	Distributional Status	IUCN Status	Commercial Value
18.	*Securicula gora*	Gora Chela		Least Concern	Low
19.	*Cyprinus carpio*	Common carp	Exotic	Vulnerable	High
	Noemacheilidae				
20.	*Acanthocobitis botia*	Mottled Loach	Wide	LC	Low
21.	*Schistura punjabensis*	Hillstream loach	Endemic	ND	Low
	Cobitidae				
22.	*Botia rostrata*	Twin–banded Loach	Wide	Vulnerable	Low
	Bagridae				
23.	*Sperata seenghala*	Giant river cat fish	Wide	LC	Very high
	Schilbeidae				
24.	*Clupisoma garua*	Garua bachwaa	Wide	LC	Very high
	Siluridae				
25.	*Ompok bimaculatus*	Butter catfish	Wide	Near Threatened	Low
	Sisoridae				
26.	*Glyptothorax pectinopterus*	Flat head catfish	Wide	LC	Low
	Channidae				
27.	*Chanda nama*	Elongate glass–perchlet	Wide	LC	Low
28.	*Parambasis baculis*	Himalayan glassy perchlet	Wide	LC	
29.	*Parambasis ranga*	Indian glassy fish	Wide	LC	
	Botidae				

No	*Scientific Name*	*English Name*	*Distributional Status*	*IUCN Status*	*Commercial Value*
30.	*Botia almorhae*	Pakistani Loach		Least Concern	Low
	Chandidae				
31.	*Channa gachua*	Dwarf Snakehead		Least Concern	Low
	Sisoridae				
32.	*Glyptothorax cavia*	Heart Throat Catfish		Least Concern	Low
33.	*Glyptothorax kashmirensis*	Kashmir Catfish		**Critically Endangered**	Low
34.	*Glyptothorax naziri*	Nazirs' Catfish	Endemic	Not Evaluated	Low
35.	*Gagata cenia*	Clown Catfish		Least Concern	Low
	Siluridae				
36.	*Ompok pabda*	Pabdah Catfish		**Near Threatened**	Low
	Mastacembelidae				
37.	*Mastacembelus armatus*	Tire–track spiny eel	Wide	LC	High

Exhibit B.5: List of Vegetation Species in the Study Area

No.	Scientific Names	Common Names	Life Form	Abundance	Medicinal Plants[137][138]
1.	*Acacia modesta*	Phulai	Tree	Common	
2.	*Achyranthes aspera*	Prickly Chaff Flower	Herb	Infrequent	
3.	*Berberis sp.*	Barberry	Shrub	Very Common	√
4.	*Broussonetia papyrifera*	Paper Mulberry	Tree	Common	
5.	*Carissa opaca*	Garanda	Shrub	Common	
6.	*Cassia fistula*	Golden Shower	Tree	Infrequent	
7.	*Chenopodium album*	Goosefoot	Herb	Common	
8.	*Conyza canadensis*	Horseweed	Herb	Common	
9.	*Dalbergia sissoo*	Sheesham	Tree	Very Common	
10.	*Dodonaea viscosa*	Sanatha	Shrub	Very Common	√
11.	*Euphorbia hirta*	Garden Spurge	Herb	Common	
12.	*Ficus carica*	Fig	Tree	Infrequent	√
13.	*Imperata cylindrica*	Cogon Grass	Herb	Common	
14.	*Ipomea carnea*	Pink Morning Glory	Shrub	Infrequent	
15.	*Juglans regia*	Walnut	Tree	Infrequent	√

[137] Dr. Muhammad Ibrar Shinwari et al 2007. Medicinal Plants of Margalla Hills National Park Islamabad, Higher Education Commission.

[138] Qammar Zaman and Riyaz Aziz Minhas, Medicinal Plants of Machiara National Park and their uses, protected Areas Management Project, Machiara National Park Department of Wildlife and Fisheries Azad Jammu and Kashmir

No.	Scientific Names	Common Names	Life Form	Abundance	Medicinal Plants[137138]
16.	*Lantana camara*	Wild Sage	Shrub	Very Common	
17.	*Malvastrum coromandelianum*	False Mallow	Herb	Common	
18.	*Melia azedarach*	Bead Tree	Tree	Infrequent	
19.	*Mentha longifolia*	Wild Mint	Herb	Infrequent	
20.	*Monotheca buxifolia*		Tree	Infrequent	
21.	*Morus nigra*	Black Mulberry	Tree	Common	
22.	*Nerium oleander*	Oleander	Shrub	Common	√
23.	*Olea ferruginea*	Indian Olive	Tree	Common	
24.	*Parthenium hysterophorus*	White top Weed	Herb	Very Common	
25.	*Pinus roxburghii*	Chir Pine	Tree	Very Common	
26.	*Populus mexicana*	Popolar	Tree	Common	
27.	*Ricinus communis*	Castor Oil Plant	Shrub	Common	
28.	*Saccharum sp.*		Grass	Common	
29.	*Solanum nigrum*	Black Nightshade	Herb	Common	√
30.	*Solanum surrattense*	Yellow-Berried Nightshade	Herb	Infrequent	
31.	*Traxicum sp.*		Herb	Infrequent	√
32.	*Xanthium strumarium*	Rough Cocklebur	Shrub	Very Common	
33.	*Ziziphus mauritiana*	Ber	Tree	Infrequent	

No.	Scientific Names	Common Names	Life Form	Abundance	Medicinal Plants[139 140]	Recorded from Area of Habita Loss
34.	*Acacia modesta*	Phulai	Tree	Common		Yes
35.	*Achyranthes aspera*	Prickly Chaff Flower	Herb	Infrequent		
36.	*Berberis sp.*	Barberry	Shrub	Very Common	√	Yes
37.	*Broussonetia papyrifera*	Paper Mulberry	Tree	Common		Yes
38.	*Carissa opaca*	Garanda	Shrub	Common		Yes
39.	*Cassia fistula*	Golden Shower	Tree	Infrequent		Yes
40.	*Chenopodium album*	Goosefoot	Herb	Common		
41.	*Conyza canadensis*	Horseweed	Herb	Common		
42.	*Dalbergia sissoo*	Sheesham	Tree	Very Common		Yes
43.	*Dodonaea viscosa*	Sanatha	Shrub	Very Common	√	Yes
44.	*Euphorbia hirta*	Garden Spurge	Herb	Common		
45.	*Ficus carica*	Fig	Tree	Infrequent		
46.	*Imperata cylindrica*	Cogon Grass	Herb	Common		
47.	*Ipomea carnea*	Pink Morning Glory	Shrub	Infrequent		Yes
48.	*Juglans regia*	Walnut	Tree	Infrequent		
49.	*Lantana camara*	Wild Sage	Shrub	Very Common		Yes
50.	*Malvastrum coromandelianum*	False Mallow	Herb	Common		
51.	*Melia azedarach*	Bead Tree	Tree	Infrequent		

[139] Dr. Muhammad Ibrar Shinwari et al 2007. Medicinal Plants of Margalla Hills National Park Islamabad, Higher Education Commission.

[140] Qammar Zaman and Riyaz Aziz Minhas, Medicinal Plants of Machiara National Park and their uses, protected Areas Management Project, Machiara National Park Department of Wildlife and Fisheries Azad Jammu and Kashmir

No.	Scientific Names	Common Names	Life Form	Abundance	Medicinal Plants[139 140]	Recorded from Area of Habita Loss
52.	*Mentha longifolia*	Wild Mint	Herb	Infrequent		
53.	*Monotheca buxifolia*		Tree	Infrequent		
54.	*Morus nigra*	Black Mulberry	Tree	Common		
55.	*Nerium oleander*	Oleander	Shrub	Common	√	Yes
56.	*Olea ferruginea*	Indian Olive	Tree	Common		Yes
57.	*Parthenium hysterophorus*	White top Weed	Herb	Very Common		
58.	*Pinus roxburghii*	Chir Pine	Tree	Very Common		
59.	*Populus mexicana*	Popolar	Tree	Common		
60.	*Ricinus communis*	Castor Oil Plant	Shrub	Common		
61.	*Saccharum sp.*		Grass	Common		Yes
62.	*Solanum nigrum*	Black Nightshade	Herb	Infrequent	√	
63.	*Solanum surrattense*	Yellow-Berried Nightshade	Herb	Infrequent		
64.	*Traxicum sp.*		Herb	Infrequent	√	
65.	*Xanthium strumarium*	Rough Cocklebur	Shrub	Very Common		
66.	*Ziziphus mauritiana*	Ber	Tree	Infrequent		Yes

Appendix C: Socio-economic Questionnaires

See following pages.

Date	DD	MM	YY	Questionnaire No.	

Rural Household Questionnaire

Investigator		Settlement	
Coordinates		Elevation	
Head of Household (HoH)		Respondent	
Relation to HoH			
Contact number			

Tenurial Status Owner ☐ Tenant ☐

Codes

Household	A household may be either a single person or a multi-person household. Household members may be related or unrelated and essentially include people who make common provisions for food and other essentials of living and have no usual place of residence elsewhere
Gender	**M** = Male **F** = Female
Marital Status	**MR** = Married **UM** = Unmarried
Education Grade or Level	**UE** = Uneducated **MD** = Madrassah **PR** = Primary (1 to 5) **SE** = Secondary (6 to 10) **IN** = Intermediate (10 to 12) **CL** = College (13 and 14) **MA** = Masters (15 and 16) **AM** = Above Masters
Employment Status	**E** = Employed **U** = Unemployed is a person seeking job since a month and is unable to find it **N** = Non-employed willingly. Is a jobless person not seeking job **S** = Student
Employment Type	**G** = Government servant **P** = Private or non-governmental **O** = Working overseas

Income Earning Activities	
FAR	Farmer who is land owner, is farming on his own land and earning income by selling farm produce
FAL	Farm labor is paid wages for helping the farmer
FAS	Sharecropper has a share in the crop in return for services on the farm
LIV	Livestock farmer who is owner of livestock and is earning income by selling livestock produce or animal
LIL	Shepherds or assists in shepherding the livestock
FIS	Catch and sale of fish
FIL	Labor services for catching and selling of fish
SAN	Sand and stone mining from own land or contractor on other person's land
SAL	Labor services for sand and stone mining
OLB	Other daily wage labor such as wood cutter, well digger, bricklayer. **Specify type of labor work.**
FOR	Cutting and selling wood
TRB	If a person earns through trade business. **Mention type of goods traded**
TOU	If a person earns by providing tourism related services, such as, tourist's guide, angler. **Specify tourist service.**
ART	Artisan makes and/or sells handicrafts, such as, carpet weaving, clothes
SHO	Shop-owner
SHK	Shopkeeper
SER	If a person is providing a service against a type of skill such as drivers, electricians, plumbers, mechanics, office peons, military, police, teacher. **Specify type of service.**
OTH	Other. **Specify type of work.**
Non-Income Generating Activities (Subsistence)	
S-FAR	Farmer is farming on his own land for the consumption of his own household
S-LIV	Livestock farmer is rearing livestock for the consumption of his own household
S-FIS	Catching fish for the consumption of his own household.

A. Household Profile

Use multiple rows where a household members has multiple occupations

No.	Relation to Head of Household	Age	Gender (M/F)	Marital Status (MR/UM)	Education		Income Earning Activities					Indicate if member also engaged in any subsistence activity
					Attending school (Yes/No)	Grade or Level Attained	Employment Status (E, U, N, R, S)	Employment Type (G, P, O)	Type of occupation	Income (PKR) *specify if daily, monthly or annual*	Work duration (days, months) *to calculate total annual income*	

No.	Relation to Head of Household	Age	Gender (M/F)	Marital Status (MR/UM)	Education		Income Earning Activities					Indicate if member also engaged in any subsistence activity
					Attending school (Yes/No)	Grade or Level Attained	Employment Status (E, U, N, R, S)	Employment Type (G, P, O)	Type of occupation	Income (PKR) *specify if daily, monthly or annual*	Work duration (days, months) *to calculate total annual income*	

A. Fuel Sources and Consumption

Type	*Price (Rs per Unit)*	*Source (e.g. grid, power plant, forest, market)*	*Use*			
			Lighting	*Space heating*	*Water heating*	*Cooking*
Electricity						
Fuel wood						
LPG						
Kerosene						
Diesel						
Other						

If any household member(s) is livestock owner, please provide the below information

Provide below information to estimate gross income from livestock rearing

Items	*No. Owned*	*Amount sold, bartered or consumed in last 12 months*	*Value per unit (PKR)*
Bullock/Buffalo			
Cow			
Goat			
Sheep			
Donkey			
Horse			
Camel			
Poultry			
Eggs (dozens)			
Milk (liters)			
Skin			
Other, specify below			
____________________			
____________________			

What is the main source of water for livestock? Tick multiple, if apply.

☐ Mountain streams ☐ River ☐ Other ____________________

Of the livestock that have to be watered, what proportion of watering is in the form of drinking at the river?

a. In summer

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

b. In winter

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

Grade water quality for livestock use for drinking:

a) Summer ☐ Poor ☐ Average ☐ Good

b) Winter ☐ Poor ☐ Average ☐ Good

Is the quality of river water for the animals affected by the flow rate? If so in what way.___________________

____

____

How much risk is there of livestock drowning during a flood? How much time do they spend near the river? Indicate incidences of drowning that occurred in the last five years.

____

____

B. Health

State the number of members who are suffering or have suffered from a disease during the last one year

Common Diseases	*Men (15 and above)*	*Women (15 and above)*	*Adult-Children (6 to 14)*	*Children (0 to 5)*
Cold and Flu				
Diarrhea				
Other stomach problems				
Breathing problems				
Jaundice or Hepatitis				
Typhoid				
Malaria				
Skin diseases				
Tetanus				
Tonsils				
Tuberculosis				
Body aches				
Diabetes				
Heart problems				
Eye disease				
Cancer				
Paralysis				
Other: ____________________				
____________________				
____________________				
____________________				
What is the average activity loss in days due to the disease incidence?				

In your opinion, which of these diseases have a relevance to the river water quality? Explain how.

____

____

Considering all the diseases the household members are suffering from, to what extent will the disease incidence worsen in case of any reduction in the river water quality?

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

C. Household Water Supply

Specify source of household water supply. Tick all that apply.

☐ Central storage tank ☐ Tap water ☐ Groundwater well

☐ Directly from mountain springs and streams ☐ Directly from river

☐ Other: ___________________________

If central storage and tap water, specify source of supply (mountain stream etc.): ________________________

If groundwater well, specify its approximate distance from the river:____________________________________

Are there ever any issues with water quality not being good enough for domestic use?

☐ Yes ☐ No

If yes, under what circumstances does this occur, such as, during floods, low flows, certain times of year? Identify issues in water quality.

____

____

D. River-related Activities

Considering all your household's recreational activities, to what extent does your household rely on the river environment as a location for recreational activities?

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________ %

What recreational activities, if any, do members of your household engage in at the river, such as, fishing, swimming, walking, relaxing and children playing?

____

____

____

Would your river recreational activities be affected by a decrease in river flow and depth during the dry season?

☐ Yes, negatively ☐ Not significantly ☐ Yes, positively

If yes, please explain how.

____

____

____

E. Sand Use

Do you use sand from River? ☐ Poonch River ☐ Mangla River ☐ No

If yes, what are its uses? ____

____

____

From where do you purchase sand?

Nearest town/Village name __________________ Vendor Name __________________ Distance (km) _______

How much sand you use in a year (specify quantity with unit)? ___________________________

Rate (specify rate with unit)? Summer __________________ Winter ___________________________

F. Gravel/boulder Use

Do you use gravel/boulder from River? ☐ Poonch River ☐ Mangla River ☐ No

If yes, what are its uses? ____

____

____

From where do you purchase gravel/boulder?

Nearest town/Village name __________________ Vendor Name __________________ Distance (km) _______

How much gravel/boulder you use in a year (specify quantity with unit)? __________________

Rate (specify rate with unit)? Summer __________________ Winter __________________

G. Fish Use

Do you use fish from River? ☐ Poonch River ☐ Mangla River ☐ No

If yes, what type of species? ____

From where do you purchase fish?

Nearest town/Village name __________________ Vendor Name __________________ Distance (km) _______

How much fish you use in a year (specify quantity with unit)? ___________________________

Rate (specify rate with unit)? Summer __________________ Winter ___________________________

Date | DD | MM | YY | **Questionnaire No.** |

Rural Settlement Questionnaire

Investigator ____________ Settlement ____________

Coordinates ____________ UC ____________

District ____________

A. Respondent Information

Name(s)	Role/Title/Responsibility	Contact Details

B. Demography

Household:	A household may be either a single person or a multi-person household. Household members may be related or unrelated and essentially include people who make common provisions for food and other essentials of living and have no usual place of residence elsewhere.
Masonry:	Houses with brick walls and concrete or tin roof.
Adobe:	Houses made of mud or unbaked bricks of clay and straw.

Total Households ____________ Estimated Population ____________

Proportion of Houses Adobe ____________ Proportion of Houses Masonry

Religion	Muslims	%	Other:	%
Ethnic Groups	*Group name*	*Share in population*	*Group name*	*Share in population*
		%		%
		%		%
		%		%

C. Occupational Profile

Occupation	*Share in employed population*	*Location/Industry (industrial area or outside)*	*Occupation*	*Share in employed population*	*Location/Industry (industrial area or outside)*
	%			%	
	%			%	
	%			%	

Date	DD	MM	YY	*Questionnaire No.*	

D. Recreational Spots

Is there any riverside recreational facility in or near the settlement? Yes ☐ No ☐

If yes, describe the facility and the recreational services provided there:

____

____

____

____

E. Educational Facilities

Facility Level	*Enrolment*	
	Male	*Female*

F. Health Facilities

Is there any healthcare facility available? Yes ☐ No ☐

Describe health care facility (Hospital, clinic, RHC, BHC, midwives)	*Location if outside settlement and distance (km)*

Date	DD	MM	YY	**Questionnaire No.**	

G. Water Supply and Sanitation

Water Supply (tick all that apply)

Source of water supply:

☐ Central storage tank ☐ Tap water ☐ Well

☐ Directly from springs ☐ River

If central storage tank or tap water, specify source of water:

____

If well, specify approximate distance of well from river:

____

Typical Sanitation (tick all that apply)

Pit Latrine ☐ Septic Tanks ☐ Other (Specify) ____________

H. Fuel Sources and Consumption

Type	*Price (Rs per Unit)*	*Source (e.g. grid, power plant, forest, market)*	*Use*			
			Lighting	*Space heating*	*Water heating*	*Cooking*
Electricity						
Fuel wood						
LPG						
Kerosene						
Diesel						
Other						

I. Infrastructure

Facility	*Access (Y/N)*	*Location if out of settlement*	*Description*
Telephone			
Mobile Phone Service			
Post Office			
Police Station			
Police Checkpost			
Regular Transport Service (Bus, Pick-up, Jeep, Car)			Provide description
Riverside hotels			

Facility	*Access (Y/N)*	*Location if out of settlement*	*Description*
Other hotels			
Recreational			
Bank			
Market			

J. Migration Patterns

Out-migration:

Has any household migrated from the settlement in the last 20 years? Yes ☐ No ☐

If yes, how many: ________________________________Migrated to:_________________________

What is the purpose of out-migration?

____

____

In-migration:

Has any household settled in the settlement during the last 20 years? Yes ☐ No ☐

If yes, how many:______________________________ Migrated from:______________________

What are the reasons for in-migration?

____

____

K. Needs Assessment

(In order of importance)

1. ____
2. ____
3. ____
4. ____
5. ____

Date	DD	MM	YY	Q. No.		Segment		Settlement	

Information on Sand/Gravel/Boulder Mining

Investigator ______________________ Coordinates ____________________

Name of Respondent ______________________ Contact ______________________

Site of mining, indicate all ____

Where do you mine sand/gravel? Name nearest town or village____________________________

Characterize your business as: ☐ small-scale ☐ mid-scale ☐ large-scale

How many other similar scale businesses there are in this area? ____________________________

How much sand/gravel/boulder are mined yearly (specify unity)? ____________________________

Do you transport sand/gravel/boulder to other locations? ☐ Yes ☐ No

If yes, specify location: ____

Distance: ______________________ Mode of transportation______________________________

Size of source______________________ Loading capacity______________________________

Provide below details

	Summer	*Winter*
Work period		
a) Daily hours		
b) Day in a month		
c) Months in a year		
Quantity of sand/gravel mined per day (specify unit)		
Sand/gravel price (specify unit)		

What are the reasons for seasonal variation in sand/gravel price? ____________________________

____

Do you use some of the extracted mine yourself? ☐ Yes ☐ No

If yes, what proportion is self-utilized? ______________________________________

What are its uses? ____

____

Do you pay any annual tax for sand/gravel/boulder mining? ☐ Yes ☐ No

If yes, mention amount? ____

Is there any annual increase in taxes? ☐ Yes ☐ No

If yes, mention %? ____

Date	DD	MM	YY	Q. No.		Segment		Settlement	

Provide information about the equipment or means you employ for mining sand/gravel. Specify if it is yours, rented or shared, and how much of its use is for sand/gravel mining against other activities. Specify how long does it last and what is its present cost to replace.

Equipment	*Number*	*Ownership*	*Equipment use for sand/gravel mining (%)*	*Durability (years)*	*Replacement cost (PKR)*

Specify how much is spent on labor and fuel for a day of mining. Indicate seasonal variations, if any.

	Wages per person (PKR)		*Persons hired per day*	
	Summer	*Winter*	*Summer*	*Winter*
Labor				

	Price per unit (specify unit)		*Units consumed per day*	
	Summer	*Winter*	*Summer*	*Winter*
Fuels				

Date DD | MM | YY **Q. No.** ____ **Segment** ____ **Settlement** ____

Information on Fishing

Investigator ____________________ Coordinates ____________________

Name of Respondent ____________________ Contact ____________________

Site of fishing, indicate all ____

Name nearest town or village to site of fishing, indicate all. ____

____

What is the total fish catch in a year (specify unit)? ____

Duration of fishing season ____

____

Characterize your fishing as: ☐ small-scale ☐ mid-scale ☐ large-scale

How many other such fishermen are there in this area? ____

Provide distribution of fish catch by fish species

Species	*Fish catch (KG)*	*Average weight/fish (KG)*	*Proportion self-consumed (%)*	*Unit Price (specify unit)*

If you sell fish to a commercial business, then specify business (hotel, market) and its location

____

Distance ____________ Mode of transport ____________________ Quantity (yearly) ____________

Do you pay any annual tax for fishing? ____

If yes, mention amount? ____

Is there any increase in taxes annually? ☐ Yes ☐ No

If yes, mention %? ____

Date	DD	MM	YY	Q. No.		Segment		Settlement	

Provide information about the equipment or means you employ for fishing. Specify if it is yours, rented or shared, and how much of its use is for fishing against other activities. Specify how long does it last and what is its present cost to replace.

Equipment	*Number*	*Ownership*	*Equipment use for fishing (%)*	*Durability (years)*	*Replacement cost*

Variable input costs of production (processing and transportation)

	Summer	*Winter*
Labor days required per year		
Proportion of labor hired (%)		
Labor wages (PKR)		
Other, specify		
______________________		
______________________		
______________________		
______________________		
______________________		

Angling

If you provide services as an angler or fishing guide for tourists, then please provide the below information for the last year

	Summer	*Winter*
Number of tourists taken		
Number of days guiding		
Income per day		
Expenditure per day		

Date	DD	MM	YY	**Questionnaire No.**	

Urban Household Questionnaire

Investigator		Segment	
Coordinates		Elevation	
Head of Household (HoH)		Respondent	
Relation to HoH			
Contact number			

Tenurial Status Owner ☐ Tenant ☐

Codes

Household	A household may be either a single person or a multi-person household. Household members may be related or unrelated and essentially include people who make common provisions for food and other essentials of living and have no usual place of residence elsewhere
Gender	**M** = Male **F** = Female
Marital Status	**MR** = Married **UM** = Unmarried
Education Grade or Level	**UE** = Uneducated **MD** = Madrassah **PR** = Primary (1 to 5) **SE** = Secondary (6 to 10) **IN** = Intermediate (10 to 12) **CL** = College (13 and 14) **MA** = Masters (15 and 16) **AM** = Above Masters
Employment Status	**E** = Employed **U** = Unemployed is a person seeking job since a month and is unable to find it **N** = Non-employed willingly. Is a jobless person not seeking job **S** = Student **R** = Retired
Employment Type	**G** = Government servant **P** = Private or non-governmental **O** = Working overseas

Income Earning Activities	
FAR	Farmer who is land owner, is farming on his own land and earning income by selling farm produce
LIV	Livestock farmer who is owner of livestock and is earning income by selling livestock produce or animal
FIS	Catch and sale of fish
SAN	Sand and stone mining from own land or contractor on other person's land
HOT	Hotel owner
OBS	Owner of other business. **Specify type of business owner**
DLB	Daily wage labor such as farm helper, wood cutter, well digger, bricklayer. **Specify type of labor work.**
TOU	If a person earns by providing tourism related services, such as, tourist's guide, angler. **Specify type of tourist service offered.**
TRD	If a person earns through trade of goods. **Mention type of goods traded**
SER	If a person is providing a service against a type of skill such as drivers, electricians, plumbers, mechanics, office peons, military, police, teacher. **Specify type of service.**
ART	Artisan makes and/or sells handicrafts, such as, carpet weaving, clothes
SHO	Shop-owner or shopkeeper
OTH	Other. **Specify type of work.**
Non-Income Generating Activities (Subsistence)	
S-FAR	Farmer is farming on his own land for the consumption of his own household
S-LIV	Livestock farmer is rearing livestock for the consumption of his own household
S-FIS	Catching fish for the consumption of his own household.

A. Household Profile

Use multiple rows where a household members has multiple occupations

No.	Relation to Head of Household	Age	Gender (M/F)	Marital Status (MR/UM)	Education		Income Earning Activities					Indicate if member also engaged in any subsistence activity
					Attending school (Yes/No)	Grade or Level Attained	Employment Status (E, U, N, R, S)	Employment Type (G, P, O)	Type of occupation	Monthly Income (PKR)	Work duration (days, months)	

No.	Relation to Head of Household	Age	Gender (M/F)	Marital Status (MR/UM)	Education		Income Earning Activities					Indicate if member also engaged in any subsistence activity
					Attending school (Yes/No)	Grade or Level Attained	Employment Status (E, U, N, R, S)	Employment Type (G, P, O)	Type of occupation	Monthly Income (PKR)	Work duration (days, months)	

If any household member(s) has identified themselves as a farmer (income or subsistence), please provide the below information

Total land cultivated (specify unit): ______________________________

What proportion is cultivated in a year? ______________________________

Provide information on cultivated land by crop type

Crop name	*Season (Summer/ Winter)*	*Area Cropped (specify unit)*	*Self Consumption (%)*

To what extent does your crop production depend on the river for water or fertile soils?

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

Does the dependence vary by crop type? Explain how and indicate variations.

____

____

If any household member(s) is involved in fishing for subsistence purposes or as a source of income, please provide the below information

Name nearest town or village to site of fishing ______________________________

How far do you have to travel to site of fishing (km)? ______________________________

What is the total fish catch in a year (*specify unit*)? ______________________________

Fishing season (indicate months) ______________________________

Provide distribution of fish catch by fish species. If species name is not known provide other characteristics, such as, adult fish size, color

Species	*Fish catch (specify unit)*	*Proportion self-consumed (%)*

If you sell fish to a commercial business, then specify business (hotel, market) and its location?

____

If any household member(s) is employed as an angler or fishing guide by tourists, then please provide the below information for the last year

	Summer	*Winter*
Number of tourists taken		
Number of days guiding		
Income per day		
Expenditure per day		

If any household member(s) has identified themselves as a sand-miner, please provide the below information

Where do you mine sand? Name nearest town or village____

Provide work timings. Include seasonal variations:

	Summer	*Winter*
Work period		
a) Daily hours		
b) Day in a month		
c) Months in a year		
Quantity of sand mined per day (specify unit)		
Sand price (specify unit)		

Do you use some of the extracted mine yourself? ☐ Yes ☐ No

If yes, what proportion is self-utilized? ____

What are its uses? ____

____

If any household member(s) is livestock owner, please provide the below information

Provide below information to estimate gross income from livestock rearing

Items	*No. Owned*	*Amount sold, bartered or consumed in last 12 months*	*Value per unit (PKR)*
Bullock/Buffalo			
Cow			
Goat			
Sheep			
Donkey			
Horse			
Camel			
Poultry			
Eggs (dozens)			
Milk (liters)			
Skin			

Items	*No. Owned*	*Amount sold, bartered or consumed in last 12 months*	*Value per unit (PKR)*
Other, specify below			
____________________			
____________________			

What is the main source of water for livestock? Tick multiple, if apply.

☐ Mountain streams ☐ River ☐ Other ____________________

Of the livestock that have to be watered, what proportion of watering is in the form of drinking at the river?

a. In summer

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

b. In winter

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

Grade water quality for livestock use for drinking:

a) Summer ☐ Poor ☐ Average ☐ Good

b) Winter ☐ Poor ☐ Average ☐ Good

Is the quality of river water for the animals affected by the flow rate? If so in what way.__________________

____

How much risk is there of livestock drowning during a flood? How much time do they spend near the river? Indicate incidences of drowning that occurred in the last five years.

____

____

Are you in debt? ☐ Yes ☐ No

If yes, specify amount (PKR/year): ____

Purpose ____

B. Migration Patterns

Years since settled in Kotli city: ____

Previous location, if applicable: ____

Purpose of relocation from previous place, if applicable: ______________________________

C. Health

State the number of members who are suffering or have suffered from a disease during the last one year

Common Diseases	*Men (15 and above)*	*Women (15 and above)*	*Adult-Children (6 to 14)*	*Children (0 to 5)*
Cold and Flu				
Diarrhea				
Other stomach problems				
Breathing problems				
Jaundice or Hepatitis				
Typhoid				
Malaria				
Skin diseases				
Tetanus				
Tonsils				
Tuberculosis				
Body aches				
Diabetes				
Heart problems				
Eye disease				
Cancer				
Paralysis				
Other: ____________________________				
___________________________________				
___________________________________				
What is the average activity loss in days due to the disease incidence?				

In your opinion, which of these diseases have a relevance to the river water quality? Explain how.

____

____

Considering all the diseases the household members are suffering from, to what extent will the disease incidence worsen in case of any reduction in the river water quality?

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________%

D. River-related Recreational Activities

Considering all your household's recreational activities, to what extent does your household rely on the river environment as a location for recreational activities?

☐ none at all ☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________ %

What recreational activities, if any, do members of your household engage in at the river, such as, fishing, swimming, walking, relaxing and children playing?

____

____

Would your river recreational activities be affected by a decrease in river flow and depth during the dry season?

☐ Yes, negatively ☐ Not significantly ☐ Yes, positively

If yes, then specify the percentage change in the river water depth and flow during the dry season:

☐ less than 25% ☐ 25% ☐ 25 to 50%

☐ 50% ☐ 50 to 75% ☐ 75% to 100% ☐ _________ %

Please explain how. ____

____

E. Other Impacts

Specify below any other ways in which the reduction in river water flow and depth can affect you and the local environment

Impact	*Positve or Negative*	*Percentage change in dry season water depth or flow at which impact will occur*

F. Sand Use

Do you use sand from River? ☐ Poonch River ☐ Mangla River ☐ No

If yes, what are its uses? ____

____

____

From where do you purchase sand?

Nearest town/Village name __________________ Vendor Name __________________ Distance (km) _______

How much sand you use in a year (specify quantity with unit)? __________________________________

Rate (specify rate with unit)? Summer __________________ Winter __________________________

G. Gravel/boulder Use

Do you use gravel/boulder from River? ☐ Poonch River ☐ Mangla River ☐ No

If yes, what are its uses? ____

____

____

From where do you purchase gravel/boulder?

Nearest town/Village name __________________ Vendor Name __________________ Distance (km) _______

How much gravel/boulder you use in a year (specify quantity with unit)? __________________

Rate (specify rate with unit)? Summer __________________ Winter __________________

H. Fish Use

Do you use fish from River? ☐ Poonch River ☐ Mangla River ☐ No

If yes, what type of species? ____

From where do you purchase fish?

Nearest town/Village name __________________ Vendor Name __________________ Distance (km) _______

How much fish you use in a year (specify quantity with unit)? ____

Rate (specify rate with unit)? Summer __________________ Winter __________________________________

Appendix D: Hydrology Specialist Report

See following pages.

HYDROLOGY SPECIALIST REPORT

FINAL REPORT – POONCH RIVER HYDROLOGY

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LIST OF ANNEXES

LIST OF APPENDICES

LIST OF ABBREVIATIONS / ACRONYMS

ADB	Asian Development Bank
EF	Environmental Flow
HBP	Hagler Bailly Pakistan (Pvt.) Limited
IFC	International Finance Corporation
IPP	Independent Power Producer
MPL	Mira Power Limited
NESPAK	National Engineering Services Pakistan (Pvt.) Ltd.
SWH	Surface Water Hydrology
WAPDA	Water and Power Development Authority

1. INTRODUCTION

1.1 BACKGROUND

Mira Power Limited (MPL), an Independent Power Producer (IPP), is planning to develop Gulpur Hydropower Project (GHP) in the Azad Jammu & Kashmir (AJK). GHP is a run-of-river hydroelectric plant, which will utilize the natural flows of Poonch River and a potential head available between the intake and the powerhouse to generate 100 MW installed capacity.

Poonch River for its full length within AJK has been declared as a national park by the Wildlife and Fisheries Department of Government of AJK. Given the environmental considerations of the area, the potential financers, International Finance Corporation (IFC) and Asian Development bank (ADB) have requested to undertake the biodiversity scoping, assessment and management study in the GHP site and vicinity.

Subsequent to the request initiated by the potential financers, MPL entrusted this study to M/S Hagler Bailly Pakistan (HBP). HBP further hired the services of National Engineering Services of Pakistan (NESPAK) as sub-consultants to undertake the hydrological study specifically to ascertain the water availability at the project site which would be required in an overall modelling framework viz. Downstream Implications of Flow Transformation (DRIFT) by HBP.

1.2 REPORT OBJECTIVES

The construction of GHP would result in a change in the flow regime in Poonch River, immediately downstream of the dam site. In order to evaluate any impacts this change might have on the environment, it is imperative that accurate stream-flow data of Poonch River is available. Furthermore, synthetic flow data (if stream-flow data is not available) at environmentally sensitive sites of the river may also be required for a comprehensive environmental assessment of the impacts of GHP.

One key objective of this report has been to check the consistency and credibility of the discharge data for Poonch River at Kotli / Rehman Bridge gauging station, provided by HBP to NESPAK. It was further required that synthetic flow data be generated for four environmental sites (ungauged) specified by HBP and communicated to NESPAK. HBP's specific requirement in this regard was a daily discharge time series of the four specified sites (also referred as EF sites in subsequent discussions), both with and without GHP. HBP intends to incorporate the hydrological data provided by NESPAK into their DRIFT Decision Support System (DSS) for environmental impact assessment of GHP.

This report provides a detailed account of the process of verification of gauged data at Kotli station, as well as a detailed description of the methodology and assumptions employed for generation of daily synthetic flows at the four predefined environmental flow sites.

1.3 SCOPE OF SERVICES

The scope of Services for the Sub-Consultancy Agreement signed between HBP (the 'Client') and NESPAK (the 'Consultant') are:

- Collection of available hydrology data and collation of data in the detail, extent, and format suitable for use in DRIFT model
- Coordination with the hydrologist in the modelling team of Southern Waters to facilitate integration into the DRIFT model
- Coordination with hydraulic survey team for the field survey requirements
- Collection of available hydraulic data and collation of data in the detail, extent, and format suitable for use in DRIFT model
- Coordination with the hydraulics expert in the modelling team of Southern Waters to facilitate integration into the DRIFT model
- Collection of available sediment data and compilation of data in the form suitable for use in DRIFT model
- Coordination with the experts in the modelling team of Southern Waters to facilitate integration of sedimentation information into the DRIFT model.

1.4 HYDROLOGICAL SETTING

The Poonch River basin is one of the five sub-basins of the Jhelum River basin upstream of Mangla Reservoir. Poonch River is a major tributary of the Jhelum River, and has a catchment area of about 3,732 km^2 at the dam site (Option 1). The Poonch River rises on the southern slopes of the Pir Panjal range and flows directly into Mangla Reservoir (Archer and Fowler, 2008). The basin area of Poonch primarily entails mountains and has small farms and dwellings along the banks of the river and its main tributaries.

Poonch has a significantly different runoff pattern than the other major tributaries of Jhelum with monsoon rains being the major runoff contributor in summers (rather than snowmelt) and direct rainfalls being the major runoff contributor in winter and spring. This might be due to the relatively low mean elevation of the Poonch basin (See Figure 1 for index map depicting physiography of the basin), which is 1,805 m (Archer and Fowler, 2008; Yaseen et. al., 2014).

The GHP dam site (Option 1) is located approximately 5 km south of Kotli, which is downstream of the confluence of Poonch River and Bann Nullah. Location map of the GHP dam site is depicted in Figure 2.

1.5 OVERVIEW OF HYDROLOGICAL DATA

The Surface Water Hydrology (SWH) Directorate of Pakistan's Water and Power Development Authority (WAPDA) records daily discharge data of Poonch River at Kotli station, which is upstream of the dam site. SWH records gauge data at the Kotli gauging station on a daily basis and use a stage-discharge relationship to compute discharge from gauge height. Discharge data at Kotli is available in published form since 1960.

HBP obtained the published daily discharge data of Kotli station from SWH for the period of 52 years from 1960-2011, and subsequently provided the same to NESPAK for the aforementioned hydrological analysis. NESPAK's assessment of the data quality at Kotli station has been discussed in subsequent sections of this report.

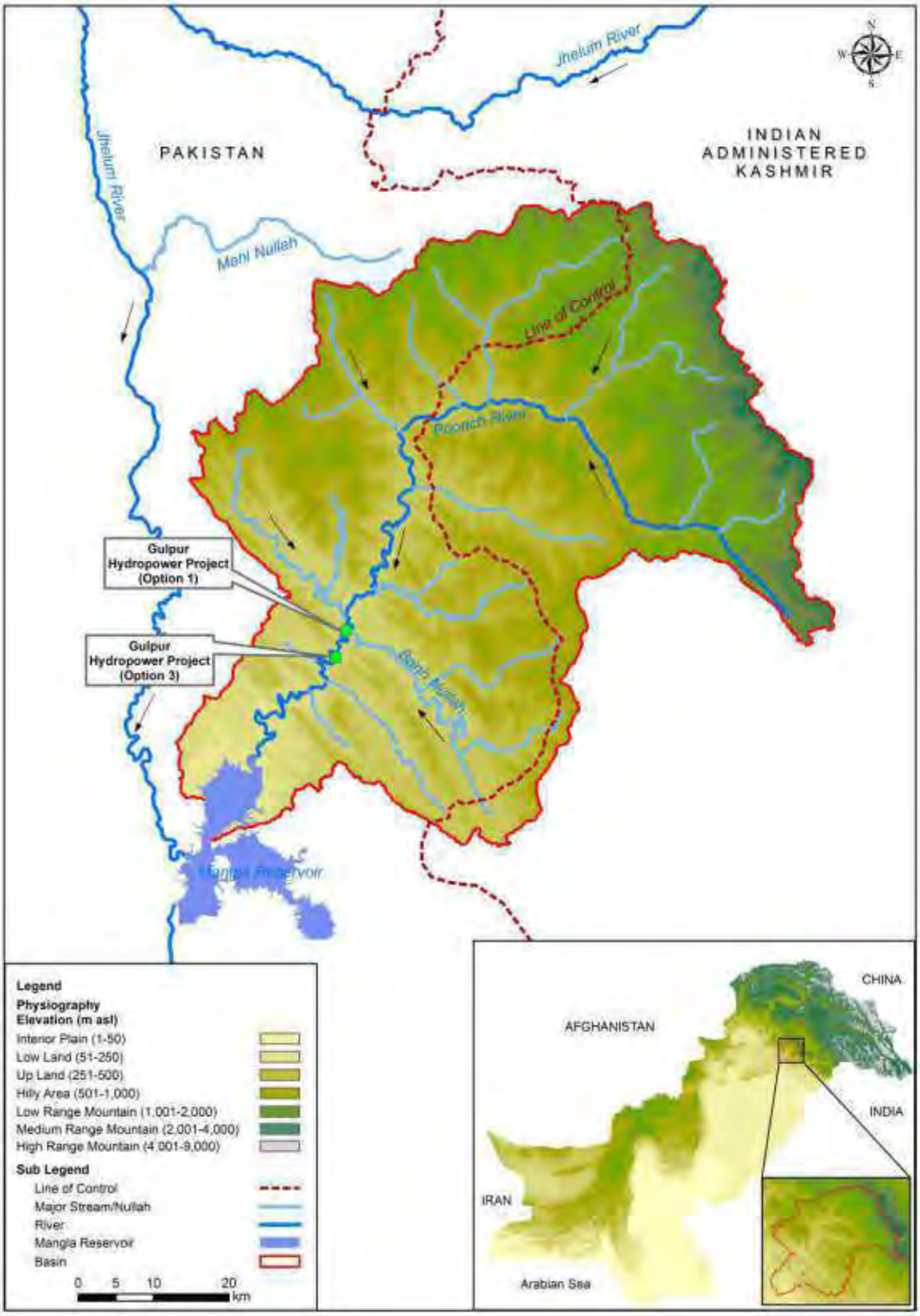

Figure 1: Basin map of Poonch depicting Physiography of the Basin

Figure 2: Gulpur Hydropower Project Layout for Option 1 and 3 and Environmental Flow Site Locations

1.6 SUMMARY OF STUDY APPROACH

The discharge data provided by HBP in electronic format has been examined via a comparison with discharge data of neighbouring streams within the Jhelum basin to ascertain the inter-tributary correlation. The analysis substantiated the uniqueness of the hydrology of Poonch River relative to other tributaries of the Jhelum River. Besides, an independent check was also applied on random values of HBP's provided electronic data to ascertain whether these are essentially similar as of the published data. Further to ascertain the quality of the data an overall understanding has been made of the discharge estimation procedures adopted by SWH.

The above steps were followed by estimation of daily synthetic discharge time series at the four environmental flow sites specified by HBP. Given the close proximity of all of the four environmental flow sites the catchment area method has been used for development of the synthetic daily discharge time series. Sections 2 and 3 of this report provide a detailed account of the hydrological analysis performed.

2. REVIEW OF HYDROLOGICAL DATA

2.1 COMPARISON WITH NEIGHBOURING STATIONS

HBP provided NESPAK with daily discharge data at Kotli station for years 1960 to 2011. The first step of the hydrological analysis was a review of the hydrological data provided by HBP. In this process, the data series at Kotli was compared against neighbouring stream-flow gauging stations of the Jhelum basin to ascertain the overall hydrological behaviour of the stream with respect to the other streams flowing within the same (Jhelum) basin.

Figure 3 provides a visual comparison of long-term 10-day average hydrographs of Poonch River at Kotli, Neelum River at Muzaffarabad, Neelum River at Gurez/Wampora, Kunhar River at Naran and Jhelum River at Hattian Bala.

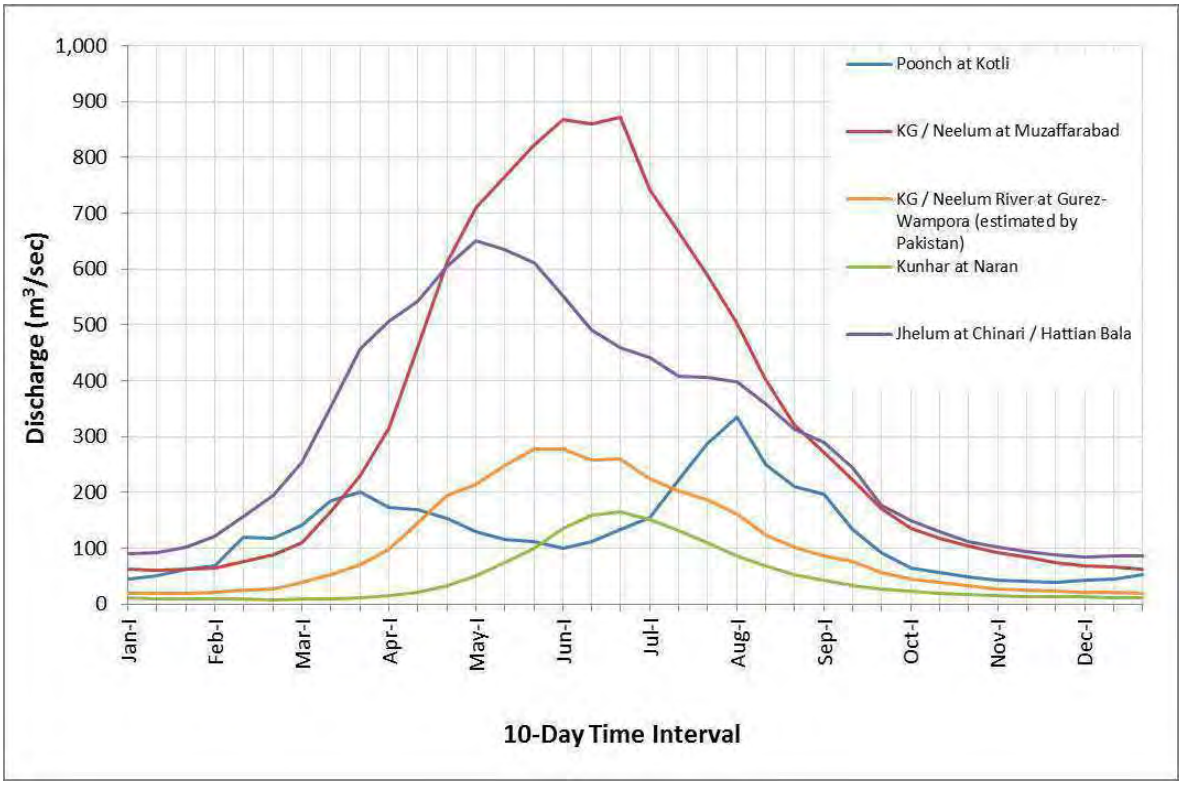

Figure 3: Comparison of long-term 10-day average hydrographs of Poonch, Neelum, Kunhar and Jhelum

It can be seen in Figure 3 that in general the streams flowing in the Jhelum basin encounter one peak except for the Ponnch River which exhibits two peaks as observed at Kotli. Hence, the hydrological behaviour of the Poonch sub-basin is different from neighbouring sub-basins of the Jhelum basin.

2.2 RELIABILITY OF DATA FROM KOTLI GAUGING STATION

Due to the considerable difference in the hydrology of Poonch basin relative to neighbouring basins, a more in depth examination of the reliability of hydrological data of Poonch River at Kotli was deemed necessary. In this regard, a team of NESPAK accompanied HBP to the Kotli gauging site on November 10, 2013. During the site visit, the NESPAK team examined the protocols adopted by SWH for collection of gauge data and reaffirmed the quality of stream-flow data being collected by SWH. During the visit, the gauge location was visited to check its condition and zero datum. The gauge record book was also checked for current readings and of past few days. Besides the discharge measuring setup was also checked which comprised 'on the spot' inspection of current meter[1] by applying timed spin test, frequency of gauge and discharge observations during different periods in a year and physical means to undertake current meter measurements across the river.

The gauge reader informed that current meter was calibrated in year 2011 and there were no subsequent calibrations, however physical condition of the current meter was satisfactory exhibiting the metal cups in proper shape with no bends, and rotor was moving freely with no abrupt stoppage. The spin time observed during the field test was slightly higher than 2 minutes. The cat whiskers of the current meter were also checked to get a strong, even click. Distinct sound of clicks is critical for noting the number of revolutions during flow measurement. On the basis of above mentioned site observations the meter was considered in good condition.

Frequency of gauge and discharge observation varies from low to high flow seasons. During low flow season current meter measurements are made per two week whereas in flood season the frequency is increased to once per week. Gauge observations are made from 8:00 am to 5:00 pm during normal flows whereas during floods i.e. 15 June to 15 August, gauge readings are observed at every hour. The observed gauges are transmitted to SWH office at Rawalpindi where these are translated into discharges as per the latest valid gauge-discharge rating table. These discharges along with their corresponding gauges are then sent to the headquarters of SWH at Lahore as raw data. SWH directorate at Lahore continuously monitor any potential shift in the gauge-discharge relation due to potential changes in bed, and act accordingly to revise and issue the applicable gauge-discharge rating table.

The visiting team was satisfied with the discharge estimation procedure and protocols followed to measure and finalise the discharges at the gauging site.

It was noted that geographical coordinates of Kotli gauge site (also known as the Rehman Bridge gauging site) as per SWH annual data publications locate the gauge site upstream of confluence of Poonch River and Bann nullah. However, during the site visit it was confirmed that gauge is located downstream of confluence of Poonch river and Bann nullah and is situated around 100m upstream of the proposed dam site. Figures 4-5 show the actual setting of gauge and discharge measuring site with reference to the confluence of Bann nullah with Poonch River.

Given the above understanding, the daily discharge data as published in SWH's 'year books' has been considered valid for use in ascertaining the long-term water availability at the GHP and the four environmental sites.

[1] Price type AA current meter is being used for discharge measurements by SWH at Kotli gauging station.

Figure 4: Pooch River at Kotli – Gauge Location is downstream of confluence of Poonch River and Bann Nullah; the painted gauge is on a rock protruding from left bank of Poonch River

Figure 5: Pooch River at Kotli – This figure illustrates that gauge location is downstream of confluence of Poonch River and Bann Nullah

3. METHODOLOGY FOR ESTIMATION OF SYNTHETIC STREAMFLOW DATA

3.1 SYNTHETIC FLOW ESTIMATION METHODOLOGY

Synthetic flow data at specified environmental flow sites was generated on the basis of catchment area proportions. The Environmental Flow sites (EF1 to EF4), dam site and gauge location are marked in Figure 6, and catchment area proportions of each site (relevant to gauge site) are provided in Table 1.

Given the fact that maximum variation in catchments from EF 1 to EF 4 are +-32% and we have no other river gauging station to measure the flows of main-stem of Poonch River, the catchment area proportion method seems most suitable for generating synthetic flows.

It is worth mentioning that the increment in catchment area between the dam site (or the hydropower intake) and the EF site 2 is about 0.2%. One option could be to simply use the flow series estimated at the dam site but due to perennial contribution from an intermediate stream pouring into Poonch River between the dam site and the EF 2, the flows estimated at the dam site have been enhanced by 0.2% (in accordance with the catchment proportion) to synthesise flow series at EF 2.

This study was initially carried out on the basis of Design Option 1, therefore numerical calculations are carried out for Option 1 and the design was later changed to Option 3. Nevertheless, the difference in catchment area between EF Site 2 for Option 1 and Option 3 is only 0.2 % (as percentage of total area at gauging station) and no perennial tributaries are present between the flows at EFlow Site 2 (Option 1) and EF Site 2 (Option 3). Therefore the numerical results for EF Site 2 of Option 3 can be considered the same as those for Option 1. As mentioned previously the EF Site 2 calculations use a catchment area proportion of 0.2%.

Table 1: Geographical coordinates, catchment areas and catchment area proportions for Rehman Bridge, EF sites and Dam site

Sr. No.	Site Description	Geographical Coordinates		Catchment Area at the Location (km^2)	Catchment Area Proportion
		Latitude	Longitude		
(1)	(2)	(3)	(4)	(5)	(6)
1.	Rehman Bridge Gauging Station	33° 29' 5"N	73° 52' 52"E	3,732	1.000
2.	EF Site 1	33° 34' 43"N	73° 56' 14"E	2,540	0.681
3.	Dam Site (Option 1) Dam Site (Option 3)	33° 29' 3"N 33° 27' 20"N	73° 52' 44"E 73° 52' 44"E	3,732 3,741	1.000 1.002
4.	EF Site 2 Old (Option 1) EF Site 2 New (Option 3)	33° 28' 19"N* 33° 27' 14"N	73° 52' 11"E 73° 52' 60"E	3,741 3,748	1.002 1.004
5.	EF Site 3 (after tail race tunnel and river confluence)	33° 26' 57"N	73° 50' 13"E	3,815	1.022
6.	EF Site 4	33° 23' 4"N	73° 47' 29"E	4,097	1.098

SWH's published mean daily discharge data of Poonch River at Kotli / Rehman Bridge station for years 1960 to 2011 is attached as Appendix A. The present day mean daily synthetic flow data, based on SWH's aforesaid published discharge data, generated for the four environmental flow sites has been attached with this document as Appendix B-E.

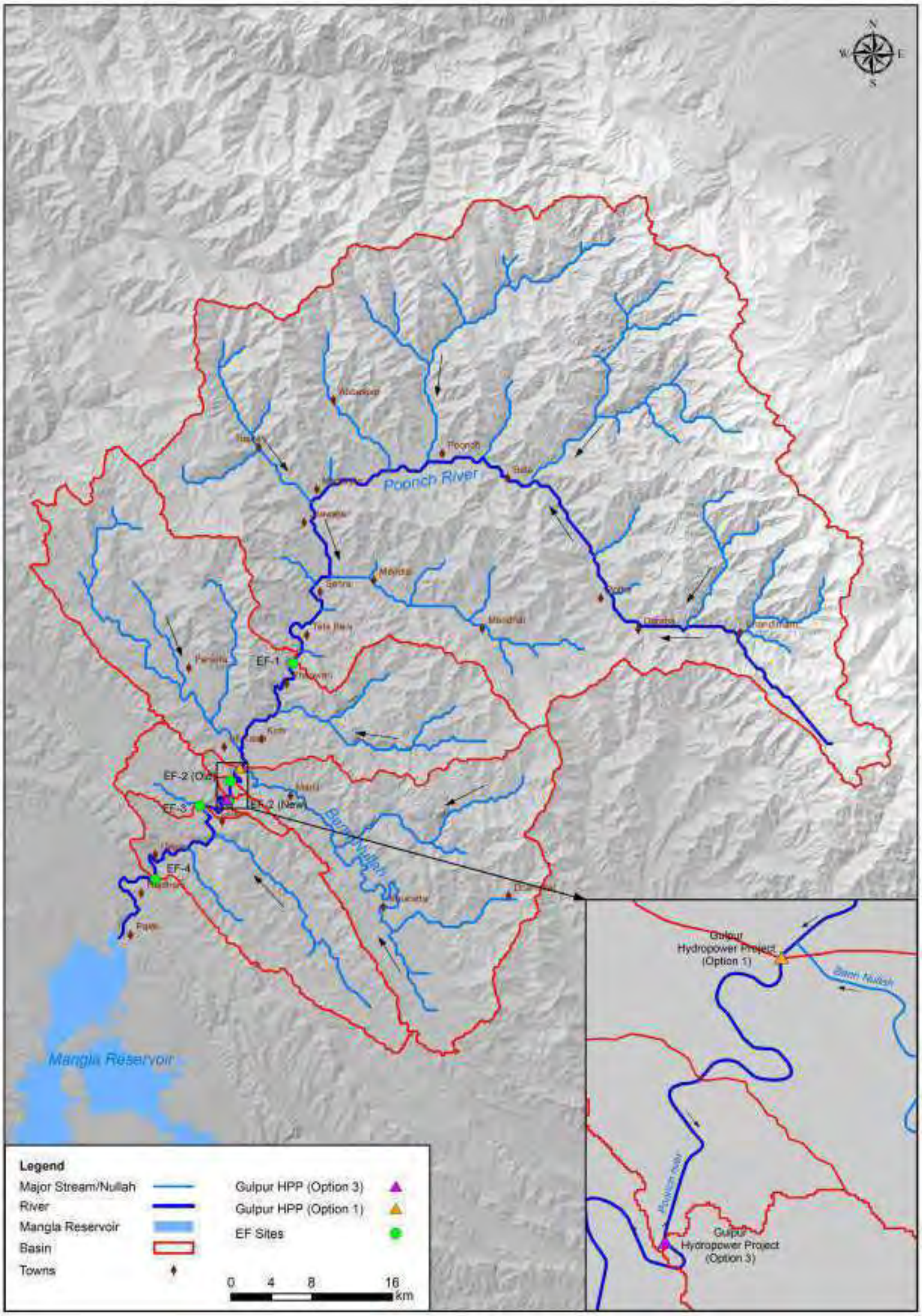

Figure 6: Catchment Area Map for Gulpur Hydropower Project Environmental Flow Sites

3.2 SYNTHETIC FLOW AT EF SITIES – ‘WITH PROJECT’

With the construction of GHP, Poonch River flows would be drawn away from the river into the GHP powerhouse and eventually returned back after a short stretch viz. between the dam and the powerhouse. Due to this variation in natural flow pattern in the river stretch in which the flows would be re-routed via the project water conductor system, certain changes would be likely in the existing (baseline) biodiversity of the river system. In this regard EF2 site would be the relevant location in terms of potential change in the natural flow pattern; EF3 is located downstream of the tailrace of GHP (see Figure 2).

It is however important to mention that the long-term natural flow regime at the dam site leads to the fact that for a significant period of time i.e. on average almost 60 days each year during winter, the natural flows at dam site remained less than even half of the design discharge of one turbine unit. This situation warrants the flow regulation to operate the plant on intermittent basis in 24 hours duration (logically at peak electricity demand hours).

To ascertain the logical peaking operation duly conforming to the natural flow variation observed in historic flow records as well as accounting for the mandatory releases to take care of integrity of the aquatic environment below the dam, optimisation study is required to be undertaken.

Keeping in view the available flows at the dam site, the given configuration (capacity and number of units) of turbines and considerable magnitude of available winter flows likely to be released below the dam for environmental purposes it is strongly appreciated that the only possible operation for GHP during the winter months of November to February would be the intermittent (instead of a typical run-of-river) operation. Such an operation would cause flow pulses downstream of the tailrace of GHP and would warrant estimation of flow time series for EF sites 3 & 4 as well.

Since the project operation has not been finalised yet and a debate is continuing concerning the project’s mode of operation and even on the layout too, the present day flow series estimated at EF2 has been modified by assuming the following:

(i) the plant will be operated in a pure run-of-river mode with no-peaking even in winter;
(ii) powerhouse design discharge equivalent to 194 m^3/s to run the plant at installed capacity; and
(iii) the minimum environmental release equivalent to 4 m^3/s

The modified flow series as estimated based on above assumptions has been termed as ‘With Project’ flow series (mean daily synthetic discharge data for the same at EF2 is attached as Appendix F).

Summary of estimated flows for both ‘Present Day’ and ‘With Project’ scenarios have been provided in Table 2 at the dam and the EF sites. Mean monthly discharge time series for Kotli / Rehman Bridge (actual) and EF sites (synthetic) are provided in Annexes I-VI. A visual comparison (histogram) of ‘Present Day’ and ‘With Project’ long-term average monthly flows at EF2 is provided in Figure 7. It can be seen that long-term average monthly flows reduce significantly at EF2 in the 'With Project' scenario.

Table 2: Comparison of 'Present Day' and 'With Project' Long-Term Monthly Flows at Different Locations on Poonch River

all values in m^3/s

Site	Condition	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kotli	Present Day	53.0	100.6	177.0	165.2	119.1	115.9	224.5	263.9	140.6	57.0	40.7	46.7
	With Project	----- No Applicable -----											
Dam (Option1)	Present Day	53.0	100.6	177.0	165.2	119.1	115.9	224.5	263.9	140.6	57.0	40.7	46.7
	With Project	----- No Applicable -----											
EF1	Present Day	36.1	68.5	120.5	112.4	81.1	78.9	152.8	179.6	95.7	38.8	27.7	31.8
	With Project	----- No Applicable -----											
EF2 (Option1)	Present Day	53.2	100.8	177.4	165.6	119.4	116.1	225.0	264.5	140.9	57.2	40.8	46.8
	With Project	**9.7**	**23.6**	**53.5**	**32.1**	**9.3**	**12.3**	**86.2**	**110.3**	**36.1**	**5.1**	**4.8**	**10.1**
EF3	Present Day	54.2	102.8	180.9	168.9	121.7	118.5	229.5	269.8	143.7	58.3	41.6	47.7
	With Project	----- No Applicable -----											
EF4	Present Day	58.2	110.4	194.3	181.3	130.7	127.2	246.5	289.7	154.3	62.6	44.7	51.2
	With Project	----- No Applicable -----											

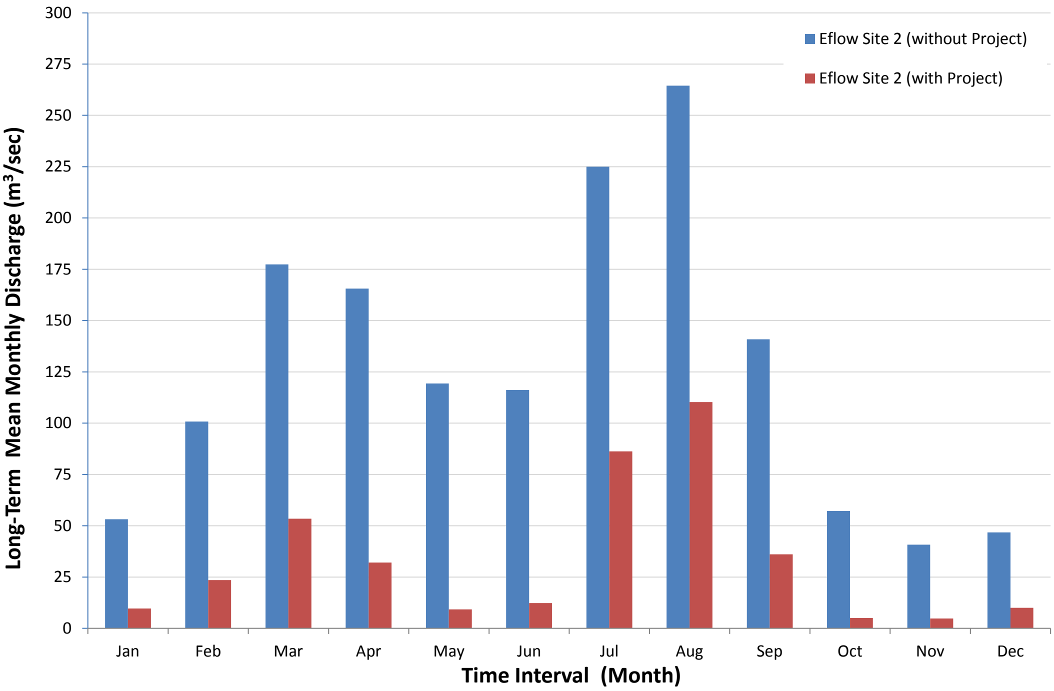

Figure 7: Visual Comparison of ‘Present Day’ and ‘With Project’ Long-Term Monthly Flows at EF Site 2

4. BASELINE HYDRAULICS

According to the TOR river flow hydraulic study was required to provide key parameters viz. flow depth, velocity, top width etc. corresponding to varying river flows relevant to various flow conditions. One of the basic requirements to undertake the hydraulic study was to undertake topographic and bathymetric survey of the river reach relevant to the current study. In this regard HBP arranged for the required river survey from its own resources. The river surveys were provided in the form of river cross sections to the DRIFT modelling team. In accordance with the TOR NESPAK has provided assistance to the DRIFT modelling team to undertake the desired modelling study. Results of numerical hydraulic modelling have been presented in a separate report.

5. BASELINE SEDIMENT DYNAMICS

Beside the discharge measurements, SWH also observes suspended sediment concentrations on sporadic basis. These concentrations are further categorised into sand, silt and clay fractions. These sediment data are available on long term basis since 1960. For the purposes of DRIFT modelling, the suspended sediment concentrations time series is required as such to ascertain the impact of varying flow regimes on the biodiversity. The available suspended sediment concentrations have been therefore provided to the DRIFT modelling team along with the respective particle size distribution for the concentrations exceeding 500 ppm. Results of DRIFT modelling duly incorporate the impact of sediments.

6. LITERATURE

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ANNEXES

(I – VI)

ANNEX I

MEAN MONTHLY DISCHARGE OF POONCH RIVER
AT REHMAN BRIDGE (KOTLI) / JUST UPSTREAM OF PROPOSED DAM SITE
(WITHOUT PROJECT)

(m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	38.0	39.4	161.2	112.6	80.7	56.2	329.8	233.0	74.1	29.7	20.1	16.0
1961	48.5	97.1	85.4	207.7	74.9	111.0	296.6	238.4	323.5	73.4	50.5	40.4
1962	21.7	53.6	77.9	159.4	82.5	70.4	154.5	142.9	122.1	45.5	32.8	31.6
1963	23.1	35.3	122.7	138.5	142.1	121.8	212.0	267.2	85.2	19.5	20.1	30.1
1964	155.3	84.5	106.9	138.5	86.7	76.7	331.1	361.0	126.3	43.4	21.2	33.1
1965	54.8	159.1	128.7	293.4	194.0	146.1	223.6	147.4	60.8	25.9	21.4	14.9
1966	12.2	94.1	152.9	143.1	140.7	137.7	238.9	286.3	354.0	119.7	34.8	28.7
1967	23.0	69.0	216.0	191.1	127.5	103.7	225.9	253.5	123.8	49.3	29.0	103.6
1968	115.4	145.4	159.7	140.2	90.6	103.1	170.9	272.4	67.7	55.4	42.4	26.4
1969	27.4	70.5	165.3	137.3	165.5	106.7	188.9	253.9	61.8	52.3	26.5	18.0
1970	25.9	32.6	76.3	73.3	52.9	76.0	113.7	297.8	256.7	53.9	23.2	17.2
1971	14.3	29.9	42.3	66.6	69.6	186.3	205.5	289.9	83.6	30.5	27.6	20.8
1972	27.2	84.5	137.5	105.8	97.5	71.8	181.1	195.7	120.7	59.9	35.6	43.4
1973	110.1	143.7	266.5	156.6	96.7	116.0	195.8	456.4	148.7	53.0	26.3	23.5
1974	34.9	73.6	101.3	76.3	52.8	119.2	157.5	111.2	45.3	25.7	14.6	16.8
1975	17.1	69.5	138.5	132.1	109.1	97.8	213.5	489.5	239.5	54.8	29.8	20.0
1976	52.5	190.3	217.4	196.7	151.1	147.3	355.2	664.5	177.0	60.3	31.4	24.9
1977	68.2	57.4	60.8	101.3	119.3	118.6	408.6	280.6	141.2	83.6	51.4	65.8
1978	70.6	94.5	362.3	200.9	163.5	166.2	451.7	455.5	154.8	67.3	74.8	35.4
1979	23.6	67.8	280.3	144.1	90.9	106.9	120.1	218.9	137.3	61.9	52.5	43.9
1980	58.8	98.1	168.4	109.8	97.3	147.0	132.6	149.9	74.9	43.6	44.9	33.5
1981	73.9	180.8	314.5	216.5	130.2	80.1	293.4	202.1	51.9	36.4	25.6	20.2
1982	22.8	53.1	269.5	264.9	189.8	119.7	196.7	324.2	58.8	40.6	52.8	41.6
1983	65.5	82.6	283.1	396.0	220.7	142.8	225.6	302.9	193.6	57.5	36.9	25.4
1984	20.5	30.3	57.5	103.9	68.4	99.2	129.9	375.2	231.1	62.6	39.7	34.9
1985	49.0	54.0	55.8	79.6	77.7	68.8	231.2	218.6	63.2	63.3	45.3	97.9
1986	46.3	99.0	303.5	256.5	169.5	148.2	223.7	318.7	85.7	71.8	113.8	171.5
1987	70.1	93.9	168.9	159.8	214.3	163.6	110.4	119.0	58.4	80.0	37.6	32.9
1988	32.7	49.8	233.8	126.6	70.8	75.2	633.3	353.3	111.9	64.4	45.1	50.9
1989	75.4	45.8	142.4	168.7	109.9	90.8	271.2	197.9	83.9	53.5	44.3	42.4
1990	54.2	109.1	338.1	180.4	141.5	105.8	161.4	271.7	114.8	48.7	28.8	163.7
1991	91.3	193.4	255.6	338.6	120.2	113.4	163.1	124.3	160.9	49.2	29.7	31.4
1992	112.7	139.8	277.4	325.2	216.7	148.7	183.1	364.4	829.5	219.6	162.8	144.3
1993	143.0	93.3	245.5	188.5	162.0	178.4	323.4	127.8	104.2	36.0	42.8	26.0
1994	36.4	68.5	80.6	180.4	141.1	133.1	484.6	427.4	190.1	69.0	41.1	110.2
1995	71.3	131.8	179.5	208.8	136.1	134.0	484.1	351.9	102.8	45.9	32.6	35.0
1996	76.5	186.2	357.4	202.3	173.3	262.8	193.1	378.3	114.8	69.9	33.4	25.1
1997	24.9	26.7	104.3	171.8	99.9	125.1	213.3	482.2	198.1	112.0	87.3	86.8
1998	66.6	282.0	380.3	340.2	161.2	94.1	194.3	98.3	72.1	35.2	23.9	21.8
1999	54.4	60.6	92.4	84.1	58.8	58.1	108.4	167.5	121.9	52.5	38.6	24.8
2000	50.1	73.1	63.9	76.5	75.4	79.8	195.2	277.0	101.7	44.5	30.8	29.2
2001	22.0	21.2	26.7	55.6	65.5	133.0	231.0	219.4	93.1	39.0	28.3	19.5
2002	32.8	63.1	92.8	80.0	76.8	102.9	80.8	209.8	122.6	38.6	24.7	20.8
2003	17.3	293.1	267.8	176.2	63.3	73.2	121.8	105.5	111.2	35.7	25.6	30.3
2004	66.8	83.0	53.2	52.9	83.8	69.9	79.5	112.5	59.4	52.5	36.1	41.8
2005	63.9	254.5	284.2	191.9	123.8	111.6	199.2	90.1	73.6	52.5	42.6	32.1
2006	63.8	89.4	108.4	106.2	116.3	88.7	206.4	345.7	160.9	44.3	68.4	187.1
2007	48.9	79.7	402.1	233.5	160.9	156.2	167.3	127.4	74.4	31.9	21.8	19.4
2008	77.4	73.3	91.9	144.8	104.0	202.7	192.7	282.5	102.8	47.7	33.5	83.5
2009	61.3	134.7	94.8	154.8	107.0	70.7	121.2	139.5	89.9	37.5	29.8	22.1
2010	19.2	157.3	139.8	97.4	120.7	98.3	240.5	355.2	127.7	61.0	29.9	23.6
2011	25.1	137.7	210.0	202.9	147.2	111.4	108.5	187.1	266.3	104.6	73.5	42.9
Average	53.0	100.6	177.0	165.2	119.1	115.9	224.5	263.9	140.6	57.0	40.7	46.7
Maximum	155.3	293.1	402.1	396.0	220.7	262.8	633.3	664.5	829.5	219.6	162.8	187.1
Minimum	12.2	21.2	26.7	52.9	52.8	56.2	79.5	90.1	45.3	19.5	14.6	14.9

ANNEX II

SYNTHETIC MEAN MONTHLY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 1
(WITHOUT PROJECT)

(m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	25.9	26.8	109.7	76.7	54.9	38.2	224.4	158.6	50.4	20.2	13.6	10.9
1961	33.0	66.1	58.1	141.4	51.0	75.5	201.8	162.3	220.2	49.9	34.4	27.5
1962	14.8	36.5	53.0	108.5	56.2	47.9	105.2	97.2	83.1	31.0	22.3	21.5
1963	15.7	24.0	83.5	94.2	96.7	82.9	144.3	181.9	58.0	13.3	13.7	20.5
1964	105.7	57.5	72.8	94.2	59.0	52.2	225.3	245.7	85.9	29.6	14.4	22.5
1965	37.3	108.3	87.6	199.7	132.1	99.4	152.2	100.3	41.4	17.6	14.6	10.2
1966	8.3	64.0	104.0	97.4	95.7	93.7	162.6	194.9	240.9	81.5	23.7	19.5
1967	15.7	47.0	147.0	130.0	86.7	70.6	153.7	172.6	84.3	33.5	19.7	70.5
1968	78.5	98.9	108.7	95.4	61.7	70.1	116.3	185.4	46.1	37.7	28.9	17.9
1969	18.6	48.0	112.5	93.4	112.7	72.6	128.6	172.8	42.1	35.6	18.1	12.3
1970	17.7	22.2	51.9	49.9	36.0	51.7	77.4	202.7	174.7	36.7	15.8	11.7
1971	9.7	20.3	28.8	45.3	47.4	126.8	139.9	197.3	56.9	20.7	18.8	14.1
1972	18.5	57.5	93.5	72.0	66.4	48.8	123.2	133.2	82.2	40.8	24.3	29.6
1973	75.0	97.8	181.4	106.6	65.8	78.9	133.3	310.6	101.2	36.1	17.9	16.0
1974	23.8	50.1	69.0	51.9	36.0	81.1	107.2	75.7	30.8	17.5	9.9	11.4
1975	11.6	47.3	94.2	89.9	74.3	66.5	145.3	333.1	163.0	37.3	20.3	13.6
1976	35.7	129.5	148.0	133.8	102.8	100.3	241.7	452.2	120.5	41.1	21.4	16.9
1977	46.4	39.1	41.4	68.9	81.2	80.7	278.1	191.0	96.1	56.9	35.0	44.8
1978	48.1	64.3	246.5	136.7	111.2	113.1	307.4	310.0	105.4	45.8	50.9	24.1
1979	16.1	46.2	190.7	98.1	61.8	72.7	81.7	149.0	93.4	42.2	35.7	29.9
1980	40.0	66.8	114.6	74.7	66.2	100.0	90.2	102.0	51.0	29.7	30.6	22.8
1981	50.3	123.0	214.1	147.3	88.6	54.5	199.7	137.5	35.3	24.8	17.4	13.7
1982	15.5	36.2	183.4	180.3	129.2	81.5	133.9	220.6	40.0	27.6	35.9	28.3
1983	44.5	56.2	192.7	269.5	150.2	97.2	153.5	206.2	131.7	39.1	25.1	17.3
1984	13.9	20.6	39.1	70.7	46.5	67.5	88.4	255.4	157.3	42.6	27.0	23.7
1985	33.4	36.8	38.0	54.2	52.9	46.8	157.3	148.8	43.0	43.1	30.8	66.6
1986	31.5	67.4	206.6	174.6	115.3	100.9	152.2	216.9	58.3	48.8	77.4	116.7
1987	47.7	63.9	115.0	108.8	145.8	111.3	75.2	81.0	39.7	54.4	25.6	22.4
1988	22.2	33.9	159.1	86.2	48.2	51.2	431.0	240.4	76.2	43.8	30.7	34.6
1989	51.3	31.1	96.9	114.8	74.8	61.8	184.6	134.7	57.1	36.4	30.1	28.8
1990	36.9	74.3	230.1	122.7	96.3	72.0	109.9	184.9	78.1	33.2	19.6	111.4
1991	62.2	131.6	174.0	230.4	81.8	77.2	111.0	84.6	109.5	33.5	20.2	21.4
1992	76.7	95.2	188.8	221.3	147.5	101.2	124.6	248.0	564.5	149.5	110.8	98.2
1993	97.4	63.5	167.1	128.3	110.3	121.4	220.1	87.0	70.9	24.5	29.2	17.7
1994	24.8	46.6	54.9	122.8	96.0	90.6	329.8	290.9	129.4	47.0	27.9	75.0
1995	48.5	89.7	122.1	142.1	92.6	91.2	329.5	239.5	70.0	31.3	22.2	23.8
1996	52.0	126.7	243.2	137.7	118.0	178.8	131.4	257.5	78.2	47.6	22.7	17.1
1997	16.9	18.2	71.0	117.0	68.0	85.1	145.2	328.2	134.8	76.2	59.4	59.1
1998	45.3	191.9	258.8	231.5	109.7	64.0	132.2	66.9	49.0	23.9	16.3	14.9
1999	37.0	41.2	62.9	57.2	40.0	39.6	73.8	114.0	82.9	35.8	26.3	16.9
2000	34.1	49.8	43.5	52.0	51.3	54.3	132.8	188.5	69.2	30.3	21.0	19.9
2001	15.0	14.4	18.2	37.9	44.6	90.5	157.2	149.3	63.4	26.6	19.2	13.3
2002	22.3	42.9	63.2	54.4	52.3	70.0	55.0	142.8	83.4	26.3	16.8	14.2
2003	11.7	199.5	182.3	119.9	43.1	49.8	82.9	71.8	75.7	24.3	17.4	20.6
2004	45.5	56.5	36.2	36.0	57.1	47.6	54.1	76.6	40.4	35.7	24.5	28.4
2005	43.5	173.2	193.5	130.6	84.3	75.9	135.6	61.3	50.1	35.8	29.0	21.9
2006	43.4	60.8	73.8	72.3	79.1	60.4	140.5	235.3	109.5	30.2	46.6	127.3
2007	33.3	54.2	273.7	158.9	109.5	106.3	113.9	86.7	50.7	21.7	14.8	13.2
2008	52.7	49.9	62.6	98.6	70.8	138.0	131.2	192.3	69.9	32.4	22.8	56.9
2009	41.7	91.7	64.5	105.4	72.8	48.1	82.5	94.9	61.2	25.5	20.3	15.0
2010	13.1	107.1	95.1	66.3	82.1	66.9	163.7	241.8	86.9	41.5	20.3	16.1
2011	17.1	93.7	142.9	138.1	100.2	75.8	73.9	127.3	181.2	71.2	50.0	29.2
Average	36.1	68.5	120.5	112.4	81.1	78.9	152.8	179.6	95.7	38.8	27.7	31.8
Maximum	105.7	199.5	273.7	269.5	150.2	178.8	431.0	452.2	564.5	149.5	110.8	127.3
Minimum	8.3	14.4	18.2	36.0	36.0	38.2	54.1	61.3	30.8	13.3	9.9	10.2

ANNEX III

SYNTHETIC MEAN MONTHLY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 2
(WITHOUT PROJECT)

(m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	38.1	39.5	161.6	112.9	80.9	56.3	330.5	233.5	74.2	29.8	20.1	16.1
1961	48.6	97.3	85.5	208.2	75.1	111.2	297.2	238.9	324.2	73.5	50.6	40.5
1962	21.8	53.7	78.1	159.8	82.7	70.6	154.9	143.2	122.4	45.6	32.9	31.7
1963	23.2	35.3	123.0	138.8	142.4	122.0	212.4	267.8	85.4	19.5	20.1	30.1
1964	155.6	84.7	107.2	138.8	86.9	76.8	331.8	361.8	126.5	43.5	21.2	33.1
1965	55.0	159.4	129.0	294.0	194.5	146.4	224.1	147.7	61.0	25.9	21.4	15.0
1966	12.3	94.3	153.2	143.4	141.0	138.0	239.5	286.9	354.8	119.9	34.8	28.8
1967	23.1	69.1	216.4	191.5	127.7	103.9	226.4	254.1	124.1	49.4	29.1	103.8
1968	115.6	145.7	160.1	140.5	90.8	103.3	171.3	273.0	67.8	55.5	42.5	26.4
1969	27.4	70.7	165.6	137.6	165.9	106.9	189.3	254.5	62.0	52.4	26.6	18.1
1970	26.0	32.6	76.4	73.5	53.0	76.1	113.9	298.5	257.3	54.0	23.2	17.3
1971	14.3	29.9	42.4	66.7	69.7	186.7	206.0	290.5	83.8	30.6	27.6	20.8
1972	27.2	84.7	137.7	106.0	97.7	71.9	181.5	196.2	121.0	60.1	35.7	43.5
1973	110.4	144.0	267.1	157.0	96.9	116.3	196.3	457.4	149.0	53.1	26.4	23.6
1974	35.0	73.7	101.5	76.4	53.0	119.5	157.9	111.4	45.4	25.7	14.6	16.8
1975	17.1	69.6	138.8	132.4	109.3	98.0	213.9	490.5	240.0	55.0	29.9	20.0
1976	52.6	190.7	217.9	197.1	151.4	147.6	356.0	665.9	177.4	60.5	31.5	24.9
1977	68.4	57.6	61.0	101.5	119.5	118.8	409.5	281.2	141.5	83.8	51.5	65.9
1978	70.8	94.7	363.0	201.3	163.8	166.6	452.7	456.5	155.1	67.4	74.9	35.5
1979	23.7	68.0	280.9	144.4	91.1	107.1	120.3	219.4	137.6	62.1	52.6	44.0
1980	59.0	98.3	168.7	110.0	97.5	147.3	132.9	150.2	75.0	43.7	45.0	33.6
1981	74.0	181.1	315.2	217.0	130.5	80.2	294.1	202.5	52.0	36.5	25.7	20.2
1982	22.8	53.3	270.1	265.4	190.2	120.0	197.1	324.9	58.9	40.7	52.9	41.7
1983	65.6	82.8	283.7	396.9	221.2	143.1	226.1	303.6	194.0	57.6	37.0	25.4
1984	20.5	30.4	57.6	104.1	68.5	99.4	130.1	376.0	231.6	62.7	39.8	34.9
1985	49.1	54.1	55.9	79.8	77.9	68.9	231.7	219.1	63.3	63.5	45.4	98.1
1986	46.4	99.2	304.2	257.1	169.8	148.6	224.1	319.4	85.9	71.9	114.0	171.8
1987	70.2	94.1	169.3	160.2	214.8	164.0	110.7	119.2	58.5	80.1	37.7	33.0
1988	32.7	49.9	234.3	126.9	71.0	75.4	634.7	354.0	112.1	64.5	45.2	51.0
1989	75.5	45.9	142.7	169.1	110.2	91.0	271.8	198.3	84.1	53.6	44.4	42.5
1990	54.3	109.4	338.9	180.7	141.8	106.1	161.8	272.3	115.1	48.8	28.8	164.1
1991	91.5	193.8	256.2	339.3	120.5	113.6	163.5	124.5	161.3	49.3	29.8	31.5
1992	112.9	140.1	278.0	325.9	217.1	149.0	183.5	365.2	831.3	220.1	163.2	144.6
1993	143.3	93.6	246.0	188.9	162.4	178.8	324.1	128.1	104.5	36.1	42.9	26.1
1994	36.5	68.7	80.8	180.8	141.4	133.4	485.7	428.3	190.5	69.2	41.2	110.4
1995	71.4	132.1	179.9	209.3	136.4	134.3	485.2	352.7	103.1	46.0	32.7	35.1
1996	76.6	186.6	358.2	202.7	173.7	263.3	193.5	379.1	115.1	70.0	33.5	25.2
1997	24.9	26.7	104.5	172.2	100.2	125.3	213.8	483.3	198.5	112.2	87.5	87.0
1998	66.8	282.6	381.1	340.9	161.5	94.3	194.7	98.5	72.2	35.2	24.0	21.9
1999	54.5	60.7	92.6	84.2	58.9	58.2	108.6	167.9	122.1	52.7	38.7	24.9
2000	50.2	73.3	64.0	76.6	75.6	80.0	195.6	277.6	102.0	44.6	30.9	29.3
2001	22.1	21.3	26.8	55.7	65.6	133.2	231.5	219.8	93.3	39.1	28.3	19.6
2002	32.9	63.2	93.0	80.1	77.0	103.1	81.0	210.3	122.8	38.7	24.7	20.9
2003	17.3	293.7	268.4	176.6	63.4	73.4	122.1	105.7	111.5	35.8	25.6	30.4
2004	67.0	83.2	53.3	53.0	84.0	70.0	79.7	112.8	59.5	52.6	36.1	41.9
2005	64.1	255.1	284.9	192.3	124.1	111.8	199.7	90.3	73.7	52.7	42.7	32.2
2006	64.0	89.6	108.7	106.4	116.5	88.9	206.9	346.5	161.2	44.4	68.6	187.5
2007	49.0	79.8	403.0	234.0	161.3	156.6	167.7	127.7	74.6	32.0	21.8	19.4
2008	77.6	73.4	92.1	145.1	104.3	203.2	193.2	283.1	103.0	47.8	33.6	83.7
2009	61.4	135.0	95.0	155.2	107.2	70.8	121.5	139.8	90.1	37.5	29.9	22.1
2010	19.2	157.7	140.1	97.6	121.0	98.5	241.0	356.0	128.0	61.1	30.0	23.7
2011	25.1	138.0	210.4	203.4	147.5	111.6	108.8	187.5	266.9	104.8	73.7	43.0
Average	53.2	100.8	177.4	165.6	119.4	116.1	225.0	264.5	140.9	57.2	40.8	46.8
Maximum	155.6	293.7	403.0	396.9	221.2	263.3	634.7	665.9	831.3	220.1	163.2	187.5
Minimum	12.3	21.3	26.8	53.0	53.0	56.3	79.7	90.3	45.4	19.5	14.6	15.0

ANNEX IV

SYNTHETIC MEAN MONTHLY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 3
(WITHOUT PROJECT)

(m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	38.9	40.3	164.8	115.2	82.5	57.4	337.1	238.2	75.7	30.4	20.5	16.4
1961	49.6	99.2	87.3	212.4	76.6	113.4	303.2	243.7	330.7	75.0	51.7	41.3
1962	22.2	54.8	79.6	163.0	84.4	72.0	158.0	146.0	124.8	46.5	33.6	32.3
1963	23.6	36.0	125.5	141.5	145.3	124.5	216.7	273.2	87.1	19.9	20.5	30.7
1964	158.7	86.4	109.3	141.5	88.6	78.4	338.4	369.1	129.1	44.4	21.7	33.8
1965	56.1	162.6	131.6	299.9	198.3	149.3	228.6	150.7	62.2	26.4	21.9	15.3
1966	12.5	96.2	156.3	146.3	143.8	140.8	244.2	292.7	361.9	122.3	35.5	29.3
1967	23.5	70.5	220.8	195.3	130.3	106.0	230.9	259.2	126.6	50.4	29.6	105.9
1968	118.0	148.6	163.3	143.3	92.7	105.4	174.7	278.5	69.2	56.6	43.3	26.9
1969	28.0	72.1	168.9	140.3	169.2	109.0	193.1	259.5	63.2	53.5	27.1	18.4
1970	26.5	33.3	78.0	74.9	54.1	77.7	116.2	304.5	262.4	55.1	23.7	17.6
1971	14.6	30.5	43.3	68.0	71.1	190.4	210.1	296.3	85.5	31.2	28.2	21.2
1972	27.8	86.4	140.5	108.1	99.7	73.4	185.1	200.1	123.4	61.3	36.4	44.4
1973	112.6	146.9	272.4	160.1	98.8	118.6	200.2	466.5	152.0	54.2	26.9	24.1
1974	35.7	75.2	103.6	78.0	54.0	121.9	161.1	113.7	46.3	26.2	14.9	17.2
1975	17.5	71.0	141.5	135.1	111.5	99.9	218.2	500.3	244.8	56.1	30.5	20.4
1976	53.6	194.5	222.3	201.0	154.5	150.6	363.1	679.2	180.9	61.7	32.1	25.4
1977	69.7	58.7	62.2	103.6	121.9	121.2	417.7	286.9	144.3	85.4	52.5	67.3
1978	72.2	96.6	370.3	205.3	167.1	169.9	461.7	465.7	158.2	68.8	76.4	36.2
1979	24.2	69.3	286.5	147.3	92.9	109.2	122.7	223.8	140.3	63.3	53.6	44.9
1980	60.1	100.3	172.1	112.2	99.5	150.2	135.5	153.2	76.5	44.6	45.9	34.2
1981	75.5	184.8	321.5	221.3	133.1	81.8	299.9	206.6	53.1	37.2	26.2	20.6
1982	23.3	54.3	275.5	270.8	194.0	122.4	201.1	331.4	60.1	41.5	53.9	42.6
1983	66.9	84.4	289.4	404.8	225.7	146.0	230.6	309.7	197.9	58.8	37.8	26.0
1984	20.9	31.0	58.7	106.2	69.9	101.4	132.8	383.6	236.3	64.0	40.6	35.6
1985	50.1	55.2	57.0	81.4	79.5	70.3	236.3	223.5	64.6	64.7	46.3	100.1
1986	47.3	101.2	310.3	262.2	173.2	151.5	228.6	325.7	87.6	73.4	116.3	175.3
1987	71.6	95.9	172.7	163.4	219.1	167.2	112.9	121.6	59.7	81.7	38.5	33.6
1988	33.4	50.9	239.0	129.4	72.4	76.9	647.4	361.1	114.4	65.8	46.1	52.0
1989	77.0	46.8	145.5	172.5	112.4	92.8	277.3	202.3	85.7	54.7	45.2	43.3
1990	55.4	111.6	345.7	184.4	144.6	108.2	165.0	277.8	117.4	49.8	29.4	167.3
1991	93.4	197.7	261.3	346.1	122.9	115.9	166.7	127.0	164.5	50.3	30.4	32.1
1992	115.2	142.9	283.5	332.4	221.5	152.0	187.1	372.5	847.9	224.5	166.4	147.5
1993	146.2	95.4	251.0	192.7	165.6	182.4	330.6	130.6	106.5	36.8	43.8	26.6
1994	37.2	70.0	82.4	184.4	144.2	136.0	495.4	436.9	194.4	70.5	42.0	112.6
1995	72.8	134.8	183.5	213.5	139.1	137.0	494.9	359.8	105.1	46.9	33.3	35.8
1996	78.2	190.3	365.3	206.8	177.2	268.6	197.4	386.7	117.4	71.4	34.1	25.7
1997	25.4	27.3	106.6	175.7	102.2	127.8	218.0	492.9	202.5	114.5	89.3	88.8
1998	68.1	288.3	388.8	347.7	164.7	96.2	198.6	100.4	73.7	35.9	24.4	22.3
1999	55.6	61.9	94.5	85.9	60.1	59.4	110.8	171.3	124.6	53.7	39.4	25.4
2000	51.2	74.8	65.3	78.2	77.1	81.6	199.5	283.1	104.0	45.5	31.5	29.8
2001	22.5	21.7	27.3	56.9	66.9	135.9	236.1	224.2	95.2	39.9	28.9	20.0
2002	33.6	64.5	94.9	81.7	78.5	105.2	82.6	214.5	125.3	39.5	25.2	21.3
2003	17.6	299.6	273.8	180.1	64.7	74.8	124.5	107.8	113.7	36.5	26.1	31.0
2004	68.3	84.9	54.4	54.0	85.7	71.4	81.3	115.0	60.7	53.6	36.9	42.7
2005	65.3	260.2	290.6	196.2	126.6	114.0	203.7	92.1	75.2	53.7	43.5	32.9
2006	65.2	91.4	110.9	108.6	118.8	90.7	211.0	353.4	164.5	45.3	69.9	191.2
2007	50.0	81.4	411.0	238.7	164.5	159.7	171.0	130.3	76.1	32.6	22.2	19.8
2008	79.1	74.9	94.0	148.0	106.3	207.2	197.0	288.8	105.0	48.7	34.3	85.4
2009	62.6	137.7	96.9	158.3	109.4	72.2	123.9	142.6	91.9	38.3	30.5	22.5
2010	19.6	160.8	142.9	99.6	123.4	100.5	245.9	363.1	130.5	62.3	30.6	24.1
2011	25.6	140.8	214.7	207.4	150.5	113.8	111.0	191.2	272.2	106.9	75.2	43.9
Average	54.2	102.8	180.9	168.9	121.7	118.5	229.5	269.8	143.7	58.3	41.6	47.7
Maximum	158.7	299.6	411.0	404.8	225.7	268.6	647.4	679.2	847.9	224.5	166.4	191.2
Minimum	12.5	21.7	27.3	54.0	54.0	57.4	81.3	92.1	46.3	19.9	14.9	15.3

ANNEX V

SYNTHETIC MEAN MONTHLY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 4
(WITHOUT PROJECT)

(m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	41.7	43.3	177.0	123.6	88.6	61.6	362.0	255.7	81.3	32.6	22.0	17.6
1961	53.2	106.5	93.7	228.0	82.2	121.8	325.5	261.7	355.1	80.6	55.5	44.3
1962	23.8	58.8	85.5	175.0	90.6	77.3	169.6	156.8	134.1	49.9	36.0	34.7
1963	25.4	38.7	134.7	152.0	156.0	133.7	232.7	293.3	93.6	21.4	22.0	33.0
1964	170.5	92.8	117.4	152.0	95.1	84.2	363.4	396.3	138.6	47.7	23.3	36.3
1965	60.2	174.6	141.3	322.0	213.0	160.3	245.4	161.8	66.8	28.4	23.5	16.4
1966	13.4	103.3	167.8	157.1	154.4	151.2	262.3	314.3	388.6	131.4	38.2	31.5
1967	25.3	75.7	237.1	209.7	139.9	113.8	247.9	278.3	135.9	54.1	31.8	113.7
1968	126.7	159.6	175.3	153.9	99.5	113.1	187.6	299.0	74.3	60.8	46.5	28.9
1969	30.0	77.4	181.4	150.7	181.7	117.1	207.4	278.7	67.9	57.4	29.1	19.8
1970	28.5	35.8	83.7	80.5	58.1	83.4	124.8	326.9	281.8	59.2	25.4	18.9
1971	15.7	32.8	46.5	73.1	76.4	204.5	225.6	318.2	91.8	33.5	30.3	22.8
1972	29.8	92.8	150.9	116.1	107.0	78.8	198.7	214.9	132.5	65.8	39.1	47.7
1973	120.9	157.7	292.5	171.9	106.1	127.3	215.0	500.9	163.2	58.2	28.9	25.8
1974	38.3	80.8	111.2	83.7	58.0	130.8	172.9	122.0	49.7	28.2	16.0	18.4
1975	18.8	76.2	152.0	145.0	119.7	107.3	234.3	537.2	262.8	60.2	32.7	22.0
1976	57.6	208.9	238.6	215.9	165.8	161.7	389.9	729.3	194.3	66.2	34.5	27.3
1977	74.9	63.0	66.8	111.2	130.9	130.1	448.5	308.0	155.0	91.7	56.4	72.2
1978	77.5	103.7	397.6	220.5	179.4	182.4	495.8	500.0	169.9	73.9	82.1	38.8
1979	26.0	74.4	307.6	158.1	99.7	117.3	131.8	240.3	150.7	68.0	57.6	48.2
1980	64.6	107.7	184.8	120.5	106.8	161.3	145.5	164.5	82.2	47.9	49.3	36.8
1981	81.1	198.4	345.3	237.6	142.9	87.9	322.1	221.8	57.0	39.9	28.1	22.2
1982	25.0	58.3	295.8	290.7	208.3	131.4	215.9	355.8	64.5	44.5	57.9	45.7
1983	71.8	90.7	310.8	434.7	242.3	156.7	247.6	332.5	212.5	63.1	40.5	27.9
1984	22.4	33.3	63.1	114.0	75.1	108.9	142.5	411.9	253.7	68.7	43.6	38.3
1985	53.8	59.3	61.3	87.4	85.3	75.5	253.7	240.0	69.4	69.5	49.7	107.5
1986	50.8	108.7	333.1	281.6	186.0	162.7	245.5	349.8	94.0	78.8	124.9	188.2
1987	76.9	103.0	185.4	175.4	235.2	179.6	121.2	130.6	64.1	87.8	41.3	36.1
1988	35.9	54.7	256.6	139.0	77.7	82.6	695.1	387.8	122.8	70.7	49.5	55.8
1989	82.7	50.2	156.3	185.2	120.7	99.7	297.7	217.2	92.1	58.7	48.6	46.5
1990	59.5	119.8	371.1	198.0	155.3	116.2	177.2	298.3	126.0	53.5	31.6	179.7
1991	100.2	212.3	280.6	371.7	132.0	124.4	179.0	136.4	176.7	54.0	32.6	34.5
1992	123.7	153.5	304.4	357.0	237.8	163.2	200.9	400.0	910.4	241.1	178.7	158.4
1993	157.0	102.5	269.5	206.9	177.9	195.8	355.0	140.3	114.4	39.5	47.0	28.6
1994	39.9	75.2	88.5	198.0	154.9	146.1	531.9	469.1	208.7	75.7	45.1	120.9
1995	78.2	144.7	197.0	229.2	149.4	147.1	531.4	386.3	112.9	50.4	35.8	38.4
1996	83.9	204.3	392.3	222.0	190.3	288.4	211.9	415.2	126.1	76.7	36.7	27.6
1997	27.3	29.3	114.5	188.6	109.7	137.3	234.1	529.3	217.4	122.9	95.9	95.3
1998	73.1	309.5	417.4	373.4	176.9	103.3	213.3	107.9	79.1	38.6	26.2	24.0
1999	59.7	66.5	101.4	92.3	64.5	63.8	119.0	183.9	133.8	57.7	42.3	27.2
2000	55.0	80.3	70.1	83.9	82.8	87.6	214.2	304.0	111.7	48.8	33.8	32.0
2001	24.2	23.3	29.4	61.1	71.9	145.9	253.5	240.8	102.2	42.8	31.0	21.4
2002	36.0	69.2	101.9	87.8	84.3	112.9	88.7	230.3	134.5	42.4	27.1	22.8
2003	18.9	321.7	294.0	193.4	69.5	80.3	133.7	115.8	122.1	39.2	28.0	33.3
2004	73.3	91.1	58.4	58.0	92.0	76.7	87.3	123.5	65.2	57.6	39.6	45.9
2005	70.2	279.4	312.0	210.6	135.9	122.5	218.7	98.8	80.8	57.7	46.7	35.3
2006	70.1	98.1	119.0	116.6	127.6	97.4	226.6	379.5	176.6	48.7	75.1	205.3
2007	53.7	87.4	441.3	256.3	176.6	171.5	183.7	139.9	81.7	35.0	23.9	21.3
2008	85.0	80.4	100.9	159.0	114.2	222.5	211.6	310.1	112.8	52.3	36.8	91.7
2009	67.2	147.9	104.0	169.9	117.4	77.6	133.1	153.1	98.7	41.1	32.8	24.2
2010	21.1	172.7	153.4	106.9	132.5	107.9	264.0	389.9	140.2	66.9	32.8	25.9
2011	27.5	151.1	230.5	222.7	161.6	122.2	119.1	205.3	292.3	114.8	80.7	47.1
Average	58.2	110.4	194.3	181.3	130.7	127.2	246.5	289.7	154.3	62.6	44.7	51.2
Maximum	170.5	321.7	441.3	434.7	242.3	288.4	695.1	729.3	910.4	241.1	178.7	205.3
Minimum	13.4	23.3	29.4	58.0	58.0	61.6	87.3	98.8	49.7	21.4	16.0	16.4

ANNEX VI

SYNTHETIC MEAN MONTHLY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 2
(WITH PROJECT)

(m3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	4.1	4.1	31.6	6.0	4.2	4.1	199.2	83.0	5.3	4.1	4.0	4.0
1961	24.1	6.9	4.2	74.2	4.3	7.0	135.7	76.4	148.9	4.2	4.1	4.1
1962	4.0	4.7	4.2	21.1	4.2	5.1	45.9	22.4	17.3	4.1	4.1	4.1
1963	4.1	4.1	13.6	18.4	9.3	8.7	78.9	94.7	11.0	4.0	4.0	4.1
1964	66.9	4.3	6.0	11.7	4.2	4.2	177.8	182.4	12.2	4.1	4.0	4.1
1965	14.5	40.1	6.3	102.4	21.1	4.3	67.3	16.4	4.1	4.1	4.0	4.0
1966	4.0	17.8	18.6	5.2	8.6	20.0	99.6	126.1	186.1	9.6	4.1	4.1
1967	4.0	19.4	76.1	47.1	9.2	5.6	87.2	88.0	16.7	4.1	4.1	41.9
1968	18.7	21.3	18.6	10.9	4.2	4.2	40.0	97.2	4.1	4.8	4.1	4.1
1969	4.1	8.1	33.8	21.1	28.1	4.2	52.2	96.7	4.1	4.1	4.1	4.0
1970	4.1	9.2	4.2	4.2	4.1	7.3	13.3	140.1	103.7	4.1	4.1	4.0
1971	4.0	12.0	4.1	6.1	4.2	47.5	66.7	131.6	7.3	4.1	4.1	4.0
1972	4.1	18.1	14.3	5.6	7.4	4.8	67.8	71.5	18.9	5.1	4.1	4.1
1973	36.0	56.1	93.5	6.5	4.2	7.3	59.4	283.6	25.0	4.1	4.1	4.1
1974	5.4	9.4	9.7	4.2	4.1	38.9	24.9	15.6	4.1	4.1	4.0	4.0
1975	4.0	10.1	18.0	11.6	7.5	4.2	75.3	305.1	76.5	4.1	4.1	4.0
1976	15.0	67.1	46.6	21.0	5.5	10.7	183.5	479.2	44.0	4.1	4.1	4.1
1977	16.8	4.1	4.1	7.5	10.1	20.9	226.5	101.7	16.3	16.5	6.4	15.7
1978	7.9	4.2	177.8	23.9	6.7	36.7	261.5	264.8	8.2	4.1	4.2	4.1
1979	4.1	16.2	98.6	7.8	4.2	9.8	23.0	67.8	7.1	4.1	4.1	4.1
1980	4.1	5.4	34.6	4.2	4.2	33.7	13.3	47.9	7.0	4.1	7.3	4.1
1981	8.6	35.7	130.2	39.6	9.1	4.2	134.2	58.2	4.1	4.1	4.1	4.0
1982	4.0	4.9	102.1	89.0	28.5	4.7	63.1	168.1	5.3	4.1	9.3	4.1
1983	15.2	8.4	109.8	202.9	36.5	4.8	72.6	116.3	63.5	4.1	4.1	4.1
1984	4.0	4.1	4.1	14.2	4.1	11.1	8.8	193.9	74.7	4.1	4.1	4.1
1985	4.1	4.1	4.1	4.2	4.2	4.1	86.8	83.1	4.1	4.1	4.1	31.0
1986	4.1	8.4	143.7	70.4	9.9	7.9	67.5	149.4	4.2	4.8	26.0	47.6
1987	4.2	14.3	30.1	12.9	49.6	21.0	5.6	6.0	4.1	5.9	4.1	4.1
1988	4.1	7.7	77.4	4.3	4.2	13.9	472.4	169.2	14.4	4.1	4.1	4.5
1989	10.6	4.1	27.3	27.0	4.2	4.2	160.3	41.7	4.2	4.1	4.1	4.1
1990	4.1	10.7	189.2	19.3	4.3	9.7	28.2	108.7	6.0	4.1	4.1	107.7
1991	4.2	51.6	67.2	152.9	4.3	4.7	29.4	18.9	33.4	4.1	4.1	4.1
1992	59.4	18.1	164.8	131.9	31.8	4.3	17.9	173.0	637.3	26.4	7.7	4.3
1993	8.0	6.2	97.0	9.8	6.0	20.0	143.6	5.8	6.1	4.1	4.4	4.1
1994	4.1	16.0	4.2	62.4	7.1	15.0	296.7	234.3	39.2	4.1	4.1	20.2
1995	4.2	17.1	35.7	25.9	4.3	7.5	322.0	159.1	5.7	4.1	4.1	4.1
1996	20.6	56.4	183.0	21.3	23.7	94.1	27.7	186.6	4.2	10.1	4.1	4.1
1997	4.1	4.1	23.5	40.8	4.2	5.5	51.3	306.5	45.9	4.2	4.2	5.6
1998	4.7	149.1	187.8	146.9	18.7	5.9	48.0	4.4	4.2	4.1	4.1	4.0
1999	6.0	4.1	11.1	4.2	4.1	4.1	13.3	30.3	6.9	4.1	4.1	4.1
2000	5.4	4.6	4.1	4.2	4.2	8.5	58.7	112.3	4.4	4.1	4.1	4.1
2001	4.0	4.0	4.1	4.1	4.1	13.6	90.3	50.8	4.4	4.1	4.1	4.0
2002	4.1	16.3	5.4	4.2	4.2	5.6	6.5	62.4	10.2	4.1	4.1	4.0
2003	4.0	200.6	81.5	9.2	7.3	4.2	5.7	8.6	12.4	4.1	4.1	4.1
2004	5.4	4.2	4.1	8.8	8.6	4.2	4.3	9.5	4.1	4.1	4.1	4.1
2005	8.9	93.1	91.3	12.2	4.3	4.2	33.9	4.2	7.6	4.1	4.1	4.1
2006	6.0	11.6	4.6	5.6	4.3	4.2	69.7	152.7	32.9	4.1	4.2	62.2
2007	4.1	7.8	222.3	44.4	7.4	9.9	18.1	16.7	4.2	4.1	4.0	4.0
2008	17.7	4.2	4.2	15.4	4.2	36.9	23.3	102.5	4.2	4.1	4.1	15.4
2009	4.1	12.7	4.2	16.5	4.2	4.2	9.0	15.3	5.2	4.1	4.1	4.0
2010	4.0	59.8	7.0	4.2	5.7	4.2	109.2	165.3	6.3	4.1	4.1	4.1
2011	4.1	37.8	36.8	39.3	4.3	4.2	7.0	27.8	83.3	4.2	4.2	4.1
Average	9.7	23.6	53.5	32.1	9.3	12.3	86.2	110.3	36.1	5.1	4.8	10.1
Maximum	66.9	200.6	222.3	202.9	49.6	94.1	472.4	479.2	637.3	26.4	26.0	107.7
Minimum	4.0	4.0	4.1	4.1	4.1	4.1	4.3	4.2	4.1	4.0	4.0	4.0

APPENDICES

(A – F)

APPENDIX A

MEAN DAILY DISCHARGE OF POONCH RIVER
AT REHMAN BRIDGE (KOTLI) / JUST UPSTREAM OF PROPOSED DAM SITE
(WITHOUT PROJECT)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1960

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.4	41.0	26.4	132.4	106.1	59.7	85.5	62.8	146.6	40.8	21.6	17.8
2	29.4	52.0	25.0	129.0	112.0	50.0	72.0	63.0	140.0	39.0	21.0	17.8
3	29.4	45.0	25.0	125.0	116.0	61.0	79.0	78.0	233.0	38.0	20.0	17.0
4	29.0	42.0	27.0	129.0	128.0	61.0	55.0	61.0	109.0	37.0	21.0	16.0
5	29.0	42.0	24.0	121.0	103.0	55.0	65.0	59.0	118.0	46.0	21.0	16.0
6	28.0	42.0	43.0	117.0	78.0	53.0	134.0	55.0	89.0	36.0	21.0	16.0
7	27.0	46.0	40.0	108.0	69.0	73.0	138.0	535.0	79.0	34.0	21.0	15.0
8	27.0	46.0	79.0	107.0	69.0	71.0	311.3	396.2	72.0	33.0	21.0	15.0
9	26.0	47.0	159.0	97.0	83.0	71.0	134.0	356.6	66.0	32.0	21.0	14.0
10	26.0	45.0	210.0	84.0	86.0	59.0	1,525.4	379.2	60.0	31.0	21.0	14.0
11	28.0	45.0	787.0	84.0	86.0	60.0	2,422.5	127.0	73.0	30.0	21.0	14.0
12	26.0	46.0	214.0	89.0	89.0	66.0	572.0	140.0	56.0	29.0	21.0	13.0
13	28.0	47.0	167.0	89.0	92.0	58.0	328.0	303.0	55.0	29.0	22.0	13.0
14	27.0	46.0	147.0	108.0	89.0	46.0	1,358.4	156.0	51.0	28.0	21.0	13.0
15	29.0	46.0	142.0	97.0	78.0	64.0	662.0	439.0	50.0	28.0	21.0	12.0
16	27.0	45.0	317.0	119.0	71.0	61.0	297.0	996.2	47.0	33.0	20.0	14.0
17	26.0	43.0	248.0	124.0	92.0	46.0	185.0	177.0	73.0	29.0	20.0	25.0
18	26.0	39.0	175.0	142.0	116.0	44.0	323.0	379.0	64.0	27.0	20.0	19.0
19	26.0	37.0	154.0	250.0	86.0	43.0	157.0	173.0	56.0	27.0	20.0	16.0
20	144.0	37.0	210.0	121.0	81.0	43.0	211.0	317.0	56.0	26.0	19.0	14.0
21	70.0	33.0	147.0	105.0	80.0	45.0	123.0	212.0	50.0	26.0	19.0	13.0
22	48.0	33.0	195.0	100.0	73.0	46.0	105.0	186.0	48.0	26.0	18.0	12.0
23	43.0	31.0	175.0	112.0	62.0	49.0	97.0	297.0	46.0	25.0	18.0	12.0
24	42.0	29.0	140.0	114.0	61.0	63.0	90.0	161.0	74.0	25.0	19.0	12.0
25	45.0	29.0	139.0	105.0	65.0	58.0	88.0	150.0	70.0	25.0	18.0	12.0
26	43.0	28.0	145.0	106.0	61.0	55.0	198.0	164.0	53.0	25.0	18.0	12.0
27	43.0	28.0	142.0	92.0	58.0	60.0	101.0	151.0	49.0	24.0	18.0	11.0
28	42.0	26.0	245.0	88.0	55.0	58.0	78.0	166.0	50.0	24.0	19.0	11.0
29	43.0	27.0	178.0	89.0	48.0	50.0	72.0	147.0	45.0	24.0	21.0	11.0
30	48.0		139.0	96.0	51.0	56.0	77.0	144.0	43.0	23.0	19.0	18.0
31	44.1		133.6		58.6		79.2	191.3		22.1		61.4
Average	38.0	39.4	161.2	112.6	80.7	56.2	329.8	233.0	74.1	29.7	20.1	16.0
Maximum	144.0	52.0	787.0	250.0	128.0	73.0	2,422.5	996.2	233.0	46.0	22.0	61.4
Minimum	26.0	26.0	24.0	84.0	48.0	43.0	55.0	55.0	43.0	22.1	18.0	11.0

Average annual discharge = 100 (m^3/sec)

Annual inflow volume = 3,160 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1961

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.4	144.0	80.0	88.0	96.0	60.0	167.0	286.0	391.0	178.0	69.0	48.0
2	19.0	273.0	76.0	91.0	95.0	66.0	102.0	487.0	529.0	103.0	55.0	32.0
3	17.0	171.0	71.0	98.0	99.0	70.0	123.0	271.0	159.0	93.0	50.0	44.0
4	11.0	173.0	63.0	89.0	101.0	75.0	128.0	169.0	164.0	89.0	46.0	43.0
5	9.0	142.0	64.0	126.0	95.0	76.0	216.0	153.0	113.0	85.0	45.0	42.0
6	8.0	124.0	59.0	98.0	88.0	134.0	236.0	122.0	216.0	82.0	45.0	42.0
7	7.0	119.0	54.0	78.0	83.0	215.0	200.0	108.0	541.0	79.0	44.0	41.0
8	7.0	97.0	54.0	73.0	77.0	263.0	337.0	114.0	1,254.0	77.0	43.0	40.0
9	7.0	81.0	50.0	74.0	83.0	188.0	221.0	778.0	940.0	98.0	43.0	39.0
10	7.0	75.0	49.0	212.0	82.0	156.0	147.0	623.0	535.0	88.0	42.0	38.0
11	7.0	72.0	60.0	942.0	81.0	130.0	136.0	267.0	345.0	72.0	41.0	37.0
12	7.0	66.0	87.0	504.0	81.0	119.0	99.0	191.0	283.0	72.0	39.0	37.0
13	6.0	59.0	82.0	906.0	80.0	98.0	86.0	158.0	300.0	59.0	38.0	37.0
14	6.0	57.0	88.0	359.0	79.0	95.0	88.0	147.0	253.0	59.0	38.0	36.0
15	6.0	55.0	97.0	267.0	201.0	83.0	205.0	169.0	495.0	56.0	39.0	35.0
16	6.0	56.0	103.0	208.0	113.0	67.0	566.0	246.0	340.0	55.0	67.0	38.0
17	6.0	75.0	112.0	185.0	69.0	63.0	340.0	193.0	258.0	52.0	56.0	84.0
18	6.0	94.0	98.0	168.0	56.0	64.0	133.0	189.0	217.0	52.0	43.0	57.0
19	6.0	91.0	130.0	158.0	55.0	71.0	98.0	108.0	188.0	53.0	41.0	45.0
20	6.0	92.0	116.0	231.0	55.0	80.0	112.0	357.0	168.0	55.0	40.0	43.0
21	6.0	85.0	99.0	244.0	58.0	68.0	147.0	139.0	163.0	57.0	39.0	41.0
22	6.0	81.0	75.0	176.0	73.0	106.0	1,163.0	104.0	171.0	55.0	38.0	40.0
23	6.0	73.0	70.0	128.0	85.0	97.0	866.0	154.0	190.0	52.0	36.0	38.0
24	6.0	75.0	127.0	102.0	62.0	88.0	357.0	255.0	273.0	49.0	34.0	37.0
25	7.0	65.0	126.0	95.0	37.0	95.0	382.0	340.0	365.0	48.0	33.0	37.0
26	34.0	66.0	85.0	91.0	35.0	164.0	512.0	177.0	354.0	44.0	53.0	37.0
27	24.0	76.0	80.0	107.0	29.0	145.0	300.0	162.0	174.0	42.0	146.0	36.0
28	19.0	81.0	111.0	105.0	29.0	89.0	229.0	125.0	113.0	40.0	103.0	35.0
29	529.0		88.0	113.0	40.0	118.0	425.0	105.0	106.0	72.0	59.0	33.0
30	441.0		92.0	116.0	52.0	186.0	654.0	202.0	107.0	138.0	51.0	31.0
31	245.0		100.0		53.0		419.0	492.0		121.0		29.0
Average	48.5	97.1	85.4	207.7	74.9	111.0	296.6	238.4	323.5	73.4	50.5	40.4
Maximum	529.0	273.0	130.0	942.0	201.0	263.0	1,163.0	778.0	1,254.0	178.0	146.0	84.0
Minimum	6.0	55.0	49.0	73.0	29.0	60.0	86.0	104.0	106.0	40.0	33.0	29.0

Average annual discharge = 137 (m^3/sec)

Annual inflow volume = 4,327 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1962

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.0	20.0	62.0	134.0	128.0	66.0	60.0	104.0	80.0	69.0	28.0	21.0
2	24.0	19.0	58.0	89.0	101.0	57.0	48.0	112.0	67.0	71.0	29.0	20.0
3	23.0	19.0	78.0	74.0	79.0	57.0	44.0	76.0	88.0	68.0	28.0	24.0
4	23.0	19.0	162.0	81.0	76.0	65.0	40.0	73.0	134.0	66.0	27.0	22.0
5	23.0	18.0	139.0	76.0	64.0	57.0	39.0	127.0	172.0	60.0	26.0	22.0
6	22.0	18.0	122.0	85.0	61.0	62.0	39.0	223.0	88.0	56.0	25.0	22.0
7	22.0	24.0	93.0	155.0	59.0	63.0	50.0	163.0	62.0	54.0	25.0	21.0
8	22.0	33.0	85.0	190.0	67.0	71.0	71.0	101.0	27.0	54.0	24.0	22.0
9	22.0	25.0	72.0	580.0	77.0	72.0	62.0	190.0	28.0	54.0	22.0	21.0
10	22.0	24.0	71.0	320.0	146.0	64.0	102.0	222.0	66.0	54.0	22.0	21.0
11	23.0	30.0	70.0	198.0	106.0	92.0	65.0	85.0	280.0	52.0	21.0	21.0
12	28.0	35.0	62.0	170.0	85.0	64.0	111.0	61.0	238.0	49.0	22.0	22.0
13	25.0	31.0	59.0	161.0	126.0	225.0	76.0	84.0	79.0	49.0	21.0	21.0
14	23.0	29.0	67.0	148.0	98.0	77.0	95.0	79.0	48.0	49.0	21.0	24.0
15	22.0	29.0	65.0	148.0	93.0	63.0	60.0	129.0	49.0	46.0	21.0	23.0
16	22.0	31.0	67.0	134.0	86.0	47.0	174.0	591.5	95.0	44.0	20.0	23.0
17	21.0	130.0	64.0	117.0	90.0	50.0	259.0	127.0	106.0	44.0	20.0	42.0
18	21.0	65.0	64.0	136.0	89.0	54.0	203.0	117.0	85.0	42.0	22.0	68.0
19	21.0	47.0	62.0	145.0	48.0	61.0	137.0	97.0	71.0	39.0	29.0	31.0
20	20.0	43.0	65.0	148.0	58.0	57.0	170.0	98.0	206.0	38.0	68.0	26.0
21	20.0	42.0	71.0	145.0	74.0	65.0	1,245.2	251.0	88.0	37.0	153.0	25.0
22	20.0	42.0	71.0	161.0	88.0	62.0	337.0	157.0	391.0	34.0	81.0	25.0
23	20.0	40.0	66.0	184.0	85.0	65.0	166.0	88.0	265.0	33.0	42.0	25.0
24	19.0	215.0	73.0	162.0	79.0	56.0	134.0	74.0	92.0	34.0	34.0	23.0
25	19.0	167.0	71.0	150.0	77.0	73.0	117.0	68.0	79.0	32.0	29.0	25.0
26	19.0	132.0	72.0	153.0	75.0	91.0	150.0	141.0	157.0	32.0	25.0	38.0
27	21.0	98.0	74.0	152.0	73.0	74.0	234.0	117.0	156.0	32.0	24.0	165.0
28	22.0	76.0	73.0	132.0	72.0	59.0	166.0	264.0	188.0	31.0	27.0	48.0
29	21.0		81.0	129.0	73.0	58.0	114.0	137.0	107.0	30.0	24.0	32.0
30	20.0		89.0	126.0	68.0	85.0	137.0	165.0	72.0	29.0	25.0	33.0
31	19.0		87.0		58.0		85.0	107.0		28.0		24.0
Average	21.7	53.6	77.9	159.4	82.5	70.4	154.5	142.9	122.1	45.5	32.8	31.6
Maximum	28.0	215.0	162.0	580.0	146.0	225.0	1,245.2	591.5	391.0	71.0	153.0	165.0
Minimum	19.0	18.0	58.0	74.0	48.0	47.0	39.0	61.0	27.0	28.0	20.0	20.0

Average annual discharge = 83 (m^3/sec)

Annual inflow volume = 2,618 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1963

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.0	21.0	32.0	83.0	60.0	241.0	216.0	877.3	402.0	34.0	14.0	23.0
2	21.0	20.0	31.0	77.0	163.0	113.0	194.0	266.0	136.0	29.0	15.0	21.0
3	22.0	20.0	34.0	187.0	134.0	100.0	140.0	130.0	87.0	25.0	18.0	22.0
4	24.0	20.0	67.0	188.0	114.0	106.0	113.0	136.0	105.0	23.0	16.0	21.0
5	25.0	19.0	202.0	51.0	181.0	107.0	74.0	342.0	122.0	21.0	15.0	20.0
6	26.0	19.0	247.0	70.0	205.0	111.0	70.0	227.0	151.0	23.0	13.0	19.0
7	25.0	19.0	124.0	96.0	129.0	100.0	85.0	194.0	91.0	27.0	15.0	19.0
8	25.0	19.0	137.0	103.0	126.0	97.0	112.0	311.0	56.0	27.0	16.0	16.0
9	25.0	19.0	141.0	108.0	208.0	88.0	75.0	267.0	134.0	27.0	13.0	17.0
10	25.0	19.0	240.0	84.0	215.0	63.0	84.0	133.0	127.0	26.0	11.0	17.0
11	24.0	19.0	117.0	91.0	145.0	93.0	170.0	276.0	71.0	25.0	10.0	17.0
12	23.0	18.0	90.0	99.0	136.0	94.0	261.0	314.0	45.0	24.0	10.0	17.0
13	27.0	19.0	76.0	106.0	165.0	91.0	182.0	211.0	33.0	22.0	10.0	158.0
14	28.0	19.0	65.0	109.0	317.0	90.0	210.0	130.0	53.0	21.0	10.0	111.0
15	27.0	37.0	75.0	106.0	185.0	91.0	103.0	128.0	56.0	21.0	17.0	32.0
16	26.0	147.0	182.0	104.0	201.0	99.0	57.0	116.0	45.0	22.0	31.0	29.0
17	23.0	101.0	198.0	161.0	188.0	100.0	58.0	274.0	76.0	18.0	32.0	29.0
18	22.0	67.0	137.0	130.0	150.0	108.0	379.0	447.0	62.0	17.0	34.0	27.0
19	23.0	53.0	97.0	116.0	120.0	231.0	202.0	196.0	46.0	16.0	30.0	28.0
20	21.0	39.0	74.0	110.0	152.0	127.0	188.0	391.0	85.0	15.0	29.0	26.0
21	21.0	31.0	66.0	96.0	122.0	109.0	492.0	560.0	70.0	15.0	27.0	27.0
22	21.0	36.0	92.0	117.0	107.0	108.0	224.0	478.0	50.0	16.0	25.0	25.0
23	21.0	39.0	233.0	134.0	100.0	114.0	128.0	317.0	39.0	14.0	24.0	24.0
24	21.0	35.0	357.0	186.0	93.0	110.0	70.0	300.0	38.0	12.0	22.0	24.0
25	21.0	34.0	114.0	120.0	97.0	105.0	59.0	200.0	39.0	11.0	22.0	25.0
26	21.0	33.0	91.0	106.0	100.0	112.0	64.0	242.0	59.0	11.0	21.0	25.0
27	21.0	33.0	94.0	230.0	98.0	100.0	60.0	209.0	85.0	12.0	22.0	22.0
28	22.0	32.0	97.0	467.0	97.0	225.0	205.0	159.0	82.0	12.0	28.0	21.0
29	22.0		97.0	295.0	99.0	228.0	289.0	129.0	62.0	13.0	25.0	21.0
30	22.0		99.0	224.0	97.0	192.0	1,302.0	79.0	50.0	12.0	27.0	22.0
31	20.0		99.0		101.0		705.0	245.0		13.0		27.0
Average	23.1	35.3	122.7	138.5	142.1	121.8	212.0	267.2	85.2	19.5	20.1	30.1
Maximum	28.0	147.0	357.0	467.0	317.0	241.0	1,302.0	877.3	402.0	34.0	34.0	158.0
Minimum	20.0	18.0	31.0	51.0	60.0	63.0	57.0	79.0	33.0	11.0	10.0	16.0

Average annual discharge = 102 (m^3/sec)

Annual inflow volume = 3,220 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1964

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.0	78.0	74.0	89.0	104.0	57.0	81.0	160.0	345.0	63.0	29.0	20.0
2	23.0	75.0	73.0	94.0	118.0	59.0	141.0	155.0	219.0	60.0	28.0	20.0
3	23.0	72.0	93.0	342.0	119.0	59.0	280.0	141.0	169.0	60.0	27.0	20.0
4	23.0	68.0	88.0	183.0	116.0	60.0	154.0	132.0	141.0	59.0	26.0	20.0
5	25.0	64.0	78.0	137.0	101.0	59.0	159.0	141.0	140.0	58.0	25.0	20.0
6	79.0	65.0	75.0	124.0	102.0	64.0	124.0	166.0	96.0	57.0	23.0	20.0
7	419.0	68.0	72.0	121.0	95.0	61.0	177.0	171.0	73.0	55.0	22.0	20.0
8	1,511.0	67.0	73.0	117.0	99.0	55.0	178.0	174.0	76.0	53.0	22.0	20.0
9	603.0	68.0	75.0	112.0	97.0	49.0	94.0	228.0	70.0	51.0	22.0	20.0
10	146.0	70.0	80.0	112.0	102.0	48.0	97.0	645.0	267.0	50.0	22.0	70.0
11	158.0	71.0	85.0	126.0	101.0	47.0	106.0	171.0	132.0	49.0	22.0	118.0
12	147.0	70.0	83.0	147.0	81.0	55.0	106.0	224.0	151.0	49.0	22.0	68.0
13	100.0	69.0	89.0	149.0	88.0	55.0	263.0	134.0	163.0	47.0	21.0	37.0
14	83.0	72.0	100.0	142.0	160.0	143.0	264.0	193.0	163.0	46.0	20.0	36.0
15	69.0	70.0	94.0	144.0	87.0	130.0	1,542.0	1,307.0	145.0	44.0	19.0	36.0
16	61.0	70.0	99.0	270.0	85.0	117.0	546.0	781.0	153.0	43.0	19.0	35.0
17	57.0	80.0	102.0	183.0	76.0	104.0	507.0	645.0	142.0	40.0	19.0	34.0
18	55.0	200.0	141.0	121.0	75.0	81.0	340.0	583.0	107.0	38.0	19.0	34.0
19	53.0	132.0	253.0	96.0	75.0	78.0	186.0	396.0	110.0	37.0	19.0	34.0
20	50.0	121.0	167.0	92.0	72.0	78.0	147.0	492.0	108.0	35.0	19.0	34.0
21	80.0	107.0	142.0	90.0	113.0	77.0	115.0	778.0	101.0	35.0	19.0	34.0
22	170.0	97.0	128.0	92.0	110.0	82.0	90.0	422.0	94.0	34.0	19.0	34.0
23	126.0	97.0	118.0	94.0	87.0	87.0	81.0	297.0	87.0	33.0	19.0	34.0
24	106.0	91.0	126.0	96.0	65.0	88.0	95.0	787.0	82.0	33.0	19.0	35.0
25	99.0	87.0	145.0	118.0	54.0	83.0	1,760.0	492.0	78.0	32.0	19.0	32.0
26	95.0	83.0	124.0	203.0	54.0	78.0	722.0	320.0	96.0	32.0	19.0	29.0
27	94.0	87.0	114.0	166.0	52.0	87.0	490.0	255.0	77.0	31.0	19.0	26.0
28	91.0	77.0	109.0	155.0	50.0	85.0	396.0	215.0	72.0	31.0	19.0	24.0
29	84.0	75.0	117.0	128.0	48.0	87.0	507.0	187.0	67.0	31.0	19.0	21.0
30	82.0		106.0	111.0	48.0	87.0	323.0	196.0	64.0	30.0	20.0	20.0
31	77.0		92.0		53.0		192.0	204.0		30.0		20.0
Average	155.3	84.5	106.9	138.5	86.7	76.7	331.1	361.0	126.3	43.4	21.2	33.1
Maximum	1,511.0	200.0	253.0	342.0	160.0	143.0	1,760.0	1,307.0	345.0	63.0	29.0	118.0
Minimum	23.0	64.0	72.0	89.0	48.0	47.0	81.0	132.0	64.0	30.0	19.0	20.0

Average annual discharge = 131 (m^3/sec)

Annual inflow volume = 4,145 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1965

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.0	59.0	118.0	317.0	227.0	161.0	115.0	200.0	85.0	39.0	19.0	17.0
2	20.0	62.0	114.0	182.0	205.0	166.0	175.0	132.0	83.0	38.0	19.0	17.0
3	20.0	141.0	116.0	155.0	189.0	168.0	153.0	122.0	91.0	35.0	19.0	17.0
4	42.0	317.0	115.0	244.0	189.0	168.0	173.0	139.0	81.0	38.0	19.0	17.0
5	27.0	157.0	112.0	201.0	185.0	164.0	132.0	142.0	69.0	34.0	27.0	17.0
6	25.0	68.0	119.0	303.0	191.0	190.0	119.0	173.0	61.0	28.0	37.0	17.0
7	24.0	87.0	116.0	430.0	193.0	176.0	113.0	155.0	59.0	26.0	24.0	16.0
8	24.0	81.0	144.0	340.0	205.0	142.0	117.0	124.0	64.0	26.0	21.0	16.0
9	25.0	71.0	203.0	297.0	200.0	139.0	171.0	164.0	65.0	28.0	20.0	16.0
10	22.0	65.0	126.0	250.0	166.0	140.0	150.0	161.0	61.0	29.0	19.0	16.0
11	21.0	68.0	112.0	234.0	164.0	134.0	120.0	117.0	62.0	27.0	19.0	16.0
12	21.0	70.0	106.0	216.0	151.0	132.0	116.0	106.0	59.0	27.0	19.0	15.0
13	21.0	115.0	112.0	234.0	144.0	142.0	114.0	93.0	56.0	36.0	19.0	15.0
14	20.0	106.0	122.0	209.0	149.0	148.0	108.0	103.0	57.0	52.0	41.0	15.0
15	20.0	87.0	128.0	188.0	163.0	147.0	203.0	95.0	52.0	24.0	36.0	15.0
16	20.0	130.0	131.0	198.0	163.0	136.0	405.0	92.0	50.0	22.0	25.0	15.0
17	20.0	829.0	123.0	196.0	164.0	123.0	218.0	121.0	49.0	22.0	20.0	14.0
18	20.0	402.0	132.0	331.0	168.0	108.0	362.0	101.0	50.0	22.0	19.0	14.0
19	521.0	246.0	251.0	501.0	171.0	109.0	226.0	104.0	69.0	21.0	18.0	14.0
20	160.0	198.0	201.0	303.0	203.0	143.0	323.0	130.0	62.0	20.0	19.0	14.0
21	79.0	166.0	126.0	217.0	253.0	156.0	156.0	102.0	63.0	19.0	19.0	14.0
22	63.0	149.0	113.0	204.0	402.0	157.0	130.0	405.0	91.0	19.0	19.0	13.0
23	59.0	139.0	105.0	251.0	354.0	158.0	320.0	161.0	57.0	18.0	19.0	13.0
24	53.0	132.0	97.0	942.0	250.0	146.0	430.0	365.0	48.0	19.0	19.0	14.0
25	47.0	129.0	101.0	467.0	178.0	146.0	577.0	173.0	52.0	19.0	19.0	15.0
26	45.0	130.0	121.0	337.0	161.0	140.0	764.0	136.0	51.0	19.0	18.0	15.0
27	38.0	126.0	123.0	297.0	169.0	135.0	297.0	110.0	47.0	19.0	18.0	14.0
28	44.0	124.0	104.0	283.0	171.0	143.0	174.0	179.0	44.0	19.0	18.0	13.0
29	44.0		101.0	245.0	163.0	140.0	143.0	146.0	46.0	19.0	17.0	13.0
30	71.0		100.0	229.0	166.0	125.0	151.0	123.0	41.0	19.0	17.0	13.0
31	64.0		199.0		158.0		176.0	96.0		19.0		13.0
Average	54.8	159.1	128.7	293.4	194.0	146.1	223.6	147.4	60.8	25.9	21.4	14.9
Maximum	521.0	829.0	251.0	942.0	402.0	190.0	764.0	405.0	91.0	52.0	41.0	17.0
Minimum	20.0	59.0	97.0	155.0	144.0	108.0	108.0	92.0	41.0	18.0	17.0	13.0

Average annual discharge = 122 (m^3/sec)

Annual inflow volume = 3,851 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1966

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13.0	12.0	88.0	161.0	148.0	99.0	155.0	1,016.0	132.0	125.0	40.0	28.0
2	13.0	12.0	79.0	145.0	127.0	83.0	101.0	515.0	93.0	122.0	41.0	27.0
3	13.0	12.0	77.0	151.0	117.0	77.0	115.0	408.0	492.0	126.0	41.0	27.0
4	13.0	12.0	136.0	157.0	130.0	78.0	247.0	362.0	176.0	207.0	42.0	27.0
5	13.0	12.0	164.0	138.0	140.0	91.0	144.0	374.0	155.0	157.0	40.0	27.0
6	13.0	12.0	115.0	126.0	139.0	80.0	102.0	507.0	136.0	166.0	38.0	27.0
7	13.0	12.0	96.0	210.0	149.0	78.0	72.0	974.0	185.0	122.0	39.0	27.0
8	12.0	52.0	99.0	139.0	156.0	96.0	79.0	450.0	2,156.0	116.0	59.0	26.0
9	12.0	70.0	98.0	120.0	156.0	107.0	73.0	325.0	2,796.0	110.0	48.0	26.0
10	12.0	62.0	97.0	112.0	150.0	98.0	69.0	311.0	430.0	291.0	35.0	26.0
11	12.0	56.0	113.0	108.0	311.0	70.0	57.0	303.0	325.0	203.0	34.0	26.0
12	12.0	320.0	118.0	105.0	215.0	64.0	193.0	215.0	256.0	145.0	34.0	26.0
13	12.0	376.0	119.0	125.0	181.0	78.0	232.0	229.0	246.0	127.0	34.0	26.0
14	12.0	187.0	119.0	212.0	144.0	79.0	181.0	203.0	227.0	119.0	34.0	25.0
15	12.0	98.0	122.0	167.0	119.0	79.0	91.0	291.0	216.0	117.0	33.0	25.0
16	12.0	67.0	123.0	161.0	102.0	115.0	121.0	191.0	204.0	114.0	33.0	25.0
17	12.0	49.0	118.0	174.0	105.0	115.0	89.0	176.0	223.0	112.0	33.0	25.0
18	12.0	40.0	264.0	138.0	106.0	140.0	87.0	183.0	206.0	109.0	32.0	25.0
19	12.0	37.0	158.0	116.0	109.0	239.0	81.0	283.0	237.0	106.0	31.0	25.0
20	12.0	35.0	140.0	113.0	113.0	187.0	186.0	365.0	198.0	255.0	31.0	24.0
21	12.0	207.0	112.0	119.0	110.0	142.0	87.0	181.0	189.0	99.0	31.0	24.0
22	12.0	142.0	161.0	145.0	110.0	176.0	262.0	121.0	174.0	75.0	30.0	24.0
23	12.0	63.0	291.0	118.0	114.0	276.0	399.0	110.0	186.0	75.0	29.0	24.0
24	12.0	56.0	229.0	120.0	115.0	402.0	241.0	114.0	161.0	76.0	29.0	24.0
25	12.0	54.0	184.0	106.0	114.0	283.0	857.0	113.0	147.0	79.0	29.0	43.0
26	12.0	271.0	176.0	106.0	130.0	131.0	979.0	90.0	143.0	79.0	29.0	44.0
27	12.0	178.0	430.0	129.0	139.0	104.0	245.0	98.0	141.0	71.0	29.0	38.0
28	12.0	131.0	217.0	190.0	120.0	137.0	294.0	104.0	136.0	59.0	29.0	36.0
29	12.0		168.0	198.0	143.0	166.0	213.0	77.0	130.0	57.0	28.0	33.0
30	12.0		169.0	185.0	202.0	262.0	379.0	85.0	124.0	50.0	28.0	35.0
31	12.0		159.0		147.0		976.0	102.0		41.0		45.0
Average	12.2	94.1	152.9	143.1	140.7	137.7	238.9	286.3	354.0	119.7	34.8	28.7
Maximum	13.0	376.0	430.0	212.0	311.0	402.0	979.0	1,016.0	2,796.0	291.0	59.0	45.0
Minimum	12.0	12.0	77.0	105.0	102.0	64.0	57.0	77.0	93.0	41.0	28.0	24.0

Average annual discharge = 145 (m^3/sec)

Annual inflow volume = 4,587 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1967

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	42.0	17.0	74.0	306.0	289.0	108.0	129.0	195.0	96.0	52.0	36.0	23.0
2	35.0	16.0	75.0	756.0	261.0	119.0	117.0	185.0	132.0	51.0	35.0	23.0
3	33.0	16.0	74.0	289.0	156.0	117.0	82.0	824.0	121.0	50.0	34.0	566.0
4	32.0	16.0	74.0	186.0	149.0	122.0	126.0	311.0	116.0	89.0	34.0	92.0
5	31.0	16.0	75.0	151.0	127.0	108.0	99.0	484.0	100.0	61.0	33.0	55.0
6	31.0	16.0	74.0	151.0	116.0	100.0	96.0	589.0	93.0	53.0	32.0	46.0
7	27.0	16.0	74.0	138.0	100.0	117.0	104.0	241.0	271.0	50.0	31.0	40.0
8	27.0	17.0	66.0	134.0	106.0	124.0	120.0	334.0	88.0	48.0	31.0	37.0
9	27.0	16.0	66.0	113.0	121.0	113.0	132.0	222.0	78.0	46.0	31.0	35.0
10	26.0	16.0	68.0	114.0	127.0	95.0	142.0	179.0	91.0	48.0	30.0	33.0
11	25.0	16.0	66.0	106.0	126.0	102.0	132.0	168.0	201.0	46.0	30.0	34.0
12	24.0	17.0	142.0	100.0	110.0	104.0	104.0	303.0	195.0	51.0	29.0	38.0
13	23.0	18.0	444.0	99.0	97.0	115.0	230.0	158.0	362.0	46.0	28.0	39.0
14	22.0	17.0	207.0	115.0	91.0	110.0	90.0	962.0	331.0	43.0	27.0	37.0
15	21.0	17.0	156.0	122.0	90.0	109.0	85.0	180.0	138.0	42.0	27.0	37.0
16	20.0	17.0	535.0	128.0	96.0	173.0	105.0	173.0	154.0	40.0	27.0	36.0
17	20.0	30.0	291.0	135.0	99.0	161.0	80.0	139.0	120.0	39.0	28.0	36.0
18	19.0	65.0	231.0	148.0	108.0	84.0	84.0	165.0	96.0	38.0	27.0	35.0
19	19.0	166.0	205.0	143.0	109.0	71.0	85.0	193.0	120.0	43.0	27.0	35.0
20	18.0	600.0	195.0	147.0	121.0	64.0	1,024.0	297.0	87.0	42.0	27.0	34.0
21	18.0	224.0	187.0	142.0	130.0	63.0	219.0	160.0	77.0	38.0	26.0	33.0
22	18.0	135.0	186.0	141.0	151.0	64.0	183.0	140.0	72.0	37.0	26.0	31.0
23	18.0	90.0	185.0	144.0	157.0	67.0	962.0	130.0	69.0	36.0	28.0	31.0
24	18.0	79.0	181.0	143.0	160.0	68.0	328.0	179.0	68.0	41.0	28.0	92.0
25	18.0	70.0	1,118.0	147.0	147.0	81.0	291.0	161.0	87.0	101.0	28.0	104.0
26	17.0	70.0	744.0	150.0	133.0	86.0	233.0	150.0	96.0	84.0	27.0	671.0
27	17.0	68.0	229.0	187.0	106.0	76.0	538.0	129.0	79.0	53.0	26.0	526.0
28	17.0	71.0	188.0	569.0	93.0	72.0	207.0	150.0	64.0	44.0	27.0	132.0
29	17.0		176.0	351.0	88.0	78.0	186.0	119.0	58.0	40.0	26.0	106.0
30	17.0		160.0	177.0	89.0	240.0	512.0	119.0	55.0	38.0	24.0	91.0
31	17.0		149.0		98.0		177.0	121.0		37.0		83.0
Average	23.0	69.0	216.0	191.1	127.5	103.7	225.9	253.5	123.8	49.3	29.0	103.6
Maximum	42.0	600.0	1,118.0	756.0	289.0	240.0	1,024.0	962.0	362.0	101.0	36.0	671.0
Minimum	17.0	16.0	66.0	99.0	88.0	63.0	80.0	119.0	55.0	36.0	24.0	23.0

Average annual discharge = 127 (m^3/sec)

Annual inflow volume = 4,002 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1968

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	78.0	125.0	143.0	104.0	135.0	80.0	79.0	187.0	104.0	47.0	107.0	25.0
2	74.0	112.0	139.0	99.0	140.0	81.0	83.0	189.0	96.0	44.0	134.0	24.0
3	71.0	106.0	138.0	95.0	114.0	81.0	80.0	144.0	90.0	43.0	64.0	23.0
4	67.0	102.0	136.0	95.0	99.0	114.0	97.0	320.0	88.0	84.0	55.0	23.0
5	61.0	96.0	138.0	104.0	96.0	99.0	91.0	266.0	83.0	72.0	53.0	23.0
6	69.0	155.0	136.0	130.0	89.0	81.0	103.0	662.0	80.0	60.0	50.0	23.0
7	67.0	130.0	135.0	130.0	83.0	81.0	85.0	185.0	78.0	218.0	46.0	23.0
8	58.0	110.0	136.0	125.0	71.0	95.0	96.0	200.0	74.0	84.0	43.0	22.0
9	54.0	101.0	136.0	123.0	61.0	96.0	213.0	273.0	81.0	57.0	41.0	22.0
10	59.0	99.0	133.0	117.0	57.0	108.0	174.0	255.0	73.0	67.0	39.0	23.0
11	66.0	98.0	137.0	109.0	61.0	104.0	135.0	857.0	68.0	56.0	38.0	31.0
12	64.0	98.0	136.0	108.0	67.0	183.0	223.0	351.0	80.0	45.0	44.0	83.0
13	67.0	97.0	132.0	106.0	77.0	102.0	148.0	278.0	70.0	42.0	42.0	40.0
14	62.0	106.0	134.0	218.0	85.0	96.0	242.0	410.0	67.0	82.0	37.0	30.0
15	58.0	100.0	126.0	376.0	74.0	97.0	126.0	314.0	64.0	79.0	37.0	28.0
16	57.0	96.0	124.0	185.0	72.0	97.0	126.0	233.0	68.0	59.0	35.0	26.0
17	57.0	97.0	128.0	155.0	69.0	98.0	101.0	235.0	65.0	51.0	34.0	25.0
18	55.0	98.0	279.0	142.0	71.0	95.0	95.0	393.0	63.0	51.0	33.0	24.0
19	54.0	106.0	419.0	140.0	75.0	98.0	132.0	524.0	62.0	44.0	33.0	23.0
20	365.0	560.0	280.0	139.0	90.0	98.0	133.0	294.0	61.0	41.0	31.0	23.0
21	311.0	177.0	225.0	141.0	119.0	95.0	204.0	204.0	56.0	40.0	31.0	22.0
22	177.0	164.0	176.0	138.0	189.0	93.0	151.0	342.0	54.0	38.0	30.0	23.0
23	126.0	153.0	161.0	168.0	169.0	92.0	197.0	222.0	52.0	37.0	30.0	23.0
24	123.0	146.0	148.0	147.0	100.0	92.0	141.0	185.0	50.0	37.0	28.0	23.0
25	120.0	143.0	138.0	137.0	78.0	136.0	99.0	191.0	50.0	36.0	27.0	25.0
26	123.0	149.0	230.0	132.0	76.0	163.0	83.0	151.0	50.0	35.0	26.0	25.0
27	201.0	303.0	157.0	136.0	81.0	113.0	92.0	130.0	49.0	34.0	26.0	24.0
28	342.0	224.0	130.0	135.0	78.0	127.0	191.0	119.0	54.0	33.0	26.0	23.0
29	219.0	165.0	112.0	135.0	76.0	108.0	1,189.0	112.0	52.0	32.0	26.0	22.0
30	139.0		104.0	136.0	77.0	89.0	221.0	110.0	49.0	34.0	26.0	22.0
31	133.0		106.0		81.0		168.0	109.0		35.0		21.0
Average	115.4	145.4	159.7	140.2	90.6	103.1	170.9	272.4	67.7	55.4	42.4	26.4
Maximum	365.0	560.0	419.0	376.0	189.0	183.0	1,189.0	857.0	104.0	218.0	134.0	83.0
Minimum	54.0	96.0	104.0	95.0	57.0	80.0	79.0	109.0	49.0	32.0	26.0	21.0

Average annual discharge = 116 (m^3/sec)

Annual inflow volume = 3,666 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1969

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.0	255.0	88.0	127.0	157.0	168.0	105.0	101.0	69.0	72.0	31.0	21.0
2	21.0	87.0	89.0	127.0	153.0	150.0	87.0	95.0	64.0	145.0	33.0	21.0
3	21.0	60.0	95.0	121.0	147.0	136.0	88.0	135.0	62.0	66.0	32.0	21.0
4	21.0	52.0	96.0	112.0	140.0	143.0	93.0	243.0	69.0	45.0	34.0	20.0
5	21.0	53.0	99.0	104.0	139.0	119.0	115.0	574.0	58.0	41.0	33.0	20.0
6	21.0	44.0	106.0	96.0	134.0	108.0	95.0	1,576.0	120.0	38.0	33.0	20.0
7	21.0	42.0	107.0	98.0	133.0	98.0	96.0	357.0	88.0	35.0	31.0	20.0
8	21.0	40.0	108.0	111.0	135.0	94.0	129.0	232.0	67.0	33.0	30.0	20.0
9	20.0	41.0	108.0	118.0	143.0	88.0	165.0	314.0	108.0	33.0	30.0	19.0
10	20.0	40.0	105.0	119.0	173.0	85.0	145.0	419.0	64.0	32.0	29.0	19.0
11	20.0	40.0	107.0	117.0	194.0	86.0	113.0	248.0	57.0	130.0	29.0	19.0
12	21.0	38.0	112.0	114.0	300.0	85.0	92.0	239.0	57.0	91.0	29.0	19.0
13	28.0	41.0	117.0	106.0	574.0	91.0	108.0	196.0	58.0	32.0	29.0	19.0
14	28.0	67.0	119.0	111.0	425.0	88.0	264.0	179.0	71.0	47.0	28.0	19.0
15	24.0	50.0	121.0	114.0	228.0	87.0	164.0	231.0	92.0	106.0	26.0	18.0
16	23.0	43.0	117.0	143.0	168.0	88.0	143.0	244.0	76.0	72.0	25.0	18.0
17	22.0	101.0	114.0	113.0	141.0	91.0	106.0	374.0	67.0	47.0	24.0	18.0
18	21.0	88.0	141.0	97.0	135.0	100.0	101.0	320.0	65.0	44.0	24.0	18.0
19	21.0	65.0	447.0	84.0	132.0	113.0	96.0	236.0	57.0	42.0	23.0	18.0
20	21.0	55.0	306.0	342.0	119.0	123.0	172.0	212.0	53.0	40.0	23.0	17.0
21	21.0	51.0	158.0	216.0	114.0	115.0	283.0	176.0	52.0	37.0	23.0	17.0
22	21.0	48.0	148.0	138.0	123.0	106.0	186.0	205.0	47.0	35.0	23.0	17.0
23	21.0	47.0	294.0	113.0	132.0	117.0	136.0	147.0	50.0	35.0	23.0	17.0
24	21.0	48.0	171.0	99.0	130.0	102.0	1,121.0	124.0	52.0	33.0	23.0	16.0
25	20.0	60.0	282.0	85.0	113.0	93.0	283.0	136.0	44.0	32.0	22.0	16.0
26	63.0	64.0	541.0	78.0	112.0	90.0	262.0	140.0	38.0	33.0	22.0	16.0
27	89.0	252.0	230.0	72.0	105.0	86.0	244.0	97.0	38.0	32.0	21.0	15.0
28	51.0	102.0	167.0	104.0	101.0	131.0	396.0	89.0	38.0	53.0	21.0	15.0
29	40.0		152.0	521.0	106.0	94.0	213.0	82.0	37.0	63.0	21.0	15.0
30	33.0		140.0	218.0	112.0	125.0	144.0	76.0	37.0	46.0	21.0	15.0
31	31.0		138.0		114.0		112.0	74.0		32.0		16.0
Average	27.4	70.5	165.3	137.3	165.5	106.7	188.9	253.9	61.8	52.3	26.5	18.0
Maximum	89.0	255.0	541.0	521.0	574.0	168.0	1,121.0	1,576.0	120.0	145.0	34.0	21.0
Minimum	20.0	38.0	88.0	72.0	101.0	85.0	87.0	74.0	37.0	32.0	21.0	15.0

Average annual discharge = 107 (m^3/sec)

Annual inflow volume = 3,366 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1970

Mean Daily Discharges (without Project) (m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.0	23.0	82.0	52.0	61.0	40.0	159.0	66.0	1,339.0	66.0	31.0	18.0
2	16.0	22.0	48.0	51.0	64.0	42.0	368.0	85.0	268.0	64.0	31.0	18.0
3	16.0	21.0	40.0	53.0	53.0	43.0	208.0	60.0	163.0	60.0	29.0	18.0
4	16.0	20.0	38.0	59.0	51.0	182.0	226.0	106.0	758.0	56.0	29.0	18.0
5	16.0	20.0	37.0	68.0	54.0	110.0	122.0	190.0	254.0	54.0	28.0	18.0
6	16.0	20.0	34.0	78.0	60.0	58.0	122.0	78.0	215.0	75.0	28.0	18.0
7	16.0	19.0	31.0	79.0	77.0	44.0	111.0	65.0	325.0	67.0	28.0	18.0
8	15.0	19.0	30.0	72.0	51.0	35.0	110.0	69.0	546.0	55.0	27.0	18.0
9	15.0	19.0	31.0	75.0	43.0	31.0	107.0	122.0	266.0	54.0	26.0	18.0
10	15.0	19.0	32.0	81.0	44.0	31.0	270.0	441.0	226.0	54.0	25.0	17.0
11	16.0	19.0	50.0	88.0	46.0	32.0	106.0	118.0	410.0	46.0	24.0	17.0
12	17.0	18.0	44.0	83.0	50.0	63.0	73.0	120.0	314.0	43.0	24.0	17.0
13	17.0	18.0	86.0	75.0	56.0	291.0	113.0	611.0	258.0	42.0	24.0	17.0
14	17.0	18.0	140.0	74.0	59.0	93.0	87.0	257.0	257.0	41.0	24.0	17.0
15	17.0	19.0	176.0	72.0	47.0	171.0	60.0	256.0	174.0	40.0	22.0	17.0
16	17.0	19.0	195.0	108.0	51.0	93.0	85.0	202.0	169.0	38.0	22.0	17.0
17	16.0	19.0	110.0	71.0	56.0	52.0	108.0	233.0	166.0	38.0	22.0	17.0
18	17.0	18.0	96.0	60.0	60.0	47.0	116.0	526.0	172.0	37.0	21.0	17.0
19	16.0	18.0	83.0	64.0	54.0	40.0	62.0	235.0	249.0	36.0	20.0	17.0
20	16.0	19.0	68.0	59.0	56.0	37.0	80.0	192.0	260.0	36.0	20.0	17.0
21	16.0	21.0	70.0	60.0	60.0	37.0	73.0	917.0	164.0	36.0	19.0	18.0
22	16.0	23.0	72.0	79.0	54.0	40.0	74.0	258.0	155.0	124.0	19.0	17.0
23	16.0	26.0	74.0	83.0	100.0	51.0	53.0	320.0	119.0	113.0	19.0	17.0
24	16.0	24.0	76.0	88.0	62.0	40.0	50.0	311.0	83.0	75.0	19.0	17.0
25	188.0	25.0	82.0	94.0	48.0	40.0	42.0	413.0	64.0	69.0	19.0	17.0
26	92.0	35.0	77.0	100.0	42.0	59.0	39.0	708.0	69.0	60.0	19.0	17.0
27	37.0	29.0	121.0	78.0	32.0	56.0	142.0	325.0	68.0	49.0	19.0	17.0
28	28.0	342.0	124.0	78.0	31.0	177.0	114.0	240.0	63.0	42.0	19.0	17.0
29	24.0		91.0	62.0	37.0	147.0	73.0	413.0	63.0	35.0	19.0	16.0
30	24.0		68.0	55.0	36.0	97.0	92.0	252.0	65.0	34.0	19.0	16.0
31	24.0		58.0		45.0		79.0	1,044.0		32.0		16.0
Average	25.9	32.6	76.3	73.3	52.9	76.0	113.7	297.8	256.7	53.9	23.2	17.2
Maximum	188.0	342.0	195.0	108.0	100.0	291.0	368.0	1,044.0	1,339.0	124.0	31.0	18.0
Minimum	15.0	18.0	30.0	51.0	31.0	31.0	39.0	60.0	63.0	32.0	19.0	16.0

Average annual discharge = 92 (m³/sec)

Annual inflow volume = 2,899 (Mm³)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1971

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.0	13.0	37.0	44.0	60.0	210.0	96.0	790.0	263.0	38.0	34.0	22.0
2	16.0	13.0	31.0	48.0	61.0	143.0	600.0	1,174.0	202.0	37.0	61.0	22.0
3	15.0	13.0	27.0	49.0	59.0	117.0	256.0	291.0	223.0	37.0	48.0	22.0
4	16.0	13.0	34.0	59.0	61.0	102.0	205.0	208.0	177.0	35.0	37.0	21.0
5	16.0	13.0	36.0	83.0	61.0	91.0	249.0	206.0	148.0	35.0	33.0	22.0
6	16.0	13.0	41.0	67.0	51.0	83.0	160.0	174.0	102.0	34.0	31.0	22.0
7	16.0	13.0	40.0	60.0	51.0	89.0	116.0	764.0	103.0	33.0	30.0	22.0
8	16.0	13.0	40.0	57.0	52.0	94.0	132.0	444.0	83.0	32.0	30.0	21.0
9	15.0	13.0	39.0	54.0	43.0	119.0	113.0	461.0	80.0	32.0	28.0	21.0
10	15.0	14.0	40.0	53.0	48.0	572.0	86.0	272.0	74.0	32.0	28.0	21.0
11	15.0	15.0	44.0	47.0	43.0	233.0	84.0	213.0	81.0	31.0	27.0	21.0
12	14.0	16.0	48.0	38.0	40.0	149.0	104.0	181.0	77.0	31.0	26.0	21.0
13	14.0	14.0	51.0	34.0	37.0	107.0	631.0	153.0	73.0	31.0	25.0	21.0
14	14.0	13.0	50.0	44.0	49.0	323.0	216.0	145.0	64.0	31.0	25.0	21.0
15	13.0	13.0	50.0	36.0	40.0	164.0	125.0	126.0	59.0	30.0	23.0	20.0
16	13.0	13.0	49.0	44.0	48.0	157.0	195.0	111.0	59.0	31.0	23.0	21.0
17	13.0	13.0	49.0	55.0	40.0	94.0	286.0	125.0	58.0	31.0	23.0	21.0
18	13.0	13.0	51.0	47.0	43.0	93.0	159.0	100.0	52.0	30.0	23.0	20.0
19	13.0	15.0	52.0	42.0	47.0	81.0	140.0	96.0	52.0	30.0	23.0	20.0
20	13.0	15.0	50.0	40.0	62.0	79.0	122.0	146.0	50.0	30.0	23.0	20.0
21	13.0	14.0	48.0	256.0	122.0	157.0	77.0	128.0	48.0	29.0	23.0	20.0
22	13.0	14.0	42.0	99.0	123.0	490.0	99.0	104.0	47.0	29.0	23.0	21.0
23	13.0	13.0	40.0	87.0	85.0	478.0	74.0	93.0	46.0	29.0	23.0	21.0
24	13.0	13.0	38.0	72.0	87.0	256.0	69.0	93.0	44.0	28.0	22.0	20.0
25	14.0	13.0	40.0	69.0	99.0	251.0	97.0	170.0	42.0	27.0	23.0	20.0
26	14.0	16.0	41.0	69.0	92.0	221.0	280.0	959.0	41.0	26.0	23.0	20.0
27	15.0	419.0	43.0	72.0	108.0	170.0	134.0	274.0	41.0	26.0	23.0	20.0
28	15.0	63.0	44.0	85.0	130.0	239.0	97.0	184.0	41.0	25.0	22.0	20.0
29	14.0		41.0	112.0	104.0	129.0	891.0	148.0	40.0	25.0	22.0	20.0
30	14.0		37.0	75.0	87.0	97.0	297.0	430.0	39.0	25.0	22.0	20.0
31	13.0		39.0		124.0		181.0	223.0		25.0		20.0
Average	14.3	29.9	42.3	66.6	69.6	186.3	205.5	289.9	83.6	30.5	27.6	20.8
Maximum	16.0	419.0	52.0	256.0	130.0	572.0	891.0	1,174.0	263.0	38.0	61.0	22.0
Minimum	13.0	13.0	27.0	34.0	37.0	79.0	69.0	93.0	39.0	25.0	22.0	20.0

Average annual discharge = 89 (m^3/sec)

Annual inflow volume = 2,818 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1972

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.0	473.0	52.0	98.0	75.0	103.0	97.0	72.0	150.0	59.0	48.0	28.3
2	20.0	202.0	59.0	94.0	64.0	98.0	67.0	67.0	111.0	53.0	45.0	27.0
3	19.0	77.0	67.0	86.0	59.0	82.0	240.0	60.0	96.0	51.0	43.0	25.0
4	20.0	53.0	72.0	82.0	58.0	75.0	142.0	49.0	114.0	48.0	42.0	24.0
5	19.0	43.0	97.0	164.0	60.0	65.0	163.0	261.0	84.0	46.0	41.0	23.0
6	19.0	40.0	69.0	108.0	68.0	55.0	150.0	1,907.0	84.0	48.0	40.0	23.0
7	19.0	36.0	60.0	89.0	84.0	47.0	158.0	40.0	123.0	51.0	39.0	22.0
8	19.0	31.0	311.0	78.0	76.0	48.0	84.0	194.0	149.0	55.0	39.0	22.0
9	19.0	27.0	223.0	95.0	86.0	42.0	1,395.0	270.0	300.0	44.0	39.0	23.0
10	19.0	25.0	118.0	75.0	85.0	39.0	413.0	118.0	487.0	44.0	39.0	128.0
11	19.0	25.0	95.0	65.0	90.0	43.0	558.0	97.0	122.0	43.0	38.0	87.0
12	19.0	323.0	89.0	74.0	92.0	53.0	351.0	96.0	91.0	42.0	37.0	37.0
13	19.0	168.0	279.0	79.0	99.0	53.0	195.0	112.0	78.0	38.0	36.0	31.0
14	19.0	77.0	135.0	85.0	105.0	60.0	117.0	164.0	82.0	37.0	34.0	30.0
15	19.0	58.0	111.0	86.0	97.0	64.0	110.0	104.0	67.0	35.0	33.0	32.0
16	19.0	53.0	103.0	146.0	93.0	65.0	87.0	115.0	122.0	36.0	32.0	29.0
17	19.0	51.0	111.0	240.0	94.0	70.0	135.0	207.0	175.0	36.0	31.0	31.0
18	19.0	49.0	101.0	186.0	106.0	71.0	95.0	115.0	74.0	64.0	30.0	42.0
19	19.0	50.0	109.0	156.0	103.0	62.0	114.0	283.0	247.0	160.0	29.0	37.0
20	19.0	57.0	222.0	125.0	110.0	48.0	94.0	268.0	177.0	75.0	29.0	54.0
21	22.0	63.0	166.0	95.0	109.0	48.0	74.0	152.0	108.0	55.0	27.0	38.0
22	137.0	60.0	122.0	82.0	98.0	59.0	64.0	98.0	78.0	228.0	29.0	32.0
23	45.0	57.0	119.0	76.0	213.0	67.0	57.0	87.0	70.0	111.0	32.0	30.0
24	25.0	63.0	127.0	80.0	283.0	62.0	80.0	96.0	69.0	82.0	34.0	32.0
25	22.0	61.0	142.0	81.0	114.0	71.0	71.0	120.0	64.0	65.0	35.0	37.0
26	21.0	60.0	164.0	78.0	85.0	109.0	82.0	80.0	60.0	54.0	38.0	44.0
27	20.0	57.0	265.0	79.0	76.0	75.0	60.0	74.0	59.0	47.0	37.0	98.0
28	20.0	61.0	189.0	140.0	78.0	218.0	56.0	110.0	57.0	41.0	32.0	100.0
29	20.0	51.0	179.0	150.0	79.0	105.0	63.0	265.0	57.0	38.0	31.0	75.0
30	20.0		185.0	101.0	82.0	96.0	144.0	201.0	67.0	37.0	30.0	57.0
31	107.0		120.0		102.0		97.0	186.0		35.0		48.0
Average	27.2	84.5	137.5	105.8	97.5	71.8	181.1	195.7	120.7	59.9	35.6	43.4
Maximum	137.0	473.0	311.0	240.0	283.0	218.0	1,395.0	1,907.0	487.0	228.0	48.0	128.0
Minimum	19.0	25.0	52.0	65.0	58.0	39.0	56.0	40.0	57.0	35.0	27.0	22.0

Average annual discharge = 97 (m^3/sec)

Annual inflow volume = 3,065 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1973

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	46.0	63.0	161.0	247.0	152.0	74.0	94.0	85.0	464.0	128.0	33.0	21.0
2	42.0	60.0	200.0	187.0	156.0	65.0	135.0	112.0	269.0	82.0	32.0	20.0
3	39.0	61.0	151.0	205.0	131.0	67.0	142.0	376.0	226.0	67.0	31.0	20.0
4	37.0	58.0	130.0	203.0	123.0	73.0	94.0	245.0	165.0	65.0	30.0	20.0
5	34.0	58.0	116.0	175.0	126.0	83.0	371.0	164.0	142.0	59.0	30.0	20.0
6	53.0	60.0	108.0	192.0	125.0	94.0	135.0	461.0	122.0	54.0	29.0	20.0
7	58.0	60.0	105.0	152.0	111.0	98.0	92.0	281.0	143.0	50.0	29.0	20.0
8	48.0	60.0	242.0	136.0	135.0	103.0	127.0	781.0	109.0	48.0	29.0	20.0
9	40.0	60.0	458.0	129.0	124.0	103.0	102.0	3,481.0	94.0	47.0	29.0	19.0
10	37.0	65.0	1,653.0	128.0	109.0	108.0	57.0	852.0	86.0	46.0	29.0	19.0
11	34.0	79.0	628.0	169.0	73.0	96.0	59.0	456.0	97.0	47.0	28.0	19.0
12	63.0	80.0	374.0	203.0	47.0	139.0	325.0	425.0	152.0	48.0	28.0	20.0
13	116.0	83.0	275.0	157.0	44.0	158.0	925.0	617.0	102.0	47.0	27.0	20.0
14	60.0	85.0	255.0	145.0	43.0	134.0	109.0	574.0	116.0	47.0	27.0	20.0
15	51.0	84.0	229.0	147.0	63.0	98.0	354.0	458.0	121.0	46.0	27.0	19.0
16	48.0	79.0	228.0	96.0	70.0	102.0	195.0	371.0	98.0	62.0	26.0	31.0
17	48.0	79.0	220.0	87.0	196.0	111.0	69.0	306.0	113.0	67.0	26.0	78.0
18	52.0	73.0	190.0	107.0	113.0	118.0	77.0	286.0	200.0	57.0	25.0	38.0
19	388.0	68.0	149.0	133.0	81.0	111.0	235.0	379.0	130.0	53.0	25.0	30.0
20	942.0	68.0	178.0	154.0	63.0	132.0	234.0	289.0	379.0	52.0	25.0	24.0
21	249.0	69.0	166.0	166.0	63.0	166.0	246.0	532.0	158.0	51.0	24.0	22.0
22	135.0	65.0	138.0	126.0	68.0	131.0	89.0	391.0	110.0	50.0	24.0	21.0
23	199.0	67.0	155.0	159.0	75.0	97.0	61.0	276.0	72.0	48.0	23.0	21.0
24	92.0	275.0	195.0	162.0	79.0	135.0	223.0	235.0	99.0	47.0	23.0	21.0
25	80.0	931.0	232.0	159.0	84.0	187.0	168.0	144.0	271.0	45.0	23.0	21.0
26	77.0	753.0	231.0	172.0	84.0	289.0	320.0	166.0	109.0	43.0	22.0	21.0
27	76.0	282.0	235.0	173.0	98.0	129.0	450.0	504.0	80.0	42.0	22.0	21.0
28	72.0	199.0	223.0	137.0	102.0	94.0	185.0	114.0	74.0	39.0	22.0	21.0
29	65.0		201.0	146.0	87.0	100.0	125.0	93.0	67.0	37.0	21.0	21.0
30	66.0		204.0	147.0	89.0	85.0	143.0	80.0	93.0	35.0	21.0	21.0
31	67.0		232.0		83.0		130.0	614.0		34.0		21.0
Average	110.1	143.7	266.5	156.6	96.7	116.0	195.8	456.4	148.7	53.0	26.3	23.5
Maximum	942.0	931.0	1,653.0	247.0	196.0	289.0	925.0	3,481.0	464.0	128.0	33.0	78.0
Minimum	34.0	58.0	105.0	87.0	43.0	65.0	57.0	80.0	67.0	34.0	21.0	19.0

Average annual discharge = 150 (m^3/sec)

Annual inflow volume = 4,728 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1974

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.0	25.0	66.0	95.0	62.0	48.0	79.0	109.0	81.0	67.0	16.0	13.0
2	21.0	42.0	80.0	84.0	62.0	42.0	79.0	132.0	76.0	42.0	16.0	13.0
3	20.0	345.0	91.0	92.0	59.0	56.0	126.0	422.0	51.0	36.0	16.0	20.0
4	19.0	104.0	95.0	94.0	63.0	48.0	128.0	303.0	57.0	34.0	16.0	21.0
5	19.0	74.0	93.0	77.0	61.0	51.0	84.0	216.0	42.0	34.0	16.0	19.0
6	18.0	67.0	76.0	74.0	60.0	151.0	75.0	167.0	45.0	33.0	16.0	16.0
7	17.0	60.0	75.0	71.0	59.0	67.0	72.0	118.0	44.0	32.0	16.0	16.0
8	17.0	52.0	86.0	68.0	64.0	46.0	74.0	86.0	76.0	30.0	15.0	15.0
9	16.0	49.0	95.0	122.0	68.0	57.0	91.0	74.0	47.0	27.0	16.0	15.0
10	16.0	44.0	84.0	81.0	62.0	48.0	297.0	65.0	46.0	27.0	15.0	15.0
11	16.0	43.0	82.0	71.0	59.0	60.0	165.0	85.0	44.0	26.0	15.0	14.0
12	16.0	42.0	74.0	71.0	42.0	48.0	117.0	138.0	39.0	25.0	15.0	14.0
13	17.0	41.0	66.0	75.0	38.0	34.0	157.0	141.0	38.0	25.0	15.0	14.0
14	27.0	40.0	63.0	80.0	36.0	37.0	108.0	202.0	34.0	24.0	15.0	14.0
15	25.0	46.0	61.0	84.0	38.0	39.0	245.0	177.0	34.0	24.0	15.0	18.0
16	24.0	54.0	65.0	78.0	53.0	39.0	172.0	98.0	38.0	23.0	15.0	34.0
17	22.0	62.0	67.0	70.0	67.0	39.0	200.0	71.0	33.0	23.0	14.0	27.0
18	21.0	66.0	58.0	74.0	52.0	39.0	118.0	63.0	33.0	23.0	14.0	17.0
19	20.0	55.0	67.0	78.0	51.0	58.0	124.0	59.0	33.0	22.0	14.0	19.0
20	238.0	55.0	97.0	72.0	56.0	146.0	351.0	71.0	34.0	22.0	14.0	18.0
21	125.0	55.0	103.0	78.0	53.0	131.0	125.0	63.0	38.0	21.0	14.0	17.0
22	57.0	119.0	118.0	70.0	47.0	68.0	248.0	69.0	33.0	20.0	14.0	16.0
23	45.0	181.0	155.0	56.0	33.0	297.0	134.0	58.0	32.0	20.0	14.0	16.0
24	43.0	80.0	311.0	63.0	30.0	974.0	328.0	56.0	31.0	19.0	14.0	15.0
25	42.0	63.0	255.0	72.0	28.0	362.0	243.0	80.0	46.0	18.0	13.0	15.0
26	31.0	67.0	141.0	77.0	36.0	197.0	308.0	54.0	61.0	17.0	13.0	15.0
27	27.0	65.0	105.0	72.0	71.0	123.0	153.0	60.0	35.0	17.0	13.0	15.0
28	26.0	64.0	113.0	66.0	65.0	99.0	101.0	51.0	50.0	17.0	13.0	15.0
29	26.0		96.0	63.0	58.0	91.0	98.0	47.0	41.0	16.0	13.0	15.0
30	25.0		105.0	60.0	53.0	81.0	92.0	56.0	67.0	16.0	13.0	15.0
31	25.0		98.0		52.0		192.0	56.0		16.0		15.0
Average	34.9	73.6	101.3	76.3	52.8	119.2	157.5	111.2	45.3	25.7	14.6	16.8
Maximum	238.0	345.0	311.0	122.0	71.0	974.0	351.0	422.0	81.0	67.0	16.0	34.0
Minimum	16.0	25.0	58.0	56.0	28.0	34.0	72.0	47.0	31.0	16.0	13.0	13.0

Average annual discharge = 69 (m^3/sec)

Annual inflow volume = 2,180 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1975

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.0	60.0	108.0	145.0	95.0	97.0	87.0	108.0	337.0	97.0	36.0	24.0
2	15.0	35.0	85.0	152.0	91.0	92.0	95.0	371.0	473.0	96.0	35.0	23.0
3	14.0	27.0	80.0	182.0	95.0	99.0	76.0	267.0	320.0	70.0	35.0	22.0
4	14.0	25.0	184.0	168.0	136.0	90.0	93.0	277.0	237.0	72.0	35.0	22.0
5	14.0	23.0	155.0	149.0	136.0	88.0	98.0	586.0	303.0	70.0	35.0	21.0
6	14.0	27.0	98.0	139.0	100.0	86.0	83.0	300.0	194.0	70.0	34.0	21.0
7	14.0	25.0	84.0	134.0	91.0	89.0	94.0	267.0	357.0	67.0	33.0	21.0
8	14.0	53.0	79.0	129.0	90.0	112.0	97.0	208.0	190.0	65.0	33.0	21.0
9	14.0	74.0	76.0	108.0	68.0	106.0	90.0	185.0	206.0	63.0	34.0	21.0
10	13.0	51.0	121.0	95.0	100.0	94.0	90.0	138.0	213.0	60.0	33.0	20.0
11	14.0	40.0	294.0	97.0	95.0	78.0	85.0	164.0	798.0	58.0	30.0	20.0
12	14.0	39.0	130.0	95.0	98.0	79.0	143.0	897.0	342.0	57.0	27.0	20.0
13	14.0	365.0	104.0	94.0	106.0	81.0	114.0	300.0	273.0	56.0	29.0	20.0
14	14.0	153.0	106.0	82.0	107.0	95.0	172.0	188.0	246.0	55.0	27.0	20.0
15	14.0	87.0	109.0	73.0	99.0	95.0	696.0	163.0	297.0	53.0	26.0	20.0
16	13.0	68.0	102.0	74.0	139.0	95.0	1,407.0	221.0	144.0	51.0	27.0	19.0
17	13.0	63.0	103.0	94.0	300.0	103.0	371.0	234.0	311.0	50.0	27.0	19.0
18	13.0	61.0	103.0	101.0	157.0	97.0	181.0	736.0	226.0	49.0	27.0	19.0
19	13.0	59.0	104.0	108.0	106.0	104.0	252.0	880.0	252.0	48.0	28.0	19.0
20	12.0	60.0	102.0	96.0	104.0	134.0	198.0	2,009.0	241.0	48.0	28.0	19.0
21	12.0	57.0	97.0	95.0	104.0	106.0	396.0	535.0	242.0	45.0	28.0	19.0
22	15.0	53.0	144.0	115.0	90.0	87.0	182.0	787.0	247.0	43.0	29.0	19.0
23	20.0	57.0	492.0	211.0	84.0	89.0	153.0	852.0	137.0	43.0	28.0	19.0
24	16.0	55.0	234.0	129.0	90.0	84.0	201.0	388.0	114.0	42.0	28.0	19.0
25	16.0	62.0	163.0	146.0	91.0	73.0	177.0	283.0	96.0	40.0	28.0	19.0
26	16.0	70.0	144.0	294.0	96.0	76.0	158.0	198.0	89.0	39.0	27.0	19.0
27	16.0	72.0	138.0	308.0	92.0	82.0	143.0	173.0	70.0	40.0	27.0	19.0
28	16.0	124.0	137.0	145.0	98.0	175.0	179.0	2,023.0	71.0	40.0	27.0	19.0
29	16.0		138.0	108.0	118.0	163.0	258.0	620.0	79.0	38.0	27.0	19.0
30	29.0		139.0	98.0	114.0	84.0	134.0	441.0	79.0	38.0	26.0	19.0
31	83.0		139.0		92.0		114.0	374.0		37.0		19.0
Average	17.1	69.5	138.5	132.1	109.1	97.8	213.5	489.5	239.5	54.8	29.8	20.0
Maximum	83.0	365.0	492.0	308.0	300.0	175.0	1,407.0	2,023.0	798.0	97.0	36.0	24.0
Minimum	12.0	23.0	76.0	73.0	68.0	73.0	76.0	108.0	70.0	37.0	26.0	19.0

Average annual discharge = 135 (m^3/sec)

Annual inflow volume = 4,254 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1976

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.0	94.0	175.0	140.0	147.0	141.0	103.0	3,707.0	256.0	181.0	39.0	26.0
2	17.0	79.0	197.0	138.0	149.0	141.0	132.0	3,877.0	419.0	95.0	38.0	27.0
3	17.0	59.0	191.0	136.0	149.0	141.0	150.0	872.0	597.0	80.0	37.0	34.0
4	17.0	53.0	196.0	114.0	147.0	135.0	119.0	739.0	478.0	73.0	36.0	31.0
5	17.0	48.0	194.0	254.0	134.0	137.0	91.0	991.0	323.0	71.0	35.0	29.0
6	17.0	45.0	164.0	211.0	129.0	140.0	106.0	991.0	235.0	64.0	35.0	29.0
7	16.0	43.0	149.0	157.0	138.0	118.0	111.0	2,205.0	209.0	91.0	35.0	28.0
8	16.0	43.0	138.0	161.0	144.0	123.0	125.0	804.0	256.0	81.0	34.0	27.0
9	16.0	43.0	245.0	195.0	134.0	123.0	195.0	549.0	174.0	67.0	34.0	27.0
10	16.0	43.0	163.0	256.0	152.0	159.0	555.0	422.0	159.0	61.0	33.0	26.0
11	16.0	44.0	126.0	231.0	164.0	134.0	263.0	328.0	153.0	57.0	33.0	26.0
12	16.0	60.0	113.0	183.0	157.0	165.0	252.0	379.0	150.0	55.0	33.0	25.0
13	25.0	101.0	136.0	165.0	175.0	243.0	300.0	252.0	165.0	54.0	32.0	25.0
14	185.0	147.0	130.0	163.0	160.0	194.0	365.0	492.0	138.0	52.0	31.0	24.0
15	44.0	1,041.0	151.0	166.0	143.0	268.0	413.0	294.0	126.0	51.0	31.0	24.0
16	29.0	334.0	521.0	168.0	151.0	207.0	951.0	359.0	119.0	51.0	30.0	24.0
17	26.0	232.0	526.0	199.0	235.0	256.0	317.0	263.0	118.0	49.0	29.0	23.0
18	24.0	436.0	342.0	192.0	185.0	208.0	1,446.0	289.0	143.0	47.0	30.0	23.0
19	22.0	393.0	281.0	190.0	197.0	173.0	492.0	334.0	102.0	46.0	30.0	23.0
20	21.0	263.0	362.0	222.0	158.0	115.0	521.0	345.0	95.0	43.0	29.0	23.0
21	20.0	206.0	294.0	239.0	138.0	134.0	478.0	243.0	91.0	42.0	29.0	23.0
22	20.0	170.0	241.0	237.0	132.0	142.0	337.0	197.0	87.0	40.0	28.0	22.0
23	20.0	150.0	207.0	223.0	127.0	128.0	374.0	173.0	83.0	38.0	28.0	22.0
24	21.0	134.0	181.0	273.0	182.0	98.0	490.0	181.0	81.0	37.0	28.0	22.0
25	23.0	342.0	172.0	259.0	174.0	94.0	311.0	212.0	78.0	76.0	29.0	22.0
26	31.0	331.0	175.0	221.0	141.0	95.0	739.0	168.0	75.0	52.0	28.0	23.0
27	535.0	221.0	225.0	212.0	121.0	95.0	425.0	294.0	74.0	45.0	27.0	24.0
28	187.0	189.0	239.0	226.0	124.0	101.0	235.0	187.0	73.0	44.0	28.0	23.0
29	78.0	175.0	186.0	203.0	125.0	104.0	221.0	174.0	72.0	44.0	27.0	22.0
30	61.0		160.0	166.0	129.0	107.0	215.0	168.0	181.0	42.0	26.0	22.0
31	55.0		160.0		143.0		179.0	109.0		41.0		22.0
Average	52.5	190.3	217.4	196.7	151.1	147.3	355.2	664.5	177.0	60.3	31.4	24.9
Maximum	535.0	1,041.0	526.0	273.0	235.0	268.0	1,446.0	3,877.0	597.0	181.0	39.0	34.0
Minimum	16.0	43.0	113.0	114.0	121.0	94.0	91.0	109.0	72.0	37.0	26.0	22.0

Average annual discharge = 190 (m^3/sec)

Annual inflow volume = 5,995 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1977

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.0	74.0	50.0	62.0	92.0	95.0	125.0	104.0	152.0	75.0	46.0	64.0
2	24.0	78.0	48.0	60.0	95.0	95.0	283.0	331.0	149.0	78.0	42.0	41.0
3	23.0	73.0	48.0	59.0	362.0	92.0	374.0	263.0	229.0	87.0	266.0	38.0
4	22.0	65.0	50.0	62.0	214.0	94.0	203.0	1,520.0	114.0	67.0	102.0	37.0
5	22.0	63.0	50.0	84.0	129.0	89.0	199.0	637.0	202.0	67.0	58.0	37.0
6	22.0	57.0	59.0	164.0	102.0	72.0	1,347.0	374.0	303.0	79.0	49.0	36.0
7	21.0	53.0	64.0	114.0	87.0	67.0	209.0	282.0	106.0	63.0	44.0	35.0
8	21.0	50.0	74.0	79.0	79.0	62.0	233.0	294.0	291.0	60.0	42.0	35.0
9	22.0	52.0	73.0	71.0	159.0	63.0	165.0	217.0	95.0	57.0	42.0	33.0
10	35.0	60.0	73.0	100.0	172.0	68.0	145.0	205.0	157.0	93.0	42.0	34.0
11	118.0	62.0	67.0	80.0	160.0	62.0	594.0	217.0	143.0	55.0	40.0	36.0
12	29.0	60.0	61.0	98.0	98.0	72.0	254.0	280.0	106.0	52.0	41.0	60.0
13	22.0	59.0	62.0	86.0	115.0	89.0	357.0	199.0	144.0	50.0	41.0	39.0
14	20.0	60.0	85.0	90.0	117.0	126.0	722.0	209.0	111.0	49.0	42.0	38.0
15	20.0	59.0	62.0	83.0	104.0	85.0	1,336.0	152.0	102.0	49.0	40.0	36.0
16	21.0	58.0	71.0	71.0	86.0	67.0	1,118.0	396.0	90.0	125.0	40.0	35.0
17	21.0	58.0	57.0	80.0	81.0	71.0	600.0	185.0	109.0	71.0	38.0	34.0
18	22.0	60.0	52.0	97.0	84.0	75.0	300.0	224.0	325.0	53.0	38.0	33.0
19	24.0	62.0	49.0	283.0	89.0	67.0	286.0	311.0	198.0	49.0	37.0	35.0
20	25.0	61.0	44.0	211.0	99.0	72.0	294.0	255.0	113.0	48.0	38.0	36.0
21	24.0	56.0	44.0	118.0	92.0	79.0	351.0	200.0	110.0	49.0	38.0	37.0
22	24.0	37.0	53.0	98.0	92.0	86.0	484.0	214.0	112.0	48.0	36.0	37.0
23	27.0	48.0	61.0	99.0	89.0	101.0	368.0	223.0	111.0	48.0	39.0	35.0
24	256.0	47.0	65.0	101.0	81.0	263.0	541.0	224.0	102.0	43.0	38.0	37.0
25	492.0	44.0	70.0	91.0	148.0	131.0	504.0	187.0	92.0	580.0	37.0	320.0
26	239.0	44.0	67.0	88.0	99.0	450.0	368.0	138.0	83.0	179.0	40.0	433.0
27	164.0	53.0	71.0	83.0	103.0	171.0	291.0	106.0	82.0	88.0	40.0	166.0
28	105.0	55.0	63.0	114.0	110.0	156.0	204.0	148.0	80.0	69.0	35.0	84.0
29	80.0		63.0	106.0	111.0	379.0	129.0	121.0	86.0	57.0	32.0	54.0
30	71.0		65.0	107.0	142.0	158.0	177.0	291.0	139.0	54.0	79.0	34.0
31	75.0		65.0		107.0		105.0	192.0		49.0		31.0
Average	68.2	57.4	60.8	101.3	119.3	118.6	408.6	280.6	141.2	83.6	51.4	65.8
Maximum	492.0	78.0	85.0	283.0	362.0	450.0	1,347.0	1,520.0	325.0	580.0	266.0	433.0
Minimum	20.0	37.0	44.0	59.0	79.0	62.0	105.0	104.0	80.0	43.0	32.0	31.0

Average annual discharge = 131 (m^3/sec)

Annual inflow volume = 4,119 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1978

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	58.0	101.0	220.0	168.0	170.0	110.0	178.0	416.0	166.0	119.0	47.0	48.0
2	57.0	92.0	177.0	167.0	170.0	123.0	170.0	402.0	154.0	108.0	45.0	48.0
3	56.0	84.0	151.0	168.0	177.0	140.0	410.0	1,240.0	162.0	102.0	43.0	47.0
4	54.0	78.0	192.0	171.0	187.0	135.0	224.0	289.0	150.0	93.0	72.0	46.0
5	51.0	73.0	306.0	165.0	183.0	152.0	382.0	251.0	130.0	87.0	63.0	45.0
6	51.0	92.0	235.0	163.0	185.0	147.0	1,557.0	227.0	136.0	81.0	199.0	49.0
7	50.0	112.0	178.0	173.0	186.0	142.0	849.0	162.0	140.0	76.0	188.0	46.0
8	49.0	82.0	157.0	187.0	161.0	142.0	371.0	212.0	130.0	75.0	122.0	47.0
9	45.0	67.0	148.0	196.0	170.0	139.0	251.0	1,644.0	135.0	74.0	132.0	49.0
10	43.0	73.0	227.0	208.0	169.0	117.0	291.0	948.0	157.0	73.0	88.0	51.0
11	40.0	72.0	294.0	207.0	168.0	113.0	188.0	815.0	152.0	72.0	78.0	52.0
12	40.0	77.0	225.0	226.0	151.0	98.0	169.0	634.0	161.0	72.0	70.0	53.0
13	50.0	87.0	183.0	228.0	140.0	142.0	345.0	778.0	131.0	71.0	134.0	54.0
14	108.0	91.0	177.0	245.0	136.0	155.0	325.0	453.0	233.0	69.0	147.0	54.0
15	63.0	110.0	169.0	247.0	140.0	112.0	235.0	351.0	191.0	67.0	78.0	51.0
16	51.0	109.0	812.0	238.0	158.0	109.0	247.0	574.0	161.0	61.0	56.0	47.0
17	49.0	108.0	3,283.0	279.0	161.0	102.0	314.0	382.0	161.0	56.0	52.0	42.0
18	47.0	110.0	705.0	458.0	166.0	101.0	282.0	371.0	134.0	53.0	50.0	38.0
19	47.0	100.0	464.0	229.0	144.0	100.0	399.0	722.0	144.0	50.0	44.0	34.0
20	47.0	96.0	365.0	183.0	151.0	98.0	306.0	436.0	126.0	50.0	45.0	31.0
21	49.0	92.0	317.0	168.0	135.0	136.0	821.0	385.0	117.0	52.0	45.0	27.0
22	48.0	93.0	279.0	159.0	139.0	153.0	535.0	515.0	131.0	52.0	57.0	24.0
23	56.0	97.0	255.0	187.0	140.0	140.0	600.0	259.0	227.0	53.0	55.0	20.0
24	55.0	95.0	245.0	185.0	167.0	135.0	560.0	241.0	169.0	52.0	48.0	16.0
25	52.0	111.0	230.0	171.0	270.0	125.0	552.0	214.0	116.0	54.0	47.0	12.0
26	52.0	121.0	214.0	169.0	200.0	121.0	518.0	200.0	100.0	52.0	47.0	11.0
27	55.0	108.0	209.0	165.0	184.0	183.0	549.0	192.0	247.0	51.0	48.0	11.0
28	250.0	115.0	229.0	171.0	145.0	149.0	430.0	244.0	202.0	53.0	48.0	11.0
29	263.0		210.0	175.0	144.0	249.0	368.0	197.0	149.0	55.0	47.0	11.0
30	139.0		196.0	170.0	149.0	1,118.0	1,067.0	179.0	132.0	53.0	48.0	11.0
31	114.0		178.0		121.0		509.0	189.0		50.0		11.0
Average	70.6	94.5	362.3	200.9	163.5	166.2	451.7	455.5	154.8	67.3	74.8	35.4
Maximum	263.0	121.0	3,283.0	458.0	270.0	1,118.0	1,557.0	1,644.0	247.0	119.0	199.0	54.0
Minimum	40.0	67.0	148.0	159.0	121.0	98.0	169.0	162.0	100.0	50.0	43.0	11.0

Average annual discharge = 193 (m^3/sec)

Annual inflow volume = 6,077 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1979

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	9.0	34.0	64.0	175.0	95.0	59.0	102.0	61.0	100.0	94.0	55.0	47.0
2	9.0	42.0	103.0	149.0	107.0	181.0	90.0	651.0	100.0	85.0	46.0	44.0
3	9.0	35.0	230.0	190.0	102.0	80.0	102.0	73.0	101.0	80.0	46.0	44.0
4	9.0	38.0	441.0	286.0	96.0	67.0	103.0	792.0	117.0	70.0	45.0	46.0
5	9.0	38.0	795.0	213.0	85.0	65.0	118.0	205.0	122.0	66.0	45.0	46.0
6	9.0	35.0	708.0	178.0	79.0	73.0	77.0	160.0	142.0	71.0	41.0	45.0
7	9.0	34.0	453.0	187.0	70.0	71.0	77.0	153.0	130.0	66.0	40.0	44.0
8	9.0	33.0	413.0	199.0	71.0	106.0	67.0	345.0	191.0	65.0	52.0	42.0
9	9.0	34.0	314.0	191.0	98.0	126.0	111.0	311.0	81.0	64.0	94.0	42.0
10	9.0	35.0	283.0	179.0	132.0	106.0	108.0	323.0	79.0	63.0	63.0	42.0
11	9.0	34.0	214.0	174.0	104.0	101.0	76.0	314.0	212.0	63.0	53.0	42.0
12	10.0	31.0	190.0	173.0	69.0	98.0	158.0	294.0	170.0	63.0	46.0	42.0
13	12.0	29.0	191.0	165.0	78.0	365.0	661.0	272.0	82.0	79.0	43.0	42.0
14	32.0	28.0	178.0	144.0	78.0	151.0	226.0	232.0	154.0	83.0	41.0	41.0
15	61.0	25.0	165.0	141.0	89.0	85.0	91.0	283.0	126.0	75.0	42.0	41.0
16	38.0	24.0	152.0	123.0	105.0	60.0	89.0	250.0	119.0	63.0	46.0	43.0
17	26.0	28.0	877.0	124.0	77.0	60.0	78.0	143.0	92.0	60.0	51.0	41.0
18	22.0	23.0	240.0	118.0	60.0	58.0	61.0	117.0	191.0	57.0	47.0	41.0
19	23.0	269.0	198.0	110.0	58.0	87.0	56.0	172.0	238.0	53.0	47.0	41.0
20	24.0	464.0	194.0	123.0	63.0	91.0	170.0	154.0	189.0	52.0	45.0	41.0
21	29.0	96.0	205.0	101.0	90.0	105.0	114.0	92.0	204.0	53.0	43.0	40.0
22	29.0	66.0	209.0	93.0	110.0	127.0	289.0	85.0	120.0	56.0	41.0	39.0
23	27.0	57.0	207.0	88.0	90.0	124.0	97.0	193.0	125.0	55.0	41.0	39.0
24	26.0	57.0	203.0	95.0	77.0	127.0	175.0	264.0	116.0	50.0	49.0	35.0
25	26.0	80.0	205.0	98.0	106.0	127.0	72.0	186.0	222.0	49.0	134.0	32.0
26	27.0	80.0	191.0	97.0	192.0	112.0	49.0	132.0	160.0	48.0	70.0	65.0
27	26.0	79.0	198.0	98.0	157.0	106.0	46.0	106.0	127.0	48.0	58.0	63.0
28	25.0	71.0	211.0	106.0	98.0	100.0	70.0	96.0	116.0	48.0	53.0	42.0
29	28.0		189.0	103.0	74.0	94.0	49.0	122.0	93.0	48.0	48.0	39.0
30	107.0		226.0	101.0	58.0	94.0	46.0	107.0	99.0	46.0	49.0	46.0
31	36.0		241.0		49.0		94.0	98.0		47.0		64.0
Average	23.6	67.8	280.3	144.1	90.9	106.9	120.1	218.9	137.3	61.9	52.5	43.9
Maximum	107.0	464.0	877.0	286.0	192.0	365.0	661.0	792.0	238.0	94.0	134.0	65.0
Minimum	9.0	23.0	64.0	88.0	49.0	58.0	46.0	61.0	79.0	46.0	40.0	32.0

Average annual discharge = 113 (m^3/sec)

Annual inflow volume = 3,555 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1980

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	110.0	49.0	97.0	121.0	109.0	122.0	68.0	143.0	221.0	40.0	45.0	44.0
2	103.0	47.0	86.0	125.0	109.0	119.0	76.0	194.0	47.0	40.0	44.0	42.0
3	65.0	155.0	75.0	138.0	108.0	114.0	98.0	968.0	27.0	40.0	42.0	40.0
4	54.0	113.0	67.0	101.0	106.0	97.0	196.0	365.0	31.0	37.0	40.0	38.0
5	53.0	94.0	560.0	108.0	102.0	86.0	182.0	282.0	57.0	35.0	38.0	37.0
6	56.0	79.0	637.0	119.0	105.0	79.0	143.0	162.0	80.0	37.0	38.0	34.0
7	57.0	73.0	211.0	123.0	111.0	74.0	82.0	178.0	81.0	35.0	36.0	33.0
8	55.0	67.0	203.0	108.0	111.0	74.0	65.0	150.0	74.0	147.0	35.0	33.0
9	53.0	62.0	147.0	114.0	110.0	84.0	82.0	529.0	85.0	84.0	34.0	33.0
10	52.0	57.0	113.0	121.0	104.0	86.0	59.0	65.0	259.0	47.0	34.0	32.0
11	51.0	54.0	103.0	116.0	91.0	102.0	359.0	35.0	89.0	55.0	33.0	31.0
12	50.0	50.0	128.0	95.0	91.0	108.0	131.0	40.0	111.0	44.0	33.0	32.0
13	49.0	54.0	94.0	85.0	89.0	222.0	105.0	58.0	184.0	39.0	32.0	32.0
14	48.0	62.0	82.0	91.0	101.0	209.0	177.0	80.0	119.0	37.0	32.0	31.0
15	46.0	199.0	169.0	85.0	107.0	126.0	185.0	92.0	84.0	35.0	31.0	31.0
16	50.0	151.0	155.0	87.0	106.0	104.0	87.0	76.0	67.0	37.0	31.0	31.0
17	50.0	104.0	122.0	109.0	96.0	91.0	94.0	155.0	58.0	35.0	30.0	29.0
18	46.0	93.0	233.0	122.0	86.0	96.0	74.0	94.0	48.0	40.0	29.0	29.0
19	50.0	84.0	145.0	121.0	90.0	98.0	84.0	72.0	49.0	48.0	29.0	29.0
20	51.0	112.0	118.0	127.0	100.0	104.0	141.0	67.0	56.0	41.0	28.0	28.0
21	52.0	99.0	114.0	128.0	85.0	173.0	110.0	59.0	49.0	40.0	28.0	28.0
22	49.0	108.0	280.0	112.0	77.0	120.0	71.0	52.0	40.0	36.0	28.0	28.0
23	48.0	122.0	168.0	96.0	71.0	108.0	97.0	47.0	37.0	33.0	27.0	29.0
24	48.0	102.0	162.0	97.0	71.0	954.0	70.0	84.0	34.0	31.0	27.0	35.0
25	48.0	85.0	154.0	108.0	76.0	238.0	73.0	83.0	67.0	31.0	26.0	32.0
26	60.0	75.0	180.0	109.0	79.0	247.0	180.0	83.0	44.0	34.0	29.0	41.0
27	79.0	146.0	124.0	104.0	88.0	118.0	270.0	84.0	38.0	33.0	294.0	52.0
28	85.0	231.0	131.0	110.0	110.0	89.0	224.0	69.0	38.0	33.0	92.0	36.0
29	78.0	118.0	126.0	109.0	113.0	70.0	218.0	65.0	35.0	34.0	56.0	31.0
30	67.0		118.0	105.0	101.0	97.0	183.0	70.0	37.0	41.0	46.0	29.0
31	61.0		117.0		114.0		126.0	145.0		53.0		28.0
Average	58.8	98.1	168.4	109.8	97.3	147.0	132.6	149.9	74.9	43.6	44.9	33.5
Maximum	110.0	231.0	637.0	138.0	114.0	954.0	359.0	968.0	259.0	147.0	294.0	52.0
Minimum	46.0	47.0	67.0	85.0	71.0	70.0	59.0	35.0	27.0	31.0	26.0	28.0

Average annual discharge = 97 (m^3/sec)

Annual inflow volume = 3,054 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1981

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.0	91.0	250.0	306.0	124.0	165.0	143.0	275.0	60.0	57.0	27.0	21.0
2	29.0	78.0	166.0	269.0	143.0	122.0	174.0	238.0	59.0	80.0	26.0	21.0
3	31.0	78.0	130.0	354.0	172.0	92.0	85.0	218.0	67.0	55.0	27.0	22.0
4	67.0	117.0	120.0	317.0	152.0	80.0	101.0	228.0	64.0	48.0	27.0	22.0
5	119.0	410.0	119.0	234.0	238.0	70.0	213.0	470.0	62.0	45.0	27.0	22.0
6	82.0	215.0	572.0	187.0	168.0	71.0	163.0	408.0	56.0	40.0	27.0	21.0
7	52.0	160.0	504.0	192.0	126.0	85.0	77.0	464.0	50.0	39.0	27.0	21.0
8	35.0	141.0	291.0	162.0	117.0	113.0	117.0	362.0	49.0	38.0	27.0	21.0
9	38.0	134.0	230.0	180.0	122.0	131.0	388.0	518.0	49.0	37.0	27.0	20.0
10	37.0	130.0	325.0	183.0	102.0	104.0	209.0	303.0	47.0	36.0	26.0	20.0
11	35.0	122.0	249.0	178.0	92.0	89.0	148.0	265.0	46.0	35.0	26.0	20.0
12	34.0	136.0	192.0	204.0	108.0	68.0	131.0	204.0	47.0	34.0	29.0	19.0
13	33.0	165.0	186.0	214.0	114.0	56.0	362.0	223.0	47.0	33.0	31.0	18.0
14	33.0	679.0	267.0	205.0	135.0	53.0	900.0	182.0	49.0	32.0	29.0	19.0
15	33.0	317.0	254.0	228.0	129.0	53.0	143.0	263.0	45.0	31.0	28.0	19.0
16	33.0	223.0	213.0	436.0	107.0	56.0	235.0	188.0	42.0	35.0	27.0	20.0
17	33.0	180.0	195.0	261.0	110.0	49.0	82.0	135.0	43.0	37.0	27.0	21.0
18	32.0	164.0	204.0	194.0	127.0	57.0	391.0	123.0	59.0	35.0	27.0	21.0
19	32.0	179.0	208.0	169.0	140.0	67.0	218.0	109.0	59.0	34.0	27.0	20.0
20	31.0	152.0	478.0	190.0	127.0	62.0	108.0	104.0	50.0	32.0	25.0	20.0
21	31.0	145.0	722.0	362.0	123.0	69.0	71.0	95.0	48.0	31.0	25.0	20.0
22	31.0	138.0	405.0	239.0	92.0	60.0	170.0	114.0	46.0	30.0	24.0	20.0
23	63.0	119.0	300.0	156.0	85.0	58.0	205.0	101.0	46.0	29.0	24.0	20.0
24	265.0	140.0	264.0	158.0	125.0	57.0	931.0	79.0	44.0	29.0	23.0	20.0
25	268.0	222.0	257.0	174.0	138.0	78.0	787.0	68.0	44.0	29.0	22.0	20.0
26	124.0	134.0	223.0	189.0	126.0	55.0	334.0	67.0	43.0	28.0	22.0	19.0
27	85.0	114.0	208.0	158.0	101.0	70.0	245.0	118.0	51.0	27.0	22.0	19.0
28	150.0	178.0	216.0	140.0	101.0	70.0	606.0	71.0	44.0	25.0	21.0	20.0
29	127.0		280.0	124.0	94.0	81.0	453.0	139.0	57.0	29.0	21.0	20.0
30	170.0		1,242.0	132.0	92.0	161.0	524.0	71.0	85.0	30.0	21.0	20.0
31	128.0		481.0		306.0		382.0	62.0		28.0		20.0
Average	73.9	180.8	314.5	216.5	130.2	80.1	293.4	202.1	51.9	36.4	25.6	20.2
Maximum	268.0	679.0	1,242.0	436.0	306.0	165.0	931.0	518.0	85.0	80.0	31.0	22.0
Minimum	29.0	78.0	119.0	124.0	85.0	49.0	71.0	62.0	42.0	25.0	21.0	18.0

Average annual discharge = 136 (m^3/sec)

Annual inflow volume = 4,275 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1982

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.0	31.0	235.0	283.0	271.0	150.0	365.0	968.0	67.0	37.0	36.0	32.0
2	19.0	29.0	215.0	266.0	323.0	106.0	151.0	439.0	66.0	35.0	35.0	38.0
3	19.0	28.0	123.0	254.0	256.0	91.0	123.0	243.0	62.0	31.0	34.0	42.0
4	21.0	47.0	97.0	251.0	220.0	96.0	90.0	191.0	61.0	28.0	33.0	37.0
5	29.0	37.0	249.0	234.0	225.0	103.0	89.0	857.0	58.0	26.0	33.0	35.0
6	23.0	33.0	211.0	215.0	218.0	122.0	85.0	294.0	56.0	23.0	33.0	35.0
7	21.0	30.0	142.0	200.0	286.0	131.0	110.0	1,333.0	54.0	21.0	33.0	34.0
8	20.0	32.0	125.0	131.0	228.0	130.0	128.0	388.0	55.0	20.0	33.0	37.0
9	19.0	27.0	105.0	130.0	189.0	122.0	86.0	572.0	53.0	20.0	33.0	80.0
10	19.0	31.0	376.0	144.0	181.0	125.0	79.0	787.0	50.0	23.0	34.0	88.0
11	19.0	70.0	197.0	136.0	354.0	120.0	65.0	470.0	48.0	21.0	34.0	45.0
12	19.0	53.0	157.0	130.0	252.0	119.0	80.0	359.0	47.0	127.0	33.0	41.0
13	19.0	29.0	127.0	131.0	180.0	136.0	137.0	419.0	50.0	55.0	32.0	47.0
14	19.0	32.0	134.0	135.0	149.0	124.0	95.0	289.0	52.0	41.0	31.0	50.0
15	19.0	30.0	138.0	136.0	154.0	211.0	79.0	297.0	48.0	31.0	86.0	43.0
16	19.0	31.0	222.0	410.0	131.0	182.0	93.0	300.0	43.0	33.0	354.0	40.0
17	19.0	36.0	230.0	795.0	124.0	153.0	102.0	189.0	41.0	31.0	76.0	37.0
18	18.0	31.0	171.0	473.0	113.0	126.0	108.0	141.0	39.0	24.0	80.0	35.0
19	18.0	38.0	157.0	308.0	128.0	104.0	232.0	176.0	42.0	31.0	70.0	35.0
20	18.0	219.0	146.0	245.0	102.0	103.0	340.0	130.0	38.0	31.0	58.0	34.0
21	17.0	129.0	146.0	204.0	97.0	124.0	258.0	114.0	68.0	30.0	60.0	33.0
22	29.0	74.0	427.0	197.0	98.0	97.0	143.0	111.0	233.0	35.0	47.0	33.0
23	48.0	60.0	518.0	183.0	278.0	91.0	444.0	108.0	94.0	38.0	40.0	35.0
24	25.0	56.0	900.0	220.0	212.0	80.0	903.0	218.0	70.0	42.0	38.0	38.0
25	22.0	49.0	855.0	201.0	136.0	63.0	166.0	125.0	54.0	34.0	36.0	34.0
26	25.0	44.0	427.0	213.0	140.0	57.0	239.0	111.0	49.0	31.0	35.0	33.0
27	27.0	43.0	331.0	340.0	169.0	125.0	110.0	90.0	44.0	35.0	35.0	32.0
28	30.0	139.0	308.0	591.0	171.0	122.0	193.0	82.0	41.0	175.0	34.0	38.0
29	27.0		283.0	484.0	147.0	88.0	186.0	79.0	41.0	67.0	34.0	63.0
30	27.0		300.0	306.0	180.0	190.0	281.0	91.0	40.0	44.0	33.0	46.0
31	33.0		303.0		171.0		538.0	79.0		38.0		41.0
Average	22.8	53.1	269.5	264.9	189.8	119.7	196.7	324.2	58.8	40.6	52.8	41.6
Maximum	48.0	219.0	900.0	795.0	354.0	211.0	903.0	1,333.0	233.0	175.0	354.0	88.0
Minimum	17.0	27.0	97.0	130.0	97.0	57.0	65.0	79.0	38.0	20.0	31.0	32.0

Average annual discharge = 137 (m^3/sec)

Annual inflow volume = 4,321 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1983

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	37.0	91.0	291.0	223.0	281.0	169.0	416.0	289.0	222.0	56.0	44.0	29.0
2	33.0	82.0	758.0	235.0	217.0	181.0	279.0	314.0	1,172.0	55.0	43.0	29.0
3	32.0	75.0	365.0	207.0	212.0	183.0	345.0	213.0	439.0	56.0	44.0	29.0
4	31.0	65.0	254.0	328.0	226.0	153.0	458.0	416.0	408.0	56.0	43.0	27.0
5	31.0	61.0	206.0	277.0	226.0	132.0	286.0	251.0	289.0	55.0	43.0	27.0
6	31.0	59.0	159.0	211.0	223.0	117.0	271.0	323.0	265.0	55.0	42.0	27.0
7	35.0	56.0	143.0	283.0	237.0	114.0	138.0	481.0	239.0	56.0	41.0	26.0
8	42.0	53.0	138.0	441.0	242.0	158.0	134.0	306.0	217.0	56.0	43.0	26.0
9	37.0	49.0	143.0	291.0	240.0	169.0	114.0	337.0	197.0	57.0	42.0	26.0
10	34.0	47.0	171.0	265.0	264.0	151.0	147.0	259.0	242.0	57.0	37.0	25.0
11	32.0	45.0	311.0	265.0	291.0	204.0	118.0	203.0	155.0	56.0	37.0	25.0
12	31.0	44.0	216.0	425.0	243.0	159.0	95.0	274.0	140.0	50.0	37.0	25.0
13	29.0	43.0	168.0	1,149.0	208.0	141.0	104.0	209.0	125.0	102.0	36.0	25.0
14	28.0	47.0	144.0	589.0	241.0	122.0	131.0	178.0	114.0	160.0	36.0	25.0
15	29.0	231.0	156.0	959.0	225.0	162.0	94.0	175.0	227.0	72.0	36.0	25.0
16	31.0	110.0	152.0	974.0	188.0	208.0	127.0	142.0	229.0	56.0	36.0	25.0
17	29.0	80.0	135.0	574.0	156.0	179.0	143.0	171.0	134.0	51.0	36.0	25.0
18	27.0	68.0	115.0	490.0	248.0	123.0	119.0	671.0	106.0	48.0	35.0	25.0
19	26.0	63.0	917.0	382.0	260.0	116.0	119.0	345.0	97.0	48.0	34.0	24.0
20	25.0	60.0	611.0	340.0	276.0	105.0	103.0	275.0	82.0	56.0	35.0	24.0
21	25.0	60.0	286.0	311.0	281.0	96.0	105.0	275.0	77.0	65.0	35.0	24.0
22	28.0	55.0	224.0	291.0	248.0	95.0	154.0	240.0	74.0	53.0	35.0	24.0
23	27.0	54.0	169.0	303.0	261.0	116.0	555.0	269.0	72.0	48.0	34.0	26.0
24	26.0	282.0	158.0	281.0	161.0	108.0	247.0	345.0	90.0	49.0	34.0	24.0
25	26.0	156.0	458.0	259.0	145.0	101.0	282.0	676.0	81.0	48.0	34.0	25.0
26	26.0	103.0	620.0	289.0	195.0	114.0	444.0	623.0	68.0	46.0	33.0	25.0
27	189.0	91.0	402.0	351.0	183.0	149.0	628.0	351.0	65.0	46.0	31.0	24.0
28	439.0	83.0	259.0	311.0	171.0	133.0	275.0	260.0	62.0	44.0	31.0	24.0
29	300.0		230.0	280.0	172.0	156.0	179.0	162.0	62.0	43.0	31.0	24.0
30	198.0		212.0	297.0	171.0	170.0	192.0	152.0	57.0	42.0	30.0	24.0
31	115.0		206.0		151.0		192.0	206.0		40.0		24.0
Average	65.5	82.6	283.1	396.0	220.7	142.8	225.6	302.9	193.6	57.5	36.9	25.4
Maximum	439.0	282.0	917.0	1,149.0	291.0	208.0	628.0	676.0	1,172.0	160.0	44.0	29.0
Minimum	25.0	43.0	115.0	207.0	145.0	95.0	94.0	142.0	57.0	40.0	30.0	24.0

Average annual discharge = 170 (m^3/sec)

Annual inflow volume = 5,356 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1984

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.0	20.0	42.0	300.0	48.0	67.0	97.0	197.0	563.2	89.0	41.0	35.0
2	24.0	19.0	42.0	325.0	59.0	69.0	98.0	117.0	532.0	87.0	39.0	35.0
3	23.0	20.0	43.0	269.0	68.0	61.0	76.0	92.0	608.5	83.0	37.0	34.0
4	23.0	20.0	43.0	156.0	71.0	78.0	92.0	81.0	441.5	81.0	36.0	33.0
5	22.0	20.0	39.0	151.0	68.0	57.0	95.0	526.4	334.0	78.0	35.0	32.0
6	22.0	20.0	36.0	95.0	75.0	78.0	113.0	182.0	334.0	75.0	34.0	31.0
7	23.0	20.0	36.0	96.0	79.0	68.0	95.0	153.0	396.2	74.0	33.0	31.0
8	23.0	21.0	35.0	79.0	79.0	55.0	172.0	696.2	317.0	72.0	33.0	30.0
9	23.0	20.0	35.0	79.0	83.0	40.0	147.0	427.0	265.0	69.0	35.0	30.0
10	23.0	20.0	35.0	75.0	75.0	59.0	101.0	245.0	239.0	69.0	39.0	29.0
11	23.0	19.0	36.0	68.0	80.0	109.0	115.0	518.0	216.0	67.0	35.0	29.0
12	23.0	19.0	34.0	71.0	83.0	78.0	101.0	348.0	201.0	66.0	34.0	28.0
13	21.0	19.0	37.0	74.0	89.0	63.0	83.0	461.3	164.0	65.0	34.0	61.0
14	21.0	18.0	35.0	89.0	72.0	55.0	65.0	616.9	234.0	63.0	34.0	53.0
15	20.0	18.0	35.0	104.0	74.0	57.0	137.0	348.1	186.0	58.0	34.0	42.0
16	20.0	18.0	39.0	89.0	60.0	52.0	114.0	730.1	149.0	60.0	34.0	38.0
17	20.0	18.0	29.0	88.0	54.0	57.0	123.0	328.0	144.0	59.0	34.0	36.0
18	20.0	42.0	154.0	73.0	57.0	382.1	147.0	254.0	157.0	59.0	34.0	36.0
19	19.0	62.0	107.0	77.0	65.0	219.0	164.0	657.0	144.0	57.0	35.0	34.0
20	19.0	112.0	58.0	76.0	57.0	132.0	190.0	385.0	123.0	57.0	35.0	34.0
21	19.0	53.0	53.0	73.0	49.0	107.0	123.0	348.0	134.0	56.0	35.0	33.0
22	18.0	40.0	53.0	63.0	56.0	87.0	186.0	628.0	153.0	54.0	58.0	33.0
23	18.0	35.0	57.0	57.0	63.0	82.0	117.0	342.0	115.0	53.0	97.0	32.0
24	18.0	34.0	62.0	59.0	60.0	87.0	100.0	524.0	162.0	51.0	59.0	32.0
25	18.0	36.0	125.0	69.0	68.0	134.0	97.0	461.0	117.0	53.0	49.0	31.0
26	18.0	35.0	93.0	70.0	76.0	150.0	80.0	317.0	105.0	53.0	40.0	31.0
27	18.0	34.0	70.0	75.0	61.0	136.0	109.0	422.0	103.0	50.0	39.0	31.0
28	17.0	33.0	70.0	81.0	80.0	134.0	319.8	328.0	101.0	48.0	37.0	31.0
29	18.0	34.0	75.0	77.0	85.0	112.0	199.0	300.0	102.0	47.0	36.0	31.0
30	18.0		75.0	58.0	64.0	111.0	216.0	254.0	93.0	46.0	36.0	32.0
31	18.0		98.0		62.0		154.0	345.3		42.0		53.0
Average	20.5	30.3	57.5	103.9	68.4	99.2	129.9	375.2	231.1	62.6	39.7	34.9
Maximum	24.0	112.0	154.0	325.0	89.0	382.1	319.8	730.1	608.5	89.0	97.0	61.0
Minimum	17.0	18.0	29.0	57.0	48.0	40.0	65.0	81.0	93.0	42.0	33.0	28.0

Average annual discharge = 105 (m^3/sec)

Annual inflow volume = 3,310 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1985

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	69.0	49.0	63.0	58.0	72.0	58.0	69.0	203.0	63.0	51.0	46.0	45.0
2	48.0	47.0	61.0	56.0	192.0	60.0	54.0	203.0	61.0	51.0	46.0	45.0
3	40.0	47.0	64.0	56.0	79.0	65.0	43.0	277.1	59.0	52.0	46.0	45.0
4	39.0	48.0	60.0	70.0	64.0	61.0	40.0	452.8	57.0	51.0	46.0	44.0
5	54.0	91.0	58.0	59.0	58.0	65.0	41.0	413.0	73.0	81.0	46.0	44.0
6	52.0	62.0	63.0	69.0	57.0	66.0	48.0	323.0	61.0	74.0	45.0	44.0
7	44.0	57.0	65.0	115.0	62.0	65.0	165.0	1,503.0	57.0	71.0	44.0	44.0
8	42.0	56.0	53.0	163.0	71.0	100.0	228.0	408.0	61.0	62.0	44.0	73.0
9	40.0	54.0	52.0	189.0	95.0	63.0	85.0	272.0	59.0	158.0	44.0	69.0
10	38.0	52.0	48.0	154.0	154.0	82.0	111.0	245.0	58.0	132.0	45.0	49.0
11	37.0	52.0	48.0	115.0	92.0	142.0	74.0	219.0	59.0	80.0	46.0	46.0
12	37.0	51.0	47.0	94.0	87.0	55.0	136.0	218.0	63.0	70.0	46.0	44.0
13	37.0	52.0	46.0	81.0	77.0	59.0	241.0	162.0	63.0	65.0	46.0	45.0
14	37.0	52.0	44.0	79.0	74.0	61.0	177.0	143.0	65.0	62.0	45.0	44.0
15	37.0	52.0	43.0	71.0	61.0	68.0	176.0	135.0	67.0	63.0	45.0	47.0
16	37.0	52.0	43.0	68.0	57.0	62.0	399.0	121.0	58.0	66.0	45.0	93.0
17	37.0	52.0	41.0	69.0	53.0	59.0	323.0	112.0	67.0	60.0	45.0	93.0
18	36.0	52.0	47.0	77.0	52.0	56.0	194.0	105.0	104.0	59.0	44.0	63.0
19	44.0	52.0	44.0	73.0	50.0	58.0	188.0	96.0	68.0	56.0	44.0	54.0
20	44.0	52.0	41.0	70.0	69.0	59.0	255.0	99.0	57.0	55.0	44.0	50.0
21	67.0	53.0	43.0	74.0	82.0	61.0	138.0	93.0	56.0	53.0	44.0	46.0
22	52.0	50.0	43.0	72.0	75.0	55.0	291.0	87.0	76.0	52.0	45.0	46.0
23	46.0	50.0	47.0	67.0	73.0	62.0	118.0	273.0	72.0	51.0	45.0	45.0
24	44.0	53.0	55.0	60.0	83.0	59.0	185.0	89.0	81.0	51.0	46.0	45.0
25	43.0	57.0	50.0	55.0	118.0	53.0	1,078.0	95.0	62.0	51.0	46.0	320.0
26	90.0	55.0	55.0	50.0	83.0	56.0	558.0	80.0	56.0	50.0	46.0	886.0
27	94.0	55.0	92.0	52.0	65.0	98.0	337.0	76.0	54.0	49.0	46.0	218.0
28	67.0	57.0	97.0	56.0	65.0	104.0	264.0	68.0	53.0	48.0	46.0	106.0
29	61.0		87.0	55.0	65.0	80.0	281.0	65.0	53.0	47.0	46.0	89.0
30	55.0		69.0	61.0	64.0	71.0	461.0	73.0	53.0	46.0	46.0	81.0
31	52.0		61.0		61.0		408.0	69.0		46.0		72.0
Average	49.0	54.0	55.8	79.6	77.7	68.8	231.2	218.6	63.2	63.3	45.3	97.9
Maximum	94.0	91.0	97.0	189.0	192.0	142.0	1,078.0	1,503.0	104.0	158.0	46.0	886.0
Minimum	36.0	47.0	41.0	50.0	50.0	53.0	40.0	65.0	53.0	46.0	44.0	44.0

Average annual discharge = 93 (m^3/sec)

Annual inflow volume = 2,922 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1986

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	65.0	38.0	99.0	226.0	184.0	151.0	165.0	824.0	104.0	68.0	55.0	106.0
2	61.0	38.0	98.0	190.0	168.0	122.0	102.0	388.0	99.0	64.0	55.0	106.0
3	57.0	38.0	98.0	184.0	164.0	127.0	96.0	376.4	98.0	61.0	54.0	107.0
4	55.0	38.0	97.0	175.0	151.0	127.0	114.0	1,732.0	95.0	61.0	55.0	110.0
5	53.0	37.0	98.0	188.0	151.0	125.0	117.0	801.0	91.0	65.0	54.0	110.0
6	52.0	37.0	99.0	210.0	161.0	117.0	109.0	475.4	89.0	58.0	54.0	104.0
7	52.0	37.0	100.0	225.0	171.0	113.0	371.0	489.6	84.0	54.0	54.0	101.0
8	52.0	36.0	98.0	231.0	178.0	118.0	160.0	354.0	82.0	55.0	55.0	97.0
9	50.0	37.0	97.0	226.0	306.0	128.0	160.0	354.0	88.0	91.0	55.0	93.0
10	50.0	40.0	99.0	234.0	262.9	137.0	140.0	306.0	111.0	53.0	55.0	89.0
11	49.0	48.0	174.0	248.0	167.0	147.0	139.0	258.0	96.0	76.0	55.0	239.0
12	48.0	52.0	574.0	256.0	184.0	130.0	158.0	226.0	83.0	74.0	56.0	1,112.0
13	46.0	285.8	758.0	235.0	192.0	158.0	101.0	235.0	97.0	63.0	56.0	529.0
14	43.0	141.5	1,503.0	250.0	192.0	154.0	98.0	195.0	85.0	62.0	56.0	252.0
15	40.0	129.6	608.0	222.0	182.0	134.0	109.0	317.0	76.0	90.0	614.0	183.0
16	38.0	115.0	436.0	196.0	176.0	131.0	228.0	209.0	73.0	80.0	311.0	171.0
17	38.0	113.0	396.0	172.0	161.0	118.0	213.0	168.0	70.0	219.0	125.0	158.0
18	37.0	226.0	555.0	171.0	153.0	129.0	492.0	276.0	68.0	115.0	105.0	154.0
19	40.0	128.0	413.0	174.0	164.0	134.0	331.0	199.0	68.0	87.0	93.0	140.0
20	40.0	112.0	328.0	180.0	181.0	122.0	179.0	154.0	67.0	76.0	87.0	130.0
21	39.0	167.0	314.0	181.0	196.0	136.0	151.0	137.0	66.0	71.0	85.0	126.0
22	40.0	177.0	328.0	185.0	167.0	156.0	229.0	131.0	68.0	68.0	83.0	123.0
23	59.0	134.0	260.0	161.3	134.0	169.0	199.0	126.0	66.0	65.0	82.0	119.0
24	46.0	125.0	222.0	220.5	125.0	183.0	173.0	123.0	83.0	61.0	79.0	117.0
25	44.0	118.0	196.0	472.6	124.0	283.0	167.0	164.0	62.0	59.0	78.0	115.0
26	43.0	113.0	182.0	744.3	124.0	206.0	166.0	164.0	78.0	56.0	192.0	114.0
27	42.0	108.0	224.0	739.0	119.0	198.4	713.0	228.0	70.0	54.0	323.0	109.0
28	40.0	103.0	294.0	340.0	136.0	126.0	453.0	128.0	123.0	55.0	149.0	106.0
29	39.0		244.0	244.0	171.0	156.0	220.0	114.0	126.0	55.0	125.0	102.0
30	39.0		215.0	215.0	147.0	212.0	391.0	114.0	104.0	54.0	113.0	100.0
31	38.0		202.0		162.0		489.6	112.0		55.0		93.0
Average	46.3	99.0	303.5	256.5	169.5	148.2	223.7	318.7	85.7	71.8	113.8	171.5
Maximum	65.0	285.8	1,503.0	744.3	306.0	283.0	713.0	1,732.0	126.0	219.0	614.0	1,112.0
Minimum	37.0	36.0	97.0	161.3	119.0	113.0	96.0	112.0	62.0	53.0	54.0	89.0

Average annual discharge = 168 (m^3/sec)

Annual inflow volume = 5,300 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1987

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	79.0	60.0	103.0	176.0	152.0	192.0	100.0	95.0	121.0	34.0	42.0	34.0
2	76.0	59.0	99.0	218.0	127.0	191.0	102.0	89.0	65.0	37.1	41.0	34.0
3	76.0	59.0	93.0	256.0	110.0	263.0	98.0	77.0	56.0	49.8	42.0	35.0
4	76.0	57.0	97.0	229.0	100.0	272.0	97.0	204.0	55.0	41.0	41.0	35.0
5	81.0	55.0	102.0	175.0	104.0	204.0	102.0	195.0	70.0	36.2	41.0	35.0
6	79.0	55.0	81.0	163.0	144.0	202.0	121.0	98.0	56.0	34.2	41.0	34.0
7	76.0	55.0	136.0	160.0	114.0	187.0	121.0	112.0	64.0	33.4	40.0	34.0
8	75.0	56.0	166.0	161.0	294.0	202.0	104.0	93.0	58.0	33.4	41.0	34.0
9	74.0	59.0	132.0	337.0	258.0	405.0	102.0	103.0	125.0	33.1	41.0	34.0
10	74.0	56.0	114.0	207.0	388.0	331.0	101.0	96.0	110.0	239.4	40.0	34.0
11	73.0	53.0	104.0	162.0	242.0	203.0	110.0	102.0	82.0	169.8	40.0	34.0
12	73.0	53.0	108.0	149.0	197.0	168.0	110.0	144.0	60.0	209.4	39.0	34.0
13	73.0	54.0	114.0	132.0	177.0	144.0	99.0	155.0	55.0	148.0	38.0	34.0
14	72.0	54.0	103.0	119.0	166.0	144.0	89.0	106.0	54.0	142.9	38.0	33.0
15	71.0	55.0	105.0	119.0	154.0	152.0	87.0	93.0	53.0	99.9	37.0	33.0
16	70.0	55.0	196.0	117.0	151.0	141.0	142.0	88.0	55.0	78.7	37.0	33.0
17	73.0	156.0	151.0	119.0	142.0	122.0	100.0	91.0	49.0	65.4	37.0	33.0
18	71.0	121.0	122.0	132.0	141.0	112.0	109.0	164.0	47.0	137.3	36.0	33.0
19	67.0	132.0	119.0	130.0	149.0	110.0	95.0	88.0	46.0	138.1	36.0	32.0
20	67.0	67.0	118.0	132.0	169.0	117.0	98.0	122.0	46.0	98.5	35.0	32.0
21	65.0	64.0	195.0	144.0	208.6	124.0	90.0	233.0	46.0	79.5	35.0	32.0
22	65.0	67.0	365.0	152.0	277.3	105.0	97.0	164.0	55.0	71.0	35.0	32.0
23	63.0	70.0	405.0	158.0	803.7	102.0	108.0	137.0	50.0	62.8	35.0	32.0
24	63.0	371.0	269.0	155.0	393.4	104.0	135.0	211.0	45.0	61.1	35.0	32.0
25	63.0	308.0	225.0	122.0	250.5	102.0	151.0	120.0	42.0	56.9	35.0	31.0
26	63.0	134.0	436.0	121.0	234.6	101.0	239.0	78.0	40.0	53.8	35.0	31.0
27	63.0	131.0	282.0	121.0	214.0	102.0	122.0	71.0	38.0	51.5	34.0	31.0
28	63.0	112.0	144.0	128.0	211.0	102.0	99.0	88.0	37.0	47.3	34.0	31.0
29	63.0		203.0	143.0	194.0	103.0	90.0	95.0	36.0	46.4	34.0	31.0
30	63.0		181.0	158.0	189.0	101.0	90.0	71.0	35.0	45.0	34.0	31.0
31	62.0		168.0		188.0		115.0	105.0		44.1		32.0
Average	70.1	93.9	168.9	159.8	214.3	163.6	110.4	119.0	58.4	80.0	37.6	32.9
Maximum	81.0	371.0	436.0	337.0	803.7	405.0	239.0	233.0	125.0	239.4	42.0	35.0
Minimum	62.0	53.0	81.0	117.0	100.0	101.0	87.0	71.0	35.0	33.1	34.0	31.0

Average annual discharge = 109 (m^3/sec)

Annual inflow volume = 3,445 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1988

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	32.0	34.2	82.6	192.4	116.0	82.1	111.5	1,327.3	103.0	83.5	45.0	42.2
2	32.0	34.0	78.4	173.8	98.8	77.5	109.8	704.7	91.1	79.0	76.4	42.2
3	31.7	33.7	84.1	142.3	80.4	54.6	194.4	585.8	93.1	75.3	44.7	41.9
4	31.7	34.0	89.4	124.5	77.0	51.2	261.8	486.8	90.3	93.4	44.7	41.9
5	31.4	34.2	100.5	111.5	75.0	48.4	180.3	410.4	84.3	79.0	44.7	41.9
6	31.4	34.2	105.8	104.1	78.4	43.6	154.2	365.1	82.6	73.0	44.7	41.6
7	31.1	34.2	199.2	111.5	73.6	43.0	97.9	328.3	82.1	71.6	44.7	41.0
8	31.1	34.0	142.3	116.6	62.0	34.8	60.8	517.9	95.4	69.6	45.0	40.5
9	30.8	43.6	101.3	124.0	57.7	34.8	48.1	583.0	116.9	68.8	44.7	39.9
10	30.6	37.4	87.4	120.0	68.8	38.5	52.6	328.3	90.3	69.6	45.0	39.3
11	30.6	35.7	1,095.2	114.3	75.8	38.5	113.2	353.8	85.2	69.1	44.7	39.3
12	31.1	35.7	1,044.3	127.9	79.5	37.9	70.2	268.3	82.1	67.1	44.7	39.1
13	31.4	34.0	311.3	131.9	77.5	38.2	724.5	413.2	80.7	65.7	44.7	38.8
14	32.3	33.7	200.9	139.5	80.4	38.8	699.0	274.2	78.7	64.8	44.4	37.9
15	31.1	34.0	164.1	140.1	67.6	43.0	1,613.1	515.1	115.5	64.0	44.1	37.4
16	30.8	32.8	228.1	138.7	68.5	45.8	3,424.3	283.0	139.0	62.8	43.9	36.8
17	30.3	32.5	215.4	124.5	69.1	46.1	922.6	297.2	95.4	62.8	43.9	36.5
18	30.0	31.7	216.2	138.1	62.3	67.1	557.5	300.0	79.2	61.7	43.9	37.4
19	29.4	31.7	177.2	164.1	56.3	53.2	551.9	277.6	73.6	60.3	43.6	39.3
20	29.1	32.3	166.4	168.4	57.7	57.7	1,222.6	239.1	73.3	58.9	43.3	44.7
21	30.3	69.1	159.3	120.0	62.3	61.4	670.7	251.0	70.8	93.1	43.3	44.1
22	50.4	57.2	162.7	112.1	65.1	77.8	1,021.6	224.7	79.2	55.5	43.6	114.9
23	39.6	44.7	169.2	109.8	62.5	71.9	775.4	210.6	68.2	54.1	43.3	210.6
24	34.2	37.1	173.8	98.8	60.8	69.6	713.2	196.4	230.4	52.9	43.3	87.4
25	33.4	41.6	169.8	94.0	60.8	67.4	469.8	302.8	469.8	51.8	43.3	66.2
26	32.8	40.8	410.4	101.3	62.8	73.3	373.6	183.4	183.9	50.9	43.3	58.9
27	32.5	47.0	243.7	103.6	69.1	128.5	441.5	186.8	126.8	49.5	43.3	49.2
28	33.1	302.8	203.5	112.6	67.1	94.5	498.1	156.2	105.0	48.7	43.3	41.0
29	36.5	117.2	212.0	123.4	68.5	489.6	1,632.9	137.0	97.1	47.5	43.3	36.5
30	34.8		227.2	114.3	67.6	148.3	551.9	127.3	94.2	46.7	43.0	34.2
31	35.1		224.7		66.2		1,313.1	116.0		45.6		34.2
Average	32.7	49.8	233.8	126.6	70.8	75.2	633.3	353.3	111.9	64.4	45.1	50.9
Maximum	50.4	302.8	1,095.2	192.4	116.0	489.6	3,424.3	1,327.3	469.8	93.4	76.4	210.6
Minimum	29.1	31.7	78.4	94.0	56.3	34.8	48.1	116.0	68.2	45.6	43.0	34.2

Average annual discharge = 155 (m^3/sec)

Annual inflow volume = 4,909 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1989

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	33.2	45.0	61.0	591.8	88.2	95.9	114.7	648.4	105.0	53.9	40.2	36.8
2	38.5	40.3	61.2	300.0	129.5	98.6	137.1	477.0	105.8	52.2	39.7	35.3
3	41.8	40.7	59.9	230.2	192.8	104.7	89.1	304.8	100.2	50.7	39.2	34.0
4	37.6	42.6	57.2	194.5	170.9	105.5	82.2	213.2	89.1	50.2	45.3	33.1
5	47.2	48.6	59.9	167.7	119.7	160.1	114.7	249.4	86.5	50.4	107.2	32.2
6	398.9	54.1	61.1	149.1	102.1	114.5	115.8	194.6	88.6	49.8	59.7	31.3
7	154.9	47.3	61.8	147.7	92.6	98.2	87.5	157.1	84.1	49.3	46.7	30.5
8	113.8	44.5	67.1	145.8	93.6	85.6	70.1	147.8	76.6	47.3	43.6	29.6
9	100.6	43.9	73.2	268.9	92.8	90.4	82.2	221.1	74.3	45.5	42.1	30.2
10	86.2	43.4	84.8	279.2	101.5	85.6	58.6	125.1	73.7	43.8	41.6	30.9
11	78.1	42.9	75.2	175.5	104.1	98.9	82.2	139.6	72.7	42.1	41.2	34.8
12	73.9	42.8	75.4	154.2	105.8	94.5	50.8	162.3	93.5	112.1	41.0	35.2
13	70.6	43.4	74.5	140.7	111.3	99.6	127.5	161.9	78.6	173.6	40.2	33.8
14	68.7	43.3	78.8	138.9	117.6	99.1	159.9	137.5	85.7	77.6	39.4	33.5
15	67.3	43.5	101.7	136.1	119.5	85.8	340.3	121.8	77.6	54.6	39.1	33.5
16	65.9	44.5	80.8	125.9	116.9	92.8	172.7	131.9	79.9	49.2	39.1	33.9
17	64.0	47.8	79.8	132.4	117.3	87.0	99.8	128.7	75.4	47.3	39.0	34.3
18	64.0	53.8	117.0	130.0	117.8	79.1	90.2	139.3	74.5	47.0	39.3	34.6
19	62.3	49.6	137.4	126.8	117.0	77.4	90.2	160.6	86.8	46.7	39.8	35.7
20	61.0	46.9	156.5	122.8	119.0	70.8	102.2	353.1	99.1	45.8	39.5	43.9
21	60.0	44.7	125.2	121.6	121.5	69.2	68.3	185.1	95.1	45.2	38.9	67.7
22	59.0	43.1	471.7	110.9	118.8	67.2	52.9	143.5	108.9	44.6	38.5	52.0
23	58.2	40.9	461.0	111.4	105.0	64.0	80.9	170.5	126.2	44.0	38.3	76.0
24	57.4	38.9	243.6	115.3	98.7	67.6	186.6	134.8	111.9	43.6	48.7	73.3
25	55.3	44.9	208.2	162.1	87.3	68.7	158.7	156.6	77.2	43.2	58.8	59.7
26	54.8	47.6	186.6	150.4	78.2	80.7	116.0	117.2	62.4	42.7	46.2	55.4
27	54.6	52.4	225.4	119.6	85.3	87.9	100.9	246.0	59.1	41.9	39.9	51.0
28	54.5	59.9	224.8	102.6	95.4	94.0	97.5	224.8	55.8	41.3	39.1	49.8
29	52.8		207.0	106.4	105.4	86.8	1,460.9	145.7	56.3	41.0	38.6	50.0
30	51.2		181.8	103.3	98.1	114.4	1,743.3	123.6	55.7	40.8	38.0	50.7
31	50.0		253.7		84.6		2,074.4	111.0		40.5		50.9
Average	75.4	45.8	142.4	168.7	109.9	90.8	271.2	197.9	83.9	53.5	44.3	42.4
Maximum	398.9	59.9	471.7	591.8	192.8	160.1	2,074.4	648.4	126.2	173.6	107.2	76.0
Minimum	33.2	38.9	57.2	102.6	78.2	64.0	50.8	111.0	55.7	40.5	38.0	29.6

Average annual discharge = 111 (m^3/sec)

Annual inflow volume = 3,506 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1990

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	50.4	55.0	143.0	210.4	123.6	108.4	191.2	99.6	164.6	71.0	37.9	23.5
2	49.8	48.3	115.7	198.5	126.5	100.7	114.0	765.8	142.3	59.8	39.5	24.5
3	49.8	42.4	99.8	189.0	125.9	101.5	141.8	141.7	134.0	57.2	37.4	25.2
4	50.6	39.2	91.2	186.1	124.4	100.5	471.3	276.7	172.7	54.3	35.8	25.2
5	51.7	37.5	84.2	190.7	137.9	92.9	160.3	308.3	250.5	50.6	34.5	25.2
6	52.1	39.4	80.8	256.6	120.2	83.9	187.7	274.9	186.3	48.5	33.2	25.2
7	55.8	80.0	75.8	443.3	126.1	76.0	341.6	244.2	146.2	47.5	31.8	25.1
8	53.7	299.3	74.9	313.3	133.3	77.3	144.1	435.0	159.0	46.0	30.6	25.0
9	51.8	222.3	77.2	213.3	142.7	82.6	350.7	1,109.0	98.5	45.3	29.6	24.9
10	50.6	122.5	113.1	180.8	151.3	73.9	180.5	530.1	101.2	44.3	28.6	25.0
11	49.4	92.3	310.5	158.4	136.3	73.6	115.9	351.3	92.1	43.0	27.7	24.9
12	48.6	79.1	140.8	145.4	154.5	110.4	95.1	265.3	87.1	42.2	27.4	24.9
13	47.5	174.0	106.9	154.4	146.3	130.4	92.3	311.3	120.7	48.6	26.9	24.7
14	47.5	207.9	119.2	164.1	147.4	79.6	81.6	369.7	146.4	42.8	26.7	25.3
15	46.5	112.5	128.7	142.5	168.1	86.7	105.5	234.2	107.8	41.1	26.4	54.7
16	45.0	95.8	144.4	141.7	185.9	69.5	134.3	202.1	105.8	40.0	26.1	142.0
17	45.0	84.1	453.0	172.7	157.9	69.7	151.5	185.7	87.4	50.0	25.9	115.6
18	53.7	71.6	418.1	179.7	164.9	71.2	113.2	170.5	82.2	128.7	25.7	60.3
19	48.0	64.7	424.9	166.5	172.5	80.2	122.3	156.1	183.4	54.6	25.5	43.6
20	42.9	61.1	770.8	145.7	138.2	96.0	218.7	122.2	97.7	44.9	25.3	39.6
21	43.2	59.8	1,273.0	145.0	122.6	90.3	151.0	113.0	83.1	42.7	25.0	37.4
22	46.4	54.8	1,961.0	131.5	112.7	90.8	114.8	112.3	88.2	41.9	35.3	37.4
23	45.4	51.9	752.0	135.6	119.8	101.9	81.5	140.9	82.4	41.6	28.3	36.5
24	45.3	86.3	461.2	147.9	136.6	143.8	93.5	114.5	96.3	41.8	27.0	42.8
25	42.5	154.5	384.4	157.8	147.5	362.7	78.5	102.5	85.9	41.5	26.1	42.5
26	40.4	228.9	322.8	164.8	147.5	124.4	278.5	100.0	69.2	41.0	25.0	38.6
27	134.5	212.5	287.6	160.5	150.7	104.7	265.3	96.5	67.2	40.7	24.2	40.0
28	119.7	177.8	264.4	146.5	146.1	135.1	124.9	174.5	62.1	40.3	23.5	926.1
29	64.8		266.1	137.9	146.8	102.1	77.2	371.1	73.8	40.1	23.3	2,280.0
30	55.9		303.0	130.1	136.5	154.0	108.1	306.9	70.6	39.6	22.6	529.2
31	52.0		233.7		135.4		117.7	237.5		39.3		259.8
Average	54.2	109.1	338.1	180.4	141.5	105.8	161.4	271.7	114.8	48.7	28.8	163.7
Maximum	134.5	299.3	1,961.0	443.3	185.9	362.7	471.3	1,109.0	250.5	128.7	39.5	2,280.0
Minimum	40.4	37.5	74.9	130.1	112.7	69.5	77.2	96.5	62.1	39.3	22.6	23.5

Average annual discharge = 144 (m^3/sec)

Annual inflow volume = 4,537 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1991

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	184.0	85.9	128.4	286.0	175.9	71.0	73.1	107.6	230.2	64.2	36.2	24.5
2	161.4	92.2	154.1	407.9	178.9	81.1	72.9	87.6	193.2	62.7	35.5	24.5
3	145.7	101.3	159.0	442.7	164.4	95.1	89.7	82.2	154.1	60.9	34.8	24.6
4	134.7	112.9	738.0	302.3	147.4	90.6	82.1	106.5	144.7	60.1	34.2	24.6
5	124.9	115.1	403.2	281.4	144.2	93.6	77.1	159.5	208.9	58.6	33.7	24.4
6	120.4	126.3	271.6	287.8	144.3	99.4	146.7	94.5	187.8	57.5	33.1	24.3
7	115.7	133.8	236.6	268.7	157.5	97.2	100.7	86.5	96.0	56.6	33.2	24.3
8	112.8	126.8	317.2	478.9	149.9	98.7	94.3	109.5	84.2	55.0	33.1	24.2
9	107.6	137.0	287.8	864.5	126.4	102.1	103.5	91.9	76.4	53.3	33.1	24.1
10	102.0	390.0	210.9	537.6	118.8	131.2	121.6	110.3	74.0	52.3	33.0	24.1
11	95.6	657.0	196.6	335.9	91.0	147.0	179.6	96.0	121.0	48.9	32.8	23.9
12	94.9	690.9	208.8	298.8	75.7	110.5	217.3	76.1	111.2	50.6	32.6	23.9
13	85.2	266.1	218.2	397.8	73.9	111.4	247.6	70.8	107.4	49.9	32.0	23.7
14	75.8	213.0	205.8	1,190.9	83.9	112.1	453.2	67.6	329.2	46.1	31.3	23.5
15	69.1	244.1	198.5	659.9	93.1	153.3	265.9	65.5	436.1	46.4	30.6	23.5
16	63.8	162.5	198.0	360.1	103.7	150.4	168.7	62.0	459.4	47.7	29.8	23.3
17	59.8	143.1	195.9	293.8	106.6	146.8	118.4	96.5	395.9	47.8	29.1	23.2
18	56.4	131.1	261.5	252.2	111.5	163.3	127.5	92.6	194.8	47.7	28.3	23.1
19	53.6	123.6	377.0	230.9	116.5	211.1	145.5	89.9	156.2	47.7	27.8	23.5
20	51.3	118.3	230.1	212.7	140.9	153.3	260.6	100.4	136.0	47.7	26.5	23.9
21	48.8	112.4	227.5	202.1	186.8	139.7	416.2	97.7	112.3	47.6	26.1	36.7
22	47.7	110.7	255.5	189.8	166.3	107.8	278.6	82.6	124.4	45.2	25.7	106.4
23	44.8	111.6	338.1	207.8	134.0	120.8	184.5	178.6	103.4	47.0	25.3	45.7
24	42.1	121.7	245.3	176.5	122.7	100.8	127.0	102.3	79.8	46.5	25.1	40.5
25	39.8	244.7	206.2	172.4	126.9	99.3	220.1	97.2	74.7	44.4	25.0	38.2
26	57.6	198.8	205.8	170.2	109.6	92.1	112.2	95.7	130.0	40.9	24.9	38.3
27	121.5	173.6	217.7	167.6	83.7	85.8	102.1	100.0	90.1	39.6	24.7	38.8
28	123.6	170.4	232.6	151.8	81.5	83.4	92.2	276.2	77.6	39.0	24.6	41.1
29	125.8		250.7	164.5	77.0	79.4	110.6	399.7	72.6	38.1	24.6	41.0
30	82.9		268.6	164.2	70.2	73.2	152.1	301.9	66.5	37.5	24.5	36.8
31	82.1		278.6		63.5		115.4	266.6		36.8		30.8
Average	91.3	193.4	255.6	338.6	120.2	113.4	163.1	124.3	160.9	49.2	29.7	31.4
Maximum	184.0	690.9	738.0	1,190.9	186.8	211.1	453.2	399.7	459.4	64.2	36.2	106.4
Minimum	39.8	85.9	128.4	151.8	63.5	71.0	72.9	62.0	66.5	36.8	24.5	23.1

Average annual discharge = 139 (m^3/sec)

Annual inflow volume = 4,370 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1992

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	35.0	220.1	107.0	277.9	253.8	138.6	151.8	146.1	357.8	254.8	192.6	139.9
2	27.4	149.2	87.1	267.3	241.9	152.6	147.1	196.0	505.9	250.5	188.5	140.4
3	26.5	127.7	80.5	262.2	355.4	182.9	158.3	924.0	451.3	244.8	184.5	140.4
4	25.5	112.5	69.2	257.9	290.6	157.7	159.0	314.0	318.7	235.6	180.5	140.1
5	24.8	101.4	62.2	271.7	243.7	145.1	137.1	329.0	305.9	226.8	176.5	139.4
6	25.6	134.8	59.2	422.5	215.1	159.5	129.8	399.2	357.2	228.0	173.6	139.3
7	32.4	234.7	45.6	833.9	215.2	154.2	131.9	218.4	348.5	229.5	169.3	139.5
8	43.6	136.8	55.1	294.3	224.0	154.9	147.7	232.2	303.8	220.8	165.7	139.8
9	33.9	122.8	56.5	281.8	222.4	146.6	150.0	536.1	5,350.5	216.1	163.0	139.7
10	31.2	113.0	56.0	735.2	210.4	146.0	147.4	317.1	6,551.0	212.0	160.3	140.0
11	45.2	106.5	58.3	268.8	210.2	182.3	201.9	247.6	1,360.7	211.9	157.1	140.4
12	42.3	102.3	63.4	253.3	219.8	168.6	158.0	227.6	868.1	207.8	153.7	145.3
13	36.8	498.1	128.3	253.1	239.2	161.4	145.7	208.2	753.6	206.0	151.1	150.5
14	33.6	239.9	130.9	245.0	242.3	146.6	188.2	261.5	702.8	205.7	149.0	146.2
15	30.8	177.4	84.3	243.1	241.5	153.7	162.6	271.6	659.6	205.3	146.9	144.7
16	34.3	154.1	73.6	242.8	237.0	149.4	154.0	842.6	553.6	204.7	144.8	143.7
17	26.4	141.4	70.5	241.2	233.7	151.5	191.6	812.2	569.2	202.5	142.8	143.7
18	25.2	134.9	81.6	305.5	203.6	137.0	225.7	468.0	481.6	201.3	140.5	144.1
19	25.4	127.1	91.8	231.2	179.7	140.2	181.4	414.5	447.9	398.5	172.4	144.6
20	25.1	115.5	102.4	250.1	166.5	145.2	215.0	369.5	419.2	245.3	298.0	145.1
21	25.0	103.1	116.5	673.8	165.8	164.5	209.6	376.4	398.8	214.6	181.7	145.5
22	24.8	93.8	169.7	399.9	157.9	134.7	213.1	391.5	377.4	207.2	150.5	146.0
23	27.0	88.8	1,164.7	259.8	176.4	128.8	158.5	279.5	359.2	203.0	146.6	145.8
24	31.0	82.8	640.3	260.7	187.0	135.6	273.5	274.4	341.5	199.7	145.7	145.1
25	41.6	77.4	912.3	268.8	189.4	122.7	352.3	328.5	322.4	197.8	142.5	144.6
26	55.8	75.5	1,503.6	268.5	240.5	120.5	265.6	326.0	307.7	197.1	141.9	144.1
27	156.6	75.7	972.7	267.5	260.4	127.9	150.7	264.5	295.7	196.8	142.4	143.7
28	256.3	76.3	441.9	271.6	205.9	136.7	150.0	254.0	283.6	196.2	142.2	143.2
29	573.9	131.1	506.3	346.8	173.4	174.9	240.9	243.2	270.4	195.8	140.7	142.7
30	1,320.8		321.5	299.9	163.7	141.2	200.4	355.1	260.4	196.0	139.7	142.0
31	349.7		285.3		150.4		176.2	468.9		196.5		182.9
Average	112.7	139.8	277.4	325.2	216.7	148.7	183.1	364.4	829.5	219.6	162.8	144.3
Maximum	1,320.8	498.1	1,503.6	833.9	355.4	182.9	352.3	924.0	6,551.0	398.5	298.0	182.9
Minimum	24.8	75.5	45.6	231.2	150.4	120.5	129.8	146.1	260.4	195.8	139.7	139.3

Average annual discharge = 260 (m^3/sec)

Annual inflow volume = 8,217 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1993

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	244.4	81.5	114.5	155.5	200.6	200.7	195.4	195.0	241.1	46.3	30.6	27.8
2	182.6	80.5	104.3	150.5	215.8	138.4	165.4	151.6	172.9	45.5	30.1	27.8
3	183.5	78.5	102.0	144.1	197.6	189.3	121.9	237.4	210.0	44.6	29.6	27.7
4	176.7	78.7	97.5	143.1	184.1	151.2	126.3	179.4	128.2	43.6	29.0	27.2
5	141.2	74.1	98.2	150.1	185.3	135.0	221.6	144.5	100.5	42.8	27.3	26.9
6	176.5	72.7	99.5	161.4	184.7	136.7	168.4	159.4	118.8	41.3	206.5	26.7
7	183.8	77.4	97.8	171.8	188.7	139.0	168.8	204.8	121.8	39.5	134.7	26.4
8	183.8	87.9	96.9	169.1	180.9	145.3	360.0	120.3	178.0	38.5	47.8	26.2
9	172.5	83.9	100.1	171.4	195.0	148.4	425.0	114.2	178.7	37.7	88.8	25.8
10	141.4	79.0	106.8	190.1	229.1	144.0	808.6	159.1	142.5	37.3	39.1	25.4
11	140.8	74.9	295.8	206.6	195.5	154.3	579.5	139.8	193.1	37.2	33.0	25.5
12	137.3	74.5	587.0	221.9	151.7	158.9	417.8	144.4	117.6	37.3	32.7	25.5
13	138.2	71.8	364.6	214.8	137.3	160.0	237.5	117.8	146.0	37.4	32.3	25.5
14	129.8	65.7	248.9	222.0	136.1	167.7	187.9	109.5	81.7	37.6	30.3	25.6
15	122.3	64.2	213.2	233.0	136.5	171.9	258.1	193.9	68.9	37.8	29.0	25.6
16	151.3	71.4	179.4	183.9	174.8	179.1	315.5	122.0	62.2	37.0	29.7	25.6
17	266.3	143.5	161.0	185.8	153.4	198.2	157.7	134.6	59.6	36.0	30.3	25.5
18	175.3	107.5	158.6	188.7	144.3	196.1	294.1	107.9	58.1	35.1	30.8	25.5
19	145.9	90.6	142.0	189.1	123.6	191.6	180.6	90.6	55.1	34.3	45.2	25.3
20	128.9	89.6	130.8	188.9	114.3	139.6	140.9	192.7	52.4	33.4	34.6	25.2
21	121.9	74.6	129.4	190.9	111.9	137.2	146.8	109.5	51.6	32.4	31.6	25.4
22	114.2	69.5	123.5	194.4	130.3	153.0	310.1	73.9	52.9	31.4	30.7	25.6
23	110.3	68.0	470.4	192.9	144.6	194.7	631.7	66.6	103.9	30.4	30.1	25.8
24	105.4	65.1	1,731.0	194.3	140.4	480.7	619.5	86.3	110.2	29.6	29.8	25.9
25	102.5	144.4	492.0	199.7	146.4	350.5	1,102.0	82.8	60.7	28.7	29.4	26.0
26	99.7	254.1	240.9	210.7	150.2	228.9	437.9	74.5	56.1	29.2	29.0	26.0
27	95.7	156.1	172.3	198.8	148.3	178.4	308.2	87.8	53.7	29.8	28.8	26.0
28	93.7	134.4	202.9	213.1	143.8	142.2	260.2	72.8	51.5	30.4	28.5	26.1
29	91.8		193.3	206.4	169.8	126.7	220.9	64.3	50.8	31.0	28.3	26.0
30	89.6		184.1	211.7	167.1	115.0	242.0	62.4	48.6	31.7	28.0	26.0
31	86.9		172.0		141.0		215.1	161.5		31.2		26.0
Average	143.0	93.3	245.5	188.5	162.0	178.4	323.4	127.8	104.2	36.0	42.8	26.0
Maximum	266.3	254.1	1,731.0	233.0	229.1	480.7	1,102.0	237.4	241.1	46.3	206.5	27.8
Minimum	86.9	64.2	96.9	143.1	111.9	115.0	121.9	62.4	48.6	28.7	27.3	25.2

Average annual discharge = 140 (m^3/sec)

Annual inflow volume = 4,407 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1994

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.9	33.8	64.9	118.6	133.9	113.5	521.8	320.3	455.3	78.1	50.7	40.5
2	25.8	30.7	62.6	80.5	169.3	98.1	171.8	276.0	435.8	46.6	47.9	41.9
3	25.6	27.2	63.2	71.0	148.1	88.1	816.2	237.9	210.5	47.1	47.3	43.4
4	25.4	25.2	83.6	258.8	133.3	80.6	330.3	380.0	284.3	80.6	46.8	50.8
5	25.3	24.1	78.1	944.1	121.4	72.3	172.8	318.4	365.7	84.0	46.4	58.9
6	25.2	36.3	76.2	988.7	124.4	69.2	142.0	331.6	329.6	88.4	46.0	117.7
7	25.1	44.8	77.5	340.6	125.7	73.4	874.4	1,187.0	255.9	83.2	45.6	149.9
8	24.9	36.4	80.8	197.9	203.3	92.4	280.2	395.2	204.6	77.4	45.5	565.0
9	24.7	40.3	81.9	180.0	277.3	102.1	239.6	273.1	201.7	74.1	44.9	201.0
10	24.5	36.4	82.2	157.1	158.9	163.3	659.9	611.3	205.2	71.1	44.4	118.5
11	25.4	35.6	78.1	140.3	199.5	134.2	346.0	292.2	235.4	68.1	43.9	82.1
12	27.3	34.3	74.2	128.0	139.0	167.1	236.7	253.7	210.9	65.0	43.3	77.0
13	46.6	32.5	64.0	123.3	123.3	164.1	208.0	218.3	214.3	62.1	42.7	72.1
14	43.5	33.0	73.5	104.5	141.8	109.6	379.3	639.1	205.5	59.4	42.2	67.4
15	43.7	33.9	98.9	140.9	191.0	94.4	242.0	306.4	200.4	56.3	41.6	69.7
16	42.3	35.1	70.5	106.3	131.9	83.0	165.0	316.5	184.5	53.0	40.9	62.6
17	41.8	36.2	54.5	103.0	118.9	89.1	207.2	1,203.9	176.0	51.5	40.4	58.4
18	41.2	37.5	51.6	100.2	116.9	91.6	681.9	505.2	168.0	50.6	39.2	60.1
19	40.5	39.1	57.8	101.1	122.3	95.0	183.7	357.8	156.0	49.9	37.9	61.0
20	41.0	44.3	184.8	93.6	125.9	120.6	1,291.6	341.4	142.3	48.7	37.3	61.9
21	36.6	530.7	102.7	81.2	121.1	122.2	353.6	465.0	121.1	47.6	36.7	63.1
22	32.9	174.7	81.7	85.2	122.4	113.9	1,158.1	589.5	103.1	46.6	36.2	68.7
23	28.4	108.1	70.6	86.9	144.1	145.1	683.0	569.7	91.4	45.6	35.6	80.3
24	25.8	94.9	66.6	81.0	124.2	137.4	1,218.0	352.0	79.2	43.3	35.2	98.1
25	24.9	91.3	73.7	68.0	123.7	229.7	245.6	321.5	79.1	69.0	33.8	106.5
26	27.9	83.2	81.8	80.4	120.1	409.4	212.1	638.3	79.1	149.6	34.1	92.6
27	97.6	72.4	82.7	88.8	124.4	171.7	221.6	363.1	77.8	120.1	33.5	152.8
28	77.4	66.0	81.9	91.7	123.5	153.0	849.5	320.5	76.8	100.9	34.7	322.5
29	49.8		75.3	124.2	126.1	132.0	379.7	294.6	76.8	84.7	37.9	170.9
30	43.0		75.7	145.7	123.4	276.6	1,090.7	287.4	77.6	73.9	39.1	104.3
31	37.9		147.2		114.3		461.2	280.9		62.6		96.1
Average	36.4	68.5	80.6	180.4	141.1	133.1	484.6	427.4	190.1	69.0	41.1	110.2
Maximum	97.6	530.7	184.8	988.7	277.3	409.4	1,291.6	1,203.9	455.3	149.6	50.7	565.0
Minimum	24.5	24.1	51.6	68.0	114.3	69.2	142.0	218.3	76.8	43.3	33.5	40.5

Average annual discharge = 165 (m^3/sec)

Annual inflow volume = 5,191 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1995

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	86.0	64.2	146.0	219.8	163.3	108.8	118.1	705.5	241.6	61.1	34.8	45.5
2	90.3	64.3	144.1	191.8	150.0	111.0	93.1	719.2	196.3	60.6	34.6	39.8
3	85.4	64.8	139.5	180.3	146.3	109.1	113.0	573.5	170.3	68.3	34.2	37.4
4	81.7	66.2	140.8	159.2	138.0	111.0	114.3	685.8	137.7	64.9	33.2	36.3
5	80.7	65.9	145.9	149.9	144.5	115.0	127.2	560.2	122.7	52.5	32.1	34.6
6	79.3	65.4	145.0	142.7	135.5	120.6	141.6	475.9	118.3	51.2	31.7	32.7
7	76.4	65.1	144.2	145.8	144.5	135.4	128.1	411.8	118.2	50.3	31.6	30.5
8	74.4	64.8	134.7	142.1	145.7	131.1	185.6	332.4	119.0	49.4	31.4	32.2
9	71.7	64.6	124.2	182.0	151.0	130.0	201.6	282.1	152.7	48.9	31.1	45.0
10	78.3	65.2	122.4	255.7	159.5	133.2	153.2	327.4	126.4	48.6	31.0	44.8
11	76.3	265.7	120.9	190.2	162.2	119.6	162.0	237.8	122.9	44.3	30.8	37.7
12	71.8	425.9	114.1	245.5	163.6	122.4	126.4	218.1	121.5	33.6	30.7	36.6
13	64.7	138.4	103.9	206.1	162.5	121.4	118.0	246.9	113.5	33.2	30.6	37.1
14	65.3	180.9	109.9	203.0	161.5	120.4	127.4	298.8	98.5	33.4	30.4	37.2
15	69.7	245.9	104.2	237.0	158.5	119.4	140.5	272.2	96.5	42.2	29.9	36.6
16	71.3	163.3	104.1	293.4	146.2	128.3	164.9	236.2	90.0	66.6	29.6	36.7
17	68.5	144.5	104.1	243.4	134.1	136.1	210.3	247.3	72.7	50.5	29.0	36.5
18	65.2	181.3	104.2	226.2	145.7	142.5	199.3	222.6	70.9	53.5	28.5	35.8
19	66.1	135.2	117.5	226.3	133.5	200.7	449.3	217.3	67.2	42.8	28.2	35.2
20	69.3	135.5	131.6	213.2	120.8	206.1	440.8	565.7	65.7	42.1	28.0	34.7
21	69.7	131.2	151.3	215.8	116.9	274.9	331.3	420.8	64.4	41.7	27.9	33.9
22	66.3	109.9	156.8	220.2	127.1	205.7	469.2	359.1	63.7	41.3	27.6	33.3
23	66.4	97.3	218.2	228.4	128.5	154.0	647.3	245.3	63.0	40.9	27.2	32.7
24	67.2	95.6	237.8	247.3	115.5	133.9	585.0	299.0	88.9	40.4	26.8	32.2
25	65.5	97.9	200.9	235.8	109.1	106.2	1,071.0	198.4	71.0	39.9	28.1	31.6
26	64.4	97.9	402.9	237.7	111.0	102.6	1,541.0	186.6	62.4	39.2	29.4	31.1
27	63.6	211.9	244.1	238.6	109.2	95.8	1,751.0	243.1	62.5	38.2	30.8	30.6
28	63.8	182.8	435.3	212.4	109.5	106.8	2,415.0	223.1	62.4	37.1	36.5	31.1
29	62.6		453.6	197.5	110.7	104.6	1,209.0	248.0	62.5	36.3	69.2	29.6
30	63.0		306.5	176.9	107.3	113.7	786.9	265.5	61.8	35.6	53.6	29.0
31	64.4		254.6		106.8		686.0	384.8		35.0		27.0
Average	71.3	131.8	179.5	208.8	136.1	134.0	484.1	351.9	102.8	45.9	32.6	35.0
Maximum	90.3	425.9	453.6	293.4	163.6	274.9	2,415.0	719.2	241.6	68.3	69.2	45.5
Minimum	62.6	64.2	103.9	142.1	106.8	95.8	93.1	186.6	61.8	33.2	26.8	27.0

Average annual discharge = 160 (m^3/sec)

Annual inflow volume = 5,051 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1996

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	27.7	46.0	168.1	321.8	212.9	161.2	361.8	228.2	159.5	91.6	40.1	28.1
2	27.2	45.7	122.8	270.5	178.4	149.9	237.5	189.7	162.4	92.8	39.1	27.3
3	26.8	60.8	132.9	231.2	157.2	131.7	191.9	287.5	185.8	275.3	37.9	26.6
4	26.4	71.5	100.9	193.7	153.0	130.5	339.4	260.0	156.4	304.1	37.1	31.5
5	26.2	65.0	108.0	203.0	148.5	126.6	282.4	278.6	160.5	135.3	36.2	32.5
6	26.0	59.7	128.7	218.8	143.5	118.5	240.3	393.2	163.3	63.7	35.9	28.9
7	25.7	62.6	173.1	255.6	129.2	125.8	171.7	262.2	168.8	60.3	36.6	26.7
8	25.3	68.8	189.9	347.4	132.9	135.0	152.2	253.1	137.2	67.5	37.5	26.6
9	24.4	129.2	155.9	202.7	129.8	157.6	149.9	241.5	135.1	76.3	38.6	26.4
10	23.5	128.9	152.4	186.0	127.3	133.7	152.8	247.3	130.6	73.1	39.7	26.3
11	35.9	74.2	160.6	182.7	122.5	133.8	178.7	258.5	114.5	69.6	40.7	25.9
12	49.8	80.6	300.9	181.0	122.9	138.9	180.9	446.9	104.3	63.2	41.8	25.7
13	65.0	88.1	281.6	176.3	118.3	227.6	189.9	920.9	96.2	53.8	38.4	25.5
14	82.3	131.3	279.7	174.5	112.3	189.2	237.2	955.5	153.2	46.7	33.1	25.2
15	584.4	565.1	426.2	186.3	139.8	227.0	173.7	637.8	114.3	39.6	30.0	24.9
16	321.5	233.2	602.8	185.0	147.3	316.2	149.6	526.3	89.9	32.4	29.1	24.6
17	152.9	175.4	914.3	211.4	131.2	245.7	133.9	451.1	77.4	26.5	28.7	24.5
18	109.3	127.5	1,199.6	209.2	99.5	195.7	118.1	369.0	77.1	22.3	28.3	24.3
19	75.8	139.1	780.9	209.1	93.1	308.3	120.1	321.0	73.4	21.3	26.8	24.1
20	64.7	164.7	523.8	194.8	85.2	621.1	237.7	231.9	68.9	27.7	25.8	23.9
21	53.9	191.0	451.9	185.8	169.1	1,084.7	244.6	182.2	65.3	43.9	30.8	23.8
22	44.8	218.3	367.2	177.5	259.2	459.6	160.2	222.1	120.6	64.9	36.2	23.5
23	66.8	246.9	302.2	169.7	271.7	346.0	174.8	985.3	107.2	57.3	34.2	23.0
24	64.5	678.1	265.3	158.4	224.8	331.0	162.1	656.4	94.6	50.3	30.3	22.6
25	50.6	441.6	217.7	177.7	420.6	260.8	135.6	494.1	92.4	47.3	27.9	22.4
26	48.6	324.1	246.3	162.7	311.8	230.7	124.1	340.8	89.8	46.0	27.8	22.4
27	49.1	310.2	300.1	161.8	247.0	247.4	104.2	272.0	88.2	44.8	27.8	22.4
28	49.4	253.5	395.7	164.2	226.7	230.4	197.0	225.8	86.0	43.6	28.0	22.5
29	48.5	217.8	768.2	168.1	207.5	294.3	262.3	194.7	85.2	42.5	28.4	22.5
30	47.3		493.7	201.0	195.3	424.2	163.8	215.4	87.1	41.7	29.0	22.4
31	46.3		367.7		155.2		257.2	177.9		41.1		22.3
Average	76.5	186.2	357.4	202.3	173.3	262.8	193.1	378.3	114.8	69.9	33.4	25.1
Maximum	584.4	678.1	1,199.6	347.4	420.6	1,084.7	361.8	985.3	185.8	304.1	41.8	32.5
Minimum	23.5	45.7	100.9	158.4	85.2	118.5	104.2	177.9	65.3	21.3	25.8	22.3

Average annual discharge = 173 (m^3/sec)

Annual inflow volume = 5,467 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1997

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.1	23.1	32.6	340.0	98.1	99.2	132.0	193.8	348.6	102.8	88.8	96.9
2	22.1	22.8	80.5	456.7	90.1	103.1	108.3	231.0	341.9	127.3	84.7	92.0
3	22.2	26.4	95.2	389.1	110.8	105.6	95.0	165.8	306.4	117.1	81.4	88.4
4	22.1	26.0	73.5	553.9	104.0	112.5	135.7	115.5	213.1	116.9	77.0	84.9
5	22.0	37.8	59.1	296.6	102.6	98.9	122.1	112.4	222.6	161.2	73.7	81.3
6	21.8	31.9	56.6	207.6	90.4	105.5	116.2	120.1	283.3	124.5	70.0	77.8
7	21.7	30.2	52.5	140.2	192.3	120.3	146.6	147.2	332.1	113.9	66.5	74.3
8	21.4	29.2	46.5	130.4	191.1	137.0	162.3	146.8	565.3	117.3	61.9	79.8
9	21.1	28.0	54.5	130.6	163.6	167.4	326.8	155.4	331.2	110.4	102.5	241.6
10	20.9	27.3	55.6	131.3	116.9	120.1	208.3	165.2	260.7	99.5	145.3	145.0
11	20.7	36.4	48.2	130.0	108.2	107.3	168.5	225.7	205.5	122.5	90.3	121.7
12	20.5	31.7	44.2	147.4	111.1	103.0	128.0	609.5	181.0	99.6	89.5	113.3
13	20.4	24.2	36.4	133.0	102.7	110.8	126.2	348.9	209.3	102.6	92.4	109.7
14	20.3	22.4	25.1	158.0	97.6	111.6	158.8	302.1	192.7	100.9	96.4	107.9
15	20.1	20.2	24.9	234.1	92.2	113.9	144.6	237.1	166.3	92.2	89.9	107.1
16	19.9	19.2	112.4	160.3	87.7	109.0	180.6	221.3	150.4	110.1	84.1	106.7
17	19.8	18.2	85.6	133.7	86.8	108.6	158.1	193.4	134.7	97.1	78.4	99.2
18	19.0	18.0	76.4	120.8	83.3	115.8	167.0	177.4	124.7	91.0	72.2	90.8
19	19.5	17.9	297.7	108.0	80.7	107.4	438.5	159.8	118.9	85.8	66.1	84.6
20	51.2	18.0	146.2	93.0	79.3	111.5	180.1	225.6	116.8	132.3	59.5	77.5
21	62.4	18.0	112.7	91.2	91.4	121.9	187.0	185.5	142.0	190.8	53.7	70.6
22	50.9	18.1	99.5	93.3	90.5	107.9	237.2	380.9	138.8	120.3	51.3	63.6
23	26.8	17.0	70.2	82.5	79.8	119.6	187.7	267.4	117.2	97.3	52.4	56.6
24	22.9	16.0	57.4	87.9	73.7	119.3	187.4	221.6	114.4	93.1	54.9	54.9
25	21.9	31.9	49.2	103.8	73.6	121.6	189.3	244.2	107.3	86.1	71.1	53.0
26	20.4	68.1	42.0	105.4	69.6	115.2	353.8	431.4	95.4	107.6	158.7	51.6
27	20.4	39.0	64.2	107.1	81.4	179.1	736.3	5,690.0	92.6	128.5	167.4	50.7
28	25.3	30.0	143.0	99.4	94.3	197.8	263.0	1,553.0	95.0	97.8	127.9	48.8
29	23.1		520.8	94.5	89.8	235.3	335.2	758.2	126.5	110.5	109.6	55.2
30	24.3		295.8	95.5	84.5	165.6	285.6	523.7	106.9	114.3	102.6	54.4
31	24.3		274.3		80.2		246.1	438.6		99.7		51.7
Average	24.9	26.7	104.3	171.8	99.9	125.1	213.3	482.2	198.1	112.0	87.3	86.8
Maximum	62.4	68.1	520.8	553.9	192.3	235.3	736.3	5,690.0	565.3	190.8	167.4	241.6
Minimum	19.0	16.0	24.9	82.5	69.6	98.9	95.0	112.4	92.6	85.8	51.3	48.8

Average annual discharge = 145 (m^3/sec)

Annual inflow volume = 4,583 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1998

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	51.6	53.1	364.1	208.4	291.2	115.8	259.1	97.0	101.5	46.2	28.4	19.5
2	48.9	63.7	404.0	236.1	287.4	111.4	195.7	79.5	86.1	45.7	28.1	20.2
3	48.7	62.6	470.8	282.0	279.9	94.5	143.3	76.3	99.5	45.1	28.2	20.8
4	47.4	60.2	2,260.0	286.8	267.3	103.8	200.8	70.9	104.7	47.5	28.1	21.6
5	48.5	59.3	1,062.0	283.5	256.5	91.4	130.8	93.1	103.7	45.1	27.6	22.3
6	47.1	61.7	608.3	283.8	224.6	87.3	213.6	141.4	79.3	44.5	28.4	23.1
7	45.7	64.1	474.3	270.2	160.9	92.2	131.1	98.7	71.6	42.4	27.2	23.8
8	51.2	68.4	448.1	1,172.0	222.6	86.6	105.8	74.1	69.1	34.6	26.1	23.9
9	52.8	71.1	394.3	663.5	190.9	75.2	103.7	68.5	102.7	34.4	25.0	23.3
10	55.9	76.9	339.2	379.0	136.6	76.2	218.0	87.8	83.9	34.5	24.3	23.3
11	60.1	84.0	303.2	350.9	125.1	93.4	198.2	98.5	90.0	34.8	25.1	24.1
12	64.2	92.9	322.9	297.8	114.6	249.1	381.1	106.7	103.8	35.5	24.5	23.3
13	78.1	102.6	316.4	257.5	109.6	132.3	368.5	119.5	80.6	34.6	25.4	23.1
14	96.9	156.9	260.5	242.9	127.8	93.2	384.8	168.2	69.9	34.3	24.7	22.9
15	214.0	764.1	226.9	240.2	124.4	73.2	433.0	204.7	69.6	34.1	25.6	22.8
16	134.4	363.7	227.3	237.9	130.1	63.3	535.2	103.6	66.6	32.6	25.0	23.3
17	95.3	534.5	231.4	231.4	145.5	63.1	329.9	94.1	63.0	35.0	25.1	23.2
18	82.8	912.7	223.1	224.8	134.3	73.4	205.6	83.5	63.8	34.9	23.6	23.0
19	75.8	420.2	238.4	238.7	129.0	74.2	156.2	81.8	62.6	34.1	23.0	22.2
20	70.1	338.1	245.0	250.2	129.9	62.8	112.2	99.0	61.0	35.2	22.3	22.0
21	66.1	290.1	222.0	270.7	129.6	69.6	113.0	83.4	60.7	33.4	21.0	21.5
22	62.3	318.3	274.3	284.1	127.4	81.3	112.5	83.0	60.3	31.7	20.9	20.6
23	58.7	329.4	253.5	298.2	124.0	82.5	113.7	86.6	57.5	30.7	20.1	20.6
24	55.2	693.4	220.0	313.5	116.0	84.7	104.4	86.4	54.9	29.6	20.0	20.1
25	51.9	630.5	215.6	337.6	118.6	85.8	100.0	81.9	52.9	30.0	19.9	20.2
26	48.8	452.0	195.9	721.3	113.9	83.5	149.3	96.6	53.0	29.4	20.5	20.3
27	49.5	397.1	187.4	397.4	123.2	88.3	96.7	87.4	49.7	29.4	20.4	19.7
28	51.6	374.5	191.2	325.6	139.5	93.3	86.6	78.7	48.1	27.7	19.7	19.8
29	50.9		214.1	315.3	175.9	116.5	82.5	78.1	46.0	27.6	19.5	20.5
30	50.2		199.9	304.0	123.3	124.7	112.6	114.1	45.8	27.6	19.4	20.6
31	50.9		195.3		116.5		145.5	123.0		28.2		21.8
Average	66.6	282.0	380.3	340.2	161.2	94.1	194.3	98.3	72.1	35.2	23.9	21.8
Maximum	214.0	912.7	2,260.0	1,172.0	291.2	249.1	535.2	204.7	104.7	47.5	28.4	24.1
Minimum	45.7	53.1	187.4	208.4	109.6	62.8	82.5	68.5	45.8	27.6	19.4	19.5

Average annual discharge = 147 (m^3/sec)

Annual inflow volume = 4,622 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 1999

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.0	58.5	59.6	103.1	85.8	36.6	116.6	297.6	119.3	119.3	26.4	26.2
2	21.4	55.2	61.6	100.4	71.0	38.5	105.0	208.8	182.5	96.1	28.0	26.3
3	21.7	52.1	65.8	76.1	70.3	39.1	103.1	197.1	103.0	76.3	29.4	26.7
4	21.1	48.9	75.4	78.5	63.3	38.8	60.5	172.6	86.5	70.6	37.3	27.1
5	21.4	45.9	93.7	85.0	64.2	55.0	50.7	191.9	97.3	77.2	61.9	26.2
6	22.6	44.3	83.5	78.7	64.8	38.0	50.8	253.7	167.1	66.9	56.3	25.7
7	37.8	41.6	233.4	85.9	66.4	39.5	45.5	581.0	101.0	63.7	62.4	25.3
8	35.5	38.5	299.8	87.5	62.2	49.3	39.6	274.0	92.1	61.7	50.8	26.3
9	34.5	41.3	276.2	93.0	61.2	51.9	39.3	209.2	156.4	60.2	45.1	25.9
10	32.8	45.0	182.6	78.0	57.1	56.8	39.2	280.7	87.7	60.9	44.1	25.7
11	30.7	50.5	134.9	97.1	47.7	50.1	112.5	206.2	91.7	60.4	43.8	25.7
12	28.5	58.8	115.1	109.2	54.0	61.3	103.8	213.1	80.0	60.4	39.7	26.0
13	25.3	60.1	95.9	121.0	57.8	54.9	95.7	260.2	75.4	57.9	39.7	25.3
14	22.0	67.2	83.8	96.8	47.4	48.7	71.3	168.7	75.2	56.4	39.0	25.0
15	20.1	61.7	74.8	83.0	40.3	47.8	51.5	132.2	163.5	54.1	38.7	24.7
16	18.7	54.5	66.1	75.3	37.1	47.4	51.5	107.3	134.9	54.2	38.8	24.7
17	19.9	53.4	59.2	76.0	46.2	46.4	199.7	89.3	145.4	53.3	38.7	24.6
18	21.2	76.4	52.8	86.4	58.0	67.9	358.2	80.2	101.5	50.1	38.7	24.0
19	22.6	127.7	47.8	80.7	56.8	75.8	298.5	78.4	240.1	47.4	38.7	23.7
20	27.7	104.7	58.1	76.7	56.3	115.3	216.5	106.5	169.9	45.2	36.5	23.7
21	124.6	63.6	67.1	72.5	72.8	111.3	155.6	83.2	95.7	43.9	36.0	23.6
22	125.8	61.7	43.9	66.9	77.2	65.6	126.1	75.0	73.1	39.0	35.1	23.7
23	89.4	60.9	39.0	73.5	65.1	56.7	91.3	109.3	105.4	35.4	34.5	23.8
24	256.7	63.5	40.2	72.7	63.3	54.4	77.2	70.1	149.6	32.6	34.2	23.6
25	170.7	68.6	47.5	74.9	70.0	88.4	99.7	83.6	119.3	32.0	33.7	23.9
26	100.3	65.2	56.2	73.4	54.4	59.5	61.6	131.9	91.1	31.7	37.6	23.8
27	73.7	66.2	58.2	85.2	58.9	62.1	51.4	151.3	79.5	24.9	31.6	23.8
28	62.2	60.4	62.1	74.4	50.2	55.6	50.1	111.5	97.6	23.9	27.5	23.9
29	58.8		66.8	73.5	51.1	64.2	132.2	75.6	140.2	23.2	26.6	23.9
30	56.9		73.7	86.5	48.0	66.7	138.8	84.3	233.8	25.0	26.5	23.2
31	59.4		89.4		42.6		166.2	109.2		25.1		23.4
Average	54.4	60.6	92.4	84.1	58.8	58.1	108.4	167.5	121.9	52.5	38.6	24.8
Maximum	256.7	127.7	299.8	121.0	85.8	115.3	358.2	581.0	240.1	119.3	62.4	27.1
Minimum	18.7	38.5	39.0	66.9	37.1	36.6	39.2	70.1	73.1	23.2	26.4	23.2

Average annual discharge = 77 (m^3/sec)

Annual inflow volume = 2,428 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2000

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.1	211.6	50.0	93.8	60.0	47.5	153.5	1,722.0	152.0	58.0	42.4	27.3
2	21.9	160.6	48.8	93.0	71.8	45.8	191.5	865.2	149.2	56.0	41.4	28.5
3	21.0	100.1	45.4	100.2	78.0	43.6	176.0	448.8	111.6	56.9	42.3	28.1
4	19.4	82.7	48.0	93.6	76.8	46.5	138.2	339.9	118.3	55.9	41.4	26.9
5	17.9	73.6	99.8	73.0	64.2	48.4	67.9	279.0	103.7	54.9	38.7	28.0
6	17.7	69.2	66.9	74.0	63.8	38.7	58.4	262.2	108.7	51.5	36.2	26.5
7	17.7	61.6	62.8	76.5	60.3	51.0	63.8	259.4	134.4	50.6	35.5	27.7
8	17.3	53.5	63.6	61.9	64.5	52.8	132.0	234.1	102.9	49.6	35.0	26.1
9	17.7	51.3	65.6	60.1	72.2	108.9	166.0	364.0	148.2	49.6	34.4	28.3
10	17.4	122.2	70.7	70.8	75.9	63.9	100.0	319.0	110.1	49.7	33.3	28.0
11	17.8	117.4	67.6	78.5	82.5	69.2	105.2	276.8	112.7	47.9	30.2	30.4
12	168.7	106.6	62.4	85.4	84.9	52.3	88.0	245.2	80.7	46.0	30.5	30.0
13	238.5	80.1	60.0	92.9	152.9	39.0	104.1	206.6	66.0	47.4	27.1	32.3
14	170.4	65.8	55.6	81.0	100.0	33.7	133.1	218.4	56.6	45.5	27.3	30.5
15	80.5	64.3	54.6	87.9	92.5	81.8	139.6	228.6	55.9	43.3	27.3	32.8
16	59.9	62.2	54.8	69.6	114.3	65.7	81.8	237.4	53.7	43.1	27.2	33.8
17	46.2	58.7	54.4	72.6	87.2	57.5	149.9	186.0	50.2	44.5	25.8	36.3
18	43.3	57.0	50.2	74.9	86.2	69.2	78.3	179.0	42.3	42.0	27.0	47.5
19	46.2	55.5	45.3	72.6	106.0	71.6	66.4	142.6	52.1	39.3	25.5	46.8
20	56.6	51.1	42.0	72.0	80.8	120.3	132.6	144.8	204.8	37.4	27.0	37.7
21	50.8	51.1	39.2	74.8	71.6	85.5	128.9	145.1	134.7	37.6	25.7	32.4
22	45.6	50.6	40.8	86.4	72.5	63.1	616.6	126.3	121.2	37.9	24.9	28.3
23	42.2	49.4	40.9	68.0	76.2	89.7	728.4	125.6	86.7	36.4	26.0	26.3
24	39.8	44.3	43.0	66.8	66.4	67.7	362.3	115.3	78.6	34.9	27.4	23.1
25	37.6	42.3	45.7	79.9	62.8	65.6	263.1	108.0	86.7	35.0	26.4	23.8
26	38.9	44.1	74.2	79.8	57.5	72.9	261.4	101.8	196.1	35.3	26.4	22.7
27	38.1	45.1	112.5	78.2	52.0	122.4	182.8	99.4	111.5	34.3	28.2	24.2
28	36.1	44.6	97.6	61.0	46.4	208.7	193.4	114.0	87.1	34.9	26.9	23.7
29	35.0	44.6	117.3	57.4	44.4	95.8	187.1	169.2	71.9	37.7	27.2	22.5
30	34.6		112.1	57.5	50.3	316.1	161.1	183.7	63.5	42.4	29.0	23.0
31	35.5		88.6		62.3		639.1	138.7		43.3		21.9
Average	50.1	73.1	63.9	76.5	75.4	79.8	195.2	277.0	101.7	44.5	30.8	29.2
Maximum	238.5	211.6	117.3	100.2	152.9	316.1	728.4	1,722.0	204.8	58.0	42.4	47.5
Minimum	17.3	42.3	39.2	57.4	44.4	33.7	58.4	99.4	42.3	34.3	24.9	21.9

Average annual discharge = 92 (m^3/sec)

Annual inflow volume = 2,901 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2001

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.3	19.8	24.1	46.3	50.5	49.3	103.3	290.3	117.9	44.2	25.3	18.8
2	23.1	21.3	23.8	37.4	50.5	120.3	71.5	257.1	130.2	46.1	27.6	19.9
3	25.6	20.5	23.0	38.9	50.4	165.9	84.9	265.6	115.4	51.0	34.1	18.9
4	25.8	19.7	22.6	48.3	49.7	113.0	72.6	453.2	126.3	64.8	44.6	18.0
5	25.3	20.9	22.2	41.6	51.1	135.7	76.1	316.4	95.1	54.7	37.3	18.9
6	24.8	19.7	22.1	40.2	59.7	122.7	51.8	328.4	103.7	49.2	41.4	18.0
7	23.5	18.6	21.1	42.5	67.4	134.7	59.6	389.7	84.4	46.5	41.4	19.1
8	21.7	18.8	20.8	46.2	69.2	122.4	103.2	251.5	101.9	43.3	36.7	18.3
9	21.7	18.9	20.7	50.1	65.5	134.0	86.5	223.8	81.0	43.7	33.4	19.1
10	20.8	18.7	20.6	50.4	68.0	140.4	78.3	233.0	78.6	43.8	32.4	18.1
11	22.2	19.6	19.0	47.5	70.7	81.8	627.8	193.5	81.1	43.6	33.2	17.1
12	21.4	20.8	18.9	50.1	73.7	71.7	155.0	161.2	154.2	44.7	31.0	17.4
13	21.1	19.9	21.2	52.1	71.7	65.2	211.5	148.0	113.9	42.8	30.4	18.0
14	22.8	18.9	23.0	48.4	68.6	116.7	133.9	366.3	203.4	43.9	29.2	18.0
15	22.0	20.0	22.3	51.8	77.8	116.3	142.6	338.2	186.8	41.1	28.3	17.3
16	22.6	21.3	24.7	59.7	62.5	177.9	378.5	281.7	112.1	40.0	28.6	19.1
17	21.3	20.4	23.7	108.5	83.6	443.3	266.1	187.4	98.7	40.7	27.5	20.3
18	20.6	20.6	20.7	151.8	60.7	172.1	168.0	163.5	88.7	37.5	25.1	21.1
19	21.1	20.1	19.7	84.9	61.1	107.2	139.3	160.7	81.1	36.8	23.4	25.0
20	21.5	20.9	23.7	88.6	144.5	85.7	131.0	163.7	75.6	35.3	24.7	23.2
21	21.1	22.2	46.4	63.2	106.5	138.1	130.0	184.5	70.9	34.2	25.1	22.7
22	21.9	21.1	37.8	53.7	76.4	179.1	406.1	176.1	64.5	33.4	23.1	21.7
23	21.6	20.9	30.0	43.9	73.7	149.4	635.3	214.3	60.7	31.7	21.6	21.1
24	20.7	23.2	26.3	45.6	60.5	160.2	520.9	161.1	57.7	31.6	22.5	21.1
25	21.7	26.9	25.0	47.6	53.0	102.6	300.0	137.7	55.1	29.1	21.1	20.0
26	21.7	26.8	25.2	44.7	48.4	121.1	195.8	131.4	58.7	29.3	20.2	19.9
27	21.6	27.1	23.8	45.2	43.6	107.7	184.9	123.4	54.5	27.8	20.9	19.7
28	20.4	26.4	26.9	42.4	45.2	64.5	155.3	126.5	50.1	26.0	20.0	19.6
29	20.5		46.3	51.3	62.6	56.7	604.1	116.9	47.0	24.5	18.8	18.2
30	20.6		59.3	46.3	48.4	233.0	527.6	111.8	44.7	24.2	19.8	19.2
31	19.6		44.6		54.1		358.6	143.3		24.5		18.5
Average	22.0	21.2	26.7	55.6	65.5	133.0	231.0	219.4	93.1	39.0	28.3	19.5
Maximum	25.8	27.1	59.3	151.8	144.5	443.3	635.3	453.2	203.4	64.8	44.6	25.0
Minimum	19.6	18.6	18.9	37.4	43.6	49.3	51.8	111.8	44.7	24.2	18.8	17.1

Average annual discharge = 80 (m^3/sec)

Annual inflow volume = 2,524 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2002

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.7	26.8	43.1	91.2	46.8	56.1	80.7	82.4	189.5	42.8	28.6	21.2
2	18.9	27.9	45.0	89.1	47.8	48.7	66.2	100.9	242.3	42.5	27.8	21.0
3	19.4	26.2	50.5	82.3	49.4	71.7	58.1	77.4	164.1	42.1	27.7	20.8
4	18.6	25.8	40.8	81.9	59.3	55.1	62.3	100.1	312.9	41.4	26.6	21.4
5	17.7	25.1	39.0	81.8	86.3	51.7	56.6	122.4	217.9	42.0	27.2	20.4
6	17.1	25.7	37.8	81.3	90.7	58.3	50.8	233.0	155.7	43.5	28.4	20.3
7	17.4	28.7	38.8	121.0	84.7	52.3	41.5	175.0	130.2	43.6	27.5	19.3
8	17.6	33.4	38.1	108.4	76.8	50.2	39.5	135.9	158.2	42.7	27.2	19.2
9	17.2	30.2	52.2	92.0	80.9	56.1	34.5	114.3	118.2	42.0	26.1	19.4
10	17.8	27.2	214.1	83.5	82.4	79.7	42.5	92.3	104.3	41.4	26.0	20.0
11	16.9	25.6	144.1	79.4	92.0	78.6	43.3	100.1	91.1	40.5	26.4	19.9
12	16.8	25.4	108.7	80.4	94.3	74.9	35.4	573.9	105.1	40.7	26.5	18.9
13	15.8	25.4	101.5	85.1	89.6	80.9	34.4	867.4	96.3	45.7	25.2	20.0
14	19.3	25.3	95.1	91.4	86.8	178.5	33.1	518.8	153.9	46.3	24.4	21.0
15	53.7	25.4	89.5	86.9	95.7	126.7	38.0	404.7	156.4	42.4	24.4	20.6
16	120.6	26.6	84.8	84.9	105.1	117.2	40.5	235.2	131.4	40.2	24.7	20.3
17	87.3	30.3	90.4	80.6	94.4	192.9	65.3	173.8	193.6	38.5	23.4	19.5
18	58.9	34.6	87.9	80.0	94.1	158.1	83.1	138.5	154.4	37.3	23.5	20.3
19	48.2	37.1	91.7	82.1	87.9	122.2	81.0	119.4	120.8	36.9	23.2	19.9
20	40.6	33.5	98.9	84.5	75.9	97.7	147.9	131.5	97.1	41.4	22.8	22.7
21	37.7	51.2	97.5	83.0	70.7	114.0	268.6	114.9	83.7	38.4	22.5	23.4
22	37.8	80.5	107.0	74.5	69.2	81.9	123.8	155.4	69.5	37.5	22.2	23.1
23	35.3	536.3	85.8	72.2	70.5	90.2	183.5	140.5	58.2	36.4	22.3	21.7
24	35.4	199.6	101.2	72.6	67.0	240.6	104.9	179.8	72.3	35.6	23.2	21.5
25	33.1	136.1	218.5	73.1	65.7	188.1	113.9	234.8	58.3	33.9	22.4	22.2
26	33.4	89.7	149.8	72.1	60.0	108.8	92.1	215.5	55.3	32.5	22.1	22.0
27	31.1	61.9	121.5	60.1	64.6	88.5	113.0	209.6	50.7	31.6	23.0	20.9
28	29.7	44.8	105.7	53.4	68.7	111.4	93.8	152.0	47.2	31.0	22.2	21.3
29	30.2		103.3	47.1	95.3	154.7	91.2	127.5	44.1	29.7	20.9	21.4
30	28.0		100.4	43.1	72.5	100.3	112.8	283.5	43.8	28.4	21.3	21.1
31	27.8		94.7		55.6		73.6	194.5		27.9		20.2
Average	32.8	63.1	92.8	80.0	76.8	102.9	80.8	209.8	122.6	38.6	24.7	20.8
Maximum	120.6	536.3	218.5	121.0	105.1	240.6	268.6	867.4	312.9	46.3	28.6	23.4
Minimum	15.8	25.1	37.8	43.1	46.8	48.7	33.1	77.4	43.8	27.9	20.9	18.9

Average annual discharge = 79 (m^3/sec)

Annual inflow volume = 2,488 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2003

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.0	26.0	450.9	168.3	295.4	27.9	76.0	196.4	76.4	72.6	27.6	18.4
2	18.9	26.5	1,157.0	163.2	152.3	34.1	67.7	284.2	81.1	60.2	26.3	20.6
3	19.1	23.4	586.4	155.8	98.2	29.8	67.7	206.9	107.3	55.2	25.9	19.2
4	19.2	20.7	418.8	163.6	87.2	25.8	73.7	126.5	175.6	47.6	27.3	21.3
5	18.6	21.6	333.8	142.9	74.8	25.8	144.4	90.4	131.7	43.7	26.2	23.3
6	18.2	20.9	302.9	126.5	62.9	26.2	157.5	72.9	112.1	43.5	26.2	21.4
7	17.7	21.7	282.7	140.2	64.7	93.3	172.3	67.8	88.5	42.1	23.7	23.2
8	18.7	21.9	247.2	155.0	61.1	94.9	92.0	80.5	101.7	39.0	24.6	21.5
9	20.0	21.3	222.9	165.9	59.0	110.2	173.2	61.9	125.8	43.8	24.2	21.8
10	18.7	20.3	201.8	175.1	55.3	103.9	112.8	55.7	93.5	41.5	22.9	24.2
11	17.5	19.8	177.7	182.0	52.5	84.5	126.8	55.4	85.4	38.1	24.1	25.4
12	16.9	19.6	162.7	188.1	52.0	77.2	104.6	55.2	81.8	39.3	22.6	24.5
13	15.7	18.7	167.2	189.8	48.8	68.5	105.6	51.4	112.0	35.3	24.8	28.3
14	15.5	18.3	177.5	193.6	49.7	68.3	84.9	46.0	90.1	33.7	23.4	56.5
15	15.1	19.1	177.6	187.5	50.3	69.4	111.4	43.6	93.5	33.6	25.7	73.6
16	15.7	23.6	201.2	277.4	51.3	70.5	164.4	42.1	75.0	32.7	24.3	54.7
17	15.0	347.8	190.2	224.4	52.3	72.4	85.6	53.6	69.1	30.5	37.4	44.8
18	15.8	3,491.0	174.6	200.0	56.0	68.7	82.3	128.5	67.1	29.5	48.5	37.7
19	15.5	1,622.0	175.2	204.7	48.4	69.5	71.4	204.2	61.7	29.6	32.1	34.6
20	15.5	413.8	180.9	226.8	56.3	90.5	114.2	232.9	60.4	29.4	27.4	30.6
21	15.2	280.1	198.1	173.6	55.9	125.3	140.4	189.7	57.2	29.2	25.4	32.5
22	15.6	239.7	215.7	158.1	53.9	95.4	129.2	120.6	54.1	27.0	25.0	30.7
23	15.1	255.7	193.5	169.7	49.0	85.7	121.2	114.5	64.1	27.2	22.7	31.6
24	15.7	238.5	194.8	183.7	40.5	82.3	241.7	89.0	185.2	26.7	24.4	29.5
25	14.7	213.7	210.5	176.5	38.0	95.7	139.4	74.4	366.9	24.5	22.5	27.2
26	13.9	209.4	197.8	175.2	36.8	93.0	142.9	74.8	273.4	25.6	20.3	29.0
27	14.3	207.2	202.1	177.5	39.1	86.8	159.9	76.4	157.6	25.3	18.3	26.8
28	13.5	344.2	201.9	146.5	37.7	80.0	125.2	74.7	116.0	24.0	20.2	28.6
29	21.0		281.1	139.1	28.1	74.0	119.1	85.3	93.0	23.8	22.3	26.8
30	22.1		232.8	154.7	26.6	66.2	156.7	130.2	79.3	25.6	20.3	27.5
31	27.6		184.6		27.3		111.7	83.4		26.1		25.0
Average	17.3	293.1	267.8	176.2	63.3	73.2	121.8	105.5	111.2	35.7	25.6	30.3
Maximum	27.6	3,491.0	1,157.0	277.4	295.4	125.3	241.7	284.2	366.9	72.6	48.5	73.6
Minimum	13.5	18.3	162.7	126.5	26.6	25.8	67.7	42.1	54.1	23.8	18.3	18.4

Average annual discharge = 109 (m^3/sec)

Annual inflow volume = 3,428 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2004

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.1	125.1	74.0	36.4	335.1	44.7	57.1	169.7	57.4	35.9	35.5	86.2
2	28.8	96.1	63.4	35.1	182.5	52.0	70.1	97.4	87.9	36.8	33.9	64.3
3	28.6	93.5	55.9	33.9	124.6	46.6	60.2	198.8	59.7	38.3	33.9	52.4
4	28.6	80.0	53.0	35.1	113.2	41.2	80.9	129.6	51.3	40.0	32.8	45.2
5	28.6	69.0	50.6	38.5	100.2	40.9	67.2	85.6	46.2	39.0	29.8	42.4
6	28.4	61.5	52.3	43.5	87.9	39.8	64.3	104.1	52.0	37.3	29.7	41.1
7	28.4	54.0	50.7	44.1	86.4	84.3	61.1	302.2	44.8	37.6	31.6	36.8
8	27.7	51.9	51.6	39.4	82.3	63.9	92.1	231.7	45.4	41.4	29.9	36.2
9	26.8	76.3	66.0	50.0	80.1	82.9	202.9	153.6	44.3	45.5	32.3	33.8
10	25.4	103.7	70.8	48.4	75.9	66.6	104.8	114.1	43.0	50.9	29.7	33.7
11	26.4	85.3	66.7	42.7	72.9	51.2	87.3	133.5	40.5	120.6	32.6	33.2
12	27.5	78.5	61.2	41.4	72.5	51.7	148.0	87.7	42.2	97.6	30.1	32.3
13	29.1	82.5	57.6	39.4	69.3	49.2	86.1	63.0	46.9	79.1	27.9	32.4
14	30.4	78.0	57.8	36.6	70.3	51.6	150.7	58.4	50.5	69.3	30.3	31.8
15	31.6	83.8	58.2	38.5	71.1	77.2	84.9	72.8	95.7	59.2	28.2	30.5
16	32.3	77.6	65.2	41.0	72.4	61.6	80.6	80.0	147.4	56.2	30.5	27.7
17	63.8	75.7	67.0	38.0	72.8	59.1	49.2	220.7	89.4	49.3	28.2	28.3
18	113.4	121.5	66.0	36.6	76.5	96.9	87.7	159.8	67.9	48.2	30.5	27.7
19	60.6	106.4	64.8	36.8	67.1	69.4	58.5	108.3	57.7	47.4	28.2	27.9
20	47.7	85.7	58.5	40.9	75.1	79.0	48.2	100.0	55.8	46.9	28.9	104.7
21	46.1	83.7	57.7	37.8	73.8	89.2	52.3	77.3	96.7	48.1	29.4	60.0
22	192.0	76.1	48.1	34.3	70.5	106.1	45.2	72.5	67.1	49.3	28.1	42.9
23	237.8	76.0	45.1	42.0	64.9	76.3	41.0	83.8	53.3	52.7	26.5	37.7
24	155.6	80.6	43.4	40.6	55.1	106.9	35.0	83.6	48.6	50.2	28.3	39.4
25	105.1	80.6	36.7	41.2	52.7	155.1	29.3	95.4	50.7	51.5	32.2	38.9
26	89.0	79.7	37.7	43.6	52.0	97.6	27.1	91.7	53.8	54.4	31.8	36.8
27	77.2	78.6	35.3	49.9	55.8	90.8	46.9	61.2	57.2	63.2	31.3	38.1
28	70.4	87.7	33.7	73.3	54.8	63.1	64.5	72.3	49.2	54.5	35.9	35.9
29	71.4	78.8	33.0	89.7	43.9	54.4	78.3	57.2	42.5	47.0	39.5	36.8
30	115.1		32.5	337.4	42.6	47.3	156.4	63.7	37.0	40.1	184.7	37.3
31	172.6		33.8		44.2		147.9	58.3		38.8		43.6
Average	66.8	83.0	53.2	52.9	83.8	69.9	79.5	112.5	59.4	52.5	36.1	41.8
Maximum	237.8	125.1	74.0	337.4	335.1	155.1	202.9	302.2	147.4	120.6	184.7	104.7
Minimum	25.1	51.9	32.5	33.9	42.6	39.8	27.1	57.2	37.0	35.9	26.5	27.7

Average annual discharge = 66 (m^3/sec)

Annual inflow volume = 2,086 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2005

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	345.6	65.0	191.3	194.8	163.3	82.8	227.9	99.0	46.9	39.2	51.1	38.2
2	146.2	63.8	192.8	206.5	159.3	76.3	232.9	95.7	43.7	39.3	48.8	40.3
3	97.6	63.0	195.2	211.1	189.3	74.4	192.3	102.2	43.5	40.5	46.0	37.1
4	83.9	57.4	205.7	216.0	177.2	73.7	156.9	95.2	42.1	40.6	49.4	39.2
5	72.7	69.6	225.5	225.0	186.8	77.9	167.0	116.2	47.4	41.8	46.5	36.0
6	63.6	71.0	228.6	216.4	182.5	74.7	162.5	93.0	56.1	41.3	44.0	32.8
7	54.5	170.6	222.1	221.7	172.4	79.4	119.3	95.3	129.5	42.6	47.0	34.8
8	46.3	157.2	209.2	225.5	177.1	82.8	155.3	97.7	96.8	41.7	44.6	31.7
9	43.8	606.8	217.5	212.9	176.1	79.1	181.2	105.4	105.9	48.3	47.1	34.1
10	41.8	375.3	203.2	177.4	158.3	79.3	186.7	106.9	71.4	49.7	44.4	32.0
11	39.2	643.9	209.8	155.7	138.1	86.5	299.6	104.7	67.2	56.4	41.5	32.2
12	40.1	695.7	205.3	156.1	127.9	88.0	416.7	99.5	78.6	100.7	44.1	31.0
13	39.8	401.6	215.8	157.0	128.1	87.2	400.1	154.3	68.3	63.2	41.2	33.5
14	41.0	321.9	209.4	164.2	117.5	74.7	294.3	97.6	53.2	55.2	43.9	30.7
15	38.6	301.2	230.0	169.0	104.0	73.8	277.3	86.3	53.7	50.8	41.0	33.2
16	39.5	303.1	267.4	175.6	109.5	85.8	329.5	124.4	48.8	61.0	43.6	30.7
17	36.2	248.6	304.9	165.1	104.8	88.4	215.3	119.5	70.9	76.1	40.8	29.0
18	38.4	267.5	352.1	171.3	101.0	101.7	178.2	100.1	301.8	63.9	37.9	31.0
19	35.3	367.0	604.8	188.0	104.6	109.8	169.3	82.2	158.5	59.4	40.5	29.0
20	37.5	259.1	482.0	192.1	94.5	121.8	174.9	84.0	93.9	58.7	37.7	29.5
21	34.5	212.9	432.4	180.5	96.9	126.8	199.9	73.9	70.4	54.6	40.2	29.4
22	50.5	215.2	556.1	194.8	85.7	138.1	193.1	69.5	57.0	55.1	37.5	31.7
23	85.1	218.7	419.6	223.5	85.9	152.0	155.4	65.5	77.8	51.1	40.0	30.6
24	60.6	209.2	377.3	202.8	93.4	164.1	150.9	60.3	53.7	52.2	37.2	29.3
25	45.1	196.3	311.9	207.3	87.2	165.4	139.7	76.7	49.9	48.6	40.1	32.0
26	39.7	190.1	284.0	234.4	81.4	180.2	135.9	64.9	45.9	49.3	37.7	29.2
27	35.6	189.7	294.3	203.6	81.7	180.6	187.0	91.3	50.5	49.1	40.6	31.8
28	66.5	185.6	286.9	190.9	77.6	167.7	119.4	72.0	45.4	49.2	40.2	29.6
29	67.4		249.7	163.4	84.5	184.7	112.9	60.8	40.0	51.1	41.2	29.5
30	59.7		220.7	154.2	95.9	189.5	145.8	51.8	39.2	48.6	41.4	30.3
31	55.3		205.9		96.0		98.7	45.8		49.7		27.5
Average	63.9	254.5	284.2	191.9	123.8	111.6	199.2	90.1	73.6	52.5	42.6	32.1
Maximum	345.6	695.7	604.8	234.4	189.3	189.5	416.7	154.3	301.8	100.7	51.1	40.3
Minimum	34.5	57.4	191.3	154.2	77.6	73.7	98.7	45.8	39.2	39.2	37.2	27.5

Average annual discharge = 126 (m^3/sec)

Annual inflow volume = 3,969 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2006

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	28.5	50.2	139.5	123.7	107.6	65.9	86.7	249.2	271.1	62.2	30.8	56.6
2	59.2	51.1	121.3	126.0	104.4	62.6	53.5	223.2	375.6	57.7	29.6	48.8
3	77.4	51.0	104.2	124.6	99.4	61.2	83.3	269.4	478.3	54.3	30.9	43.9
4	68.8	52.1	90.2	103.5	102.4	99.1	63.3	1,117.0	406.5	51.7	28.6	75.1
5	53.4	51.8	77.5	115.6	122.3	87.7	76.7	960.9	285.8	46.9	27.4	1,394.0
6	45.6	51.5	63.6	119.7	120.9	88.4	75.3	698.1	226.4	47.7	27.9	613.2
7	42.4	51.0	62.7	124.1	130.5	62.7	144.1	512.0	195.5	46.0	27.5	298.6
8	43.6	54.5	62.0	119.2	130.3	50.4	143.2	685.2	173.2	43.9	27.7	236.9
9	39.5	55.7	62.3	117.6	141.3	51.7	141.8	479.6	168.4	43.8	30.0	212.4
10	35.3	54.9	62.6	238.0	129.5	53.6	184.9	400.8	154.9	44.3	32.4	211.7
11	36.5	52.6	63.8	130.7	126.6	56.3	162.9	295.0	160.3	42.9	32.6	211.3
12	33.3	53.5	66.7	104.6	123.5	58.4	277.5	249.5	164.1	42.5	49.3	188.9
13	33.7	52.2	89.0	86.4	127.1	60.8	463.7	247.4	158.2	45.8	143.8	173.5
14	29.6	64.2	124.0	83.9	127.5	60.0	238.1	267.5	129.0	44.3	91.6	162.1
15	32.9	171.3	125.9	78.9	109.5	66.5	168.9	297.9	117.1	44.8	68.8	154.3
16	160.3	146.5	141.0	73.6	125.6	152.7	119.7	253.8	123.2	41.0	71.9	143.3
17	255.2	102.2	97.3	71.4	165.6	167.5	89.5	242.6	114.8	37.3	90.2	133.4
18	195.7	77.0	88.5	75.0	118.4	114.5	71.1	219.4	109.3	37.8	199.7	133.9
19	96.3	86.9	88.0	71.0	106.7	88.1	64.1	192.0	99.6	45.5	170.3	125.2
20	68.7	64.8	157.0	72.2	102.8	69.8	73.0	341.1	124.2	75.9	115.9	122.3
21	62.6	64.8	208.2	74.1	128.7	63.1	80.4	263.5	99.3	53.5	90.2	121.8
22	56.4	62.2	137.4	81.7	112.3	62.5	117.5	222.5	92.6	46.0	85.7	141.7
23	52.7	64.2	131.6	101.3	124.2	59.4	315.9	243.9	84.6	42.5	97.4	109.5
24	48.2	64.3	120.9	90.2	120.0	64.7	492.0	202.5	82.8	39.8	79.3	96.0
25	46.6	82.7	128.1	97.1	122.7	74.0	237.3	207.4	77.3	36.9	65.3	85.8
26	43.5	348.3	150.4	109.3	110.6	102.7	306.1	199.9	73.4	35.1	62.0	87.1
27	44.0	254.5	131.7	121.9	111.6	129.8	507.1	235.2	74.5	37.5	63.2	98.0
28	46.3	166.3	123.9	122.6	103.7	190.0	610.3	270.6	72.9	34.1	60.8	89.5
29	47.1		115.1	112.2	91.4	160.2	389.1	223.4	69.8	33.1	62.2	81.4
30	47.0		113.3	115.9	81.8	178.0	317.6	239.7	63.8	31.3	59.5	76.5
31	48.4		114.2		75.1		245.0	207.8		28.7		73.0
Average	63.8	89.4	108.4	106.2	116.3	88.7	206.4	345.7	160.9	44.3	68.4	187.1
Maximum	255.2	348.3	208.2	238.0	165.6	190.0	610.3	1,117.0	478.3	75.9	199.7	1,394.0
Minimum	28.5	50.2	62.0	71.0	75.1	50.4	53.5	192.0	63.8	28.7	27.4	43.9

Average annual discharge = 133 (m^3/sec)

Annual inflow volume = 4,187 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2007

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	67.7	36.5	205.2	410.4	162.9	106.3	221.8	117.7	84.1	47.0	22.8	21.0
2	64.6	35.6	169.2	365.9	160.5	114.1	294.0	110.3	79.7	46.2	26.4	21.0
3	60.5	34.8	146.7	331.7	158.3	126.7	204.9	93.1	73.6	45.7	23.1	21.0
4	62.7	35.4	149.6	290.4	161.5	146.0	165.0	97.0	65.8	43.2	25.2	20.6
5	66.6	38.1	168.8	268.3	163.5	155.0	124.0	94.4	83.7	42.8	23.2	18.8
6	64.2	34.9	157.1	255.9	157.3	126.8	144.5	123.6	74.1	39.4	23.7	18.7
7	62.4	34.9	156.5	249.0	149.3	129.2	145.0	103.2	73.4	39.3	23.8	18.9
8	63.3	36.2	158.9	235.0	169.2	132.3	402.7	87.1	82.9	37.3	23.8	19.2
9	59.5	35.4	160.2	232.7	175.4	144.1	215.1	76.8	86.2	35.9	26.1	18.8
10	61.6	39.6	152.1	225.8	168.6	147.7	151.6	70.3	77.4	35.4	23.4	19.0
11	56.4	127.2	147.6	222.0	155.7	151.2	124.1	67.1	87.3	35.8	21.5	19.3
12	54.6	190.1	492.6	221.4	142.2	157.8	182.6	67.5	74.1	31.5	23.0	19.2
13	52.0	121.6	626.9	220.8	152.1	167.9	134.2	107.0	62.2	32.7	21.5	20.9
14	46.8	99.5	383.9	219.2	160.6	203.3	88.9	475.4	62.9	31.2	21.6	23.0
15	46.0	95.2	300.8	224.6	175.2	203.2	165.4	286.9	67.5	28.1	22.6	19.5
16	42.0	80.9	270.7	223.6	195.0	167.6	116.2	164.4	69.2	31.1	21.9	19.9
17	41.7	79.6	252.9	222.9	191.8	171.0	85.2	140.9	82.0	29.2	21.0	19.6
18	40.0	74.9	253.3	243.7	185.6	166.3	87.3	126.8	76.4	30.2	20.3	19.4
19	39.5	65.1	274.0	227.4	256.6	130.4	89.7	89.4	64.6	27.3	20.9	19.8
20	39.3	60.4	2,305.0	228.2	234.1	127.1	186.4	135.2	90.5	26.4	20.3	18.5
21	38.2	57.2	1,277.0	218.0	193.9	115.8	231.2	114.0	117.5	26.5	19.4	20.8
22	39.7	96.0	662.4	203.3	164.4	117.4	208.5	126.7	93.6	26.3	20.1	18.5
23	40.2	73.9	464.0	200.9	156.6	152.6	192.2	134.4	84.0	23.3	19.2	20.7
24	40.6	59.8	413.6	206.2	146.5	129.9	229.8	216.2	82.7	25.0	20.9	19.5
25	37.6	59.4	390.9	181.3	131.2	149.5	156.9	118.0	61.3	25.1	18.9	18.3
26	40.8	57.9	378.9	166.4	122.1	162.1	127.8	141.5	58.4	23.8	19.4	19.3
27	40.9	171.9	375.7	181.3	121.4	135.8	131.1	106.9	56.7	24.8	19.8	19.7
28	36.9	298.7	377.7	181.3	125.7	215.2	111.3	88.1	56.6	23.6	19.0	17.5
29	38.0		389.3	174.1	126.1	310.2	201.1	98.1	56.0	24.9	19.6	17.0
30	35.2		400.0	174.3	110.8	224.9	148.5	88.9	48.6	24.9	20.5	17.1
31	36.6		403.2		114.2		120.1	83.5		24.9		16.9
Average	48.9	79.7	402.1	233.5	160.9	156.2	167.3	127.4	74.4	31.9	21.8	19.4
Maximum	67.7	298.7	2,305.0	410.4	256.6	310.2	402.7	475.4	117.5	47.0	26.4	23.0
Minimum	35.2	34.8	146.7	166.4	110.8	106.3	85.2	67.1	48.6	23.3	18.9	16.9

Average annual discharge = 127 (m^3/sec)

Annual inflow volume = 4,018 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2008

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.5	35.0	128.2	78.4	83.6	82.4	197.7	283.7	139.1	43.9	37.0	28.8
2	17.0	35.0	131.7	84.6	92.1	116.7	159.5	296.3	136.3	41.0	35.3	31.4
3	17.9	38.6	122.4	100.4	96.1	113.2	129.3	907.2	149.1	42.1	33.4	31.6
4	15.3	46.9	102.4	122.4	109.5	110.0	141.0	545.7	166.1	37.3	33.1	28.7
5	16.8	70.3	105.8	196.5	97.0	108.5	126.7	501.7	149.0	36.9	34.0	29.6
6	15.4	68.7	103.6	397.9	94.2	139.1	307.6	399.1	138.6	62.6	28.7	29.5
7	17.9	53.8	117.5	160.5	89.7	182.1	251.2	329.7	172.2	51.0	33.3	31.5
8	30.3	82.2	104.2	127.5	83.9	168.9	192.9	325.4	148.5	63.1	35.8	34.2
9	130.2	66.2	106.4	121.2	84.8	187.9	155.8	374.6	145.4	48.3	31.2	253.2
10	179.9	56.8	105.3	129.8	78.4	148.1	135.9	289.4	121.9	47.4	32.4	102.2
11	114.3	50.5	98.2	211.6	83.7	181.1	165.7	330.2	115.8	42.5	28.2	70.1
12	60.5	51.1	97.4	236.2	76.9	261.4	198.6	326.4	118.1	39.2	27.7	57.8
13	49.2	53.3	98.0	174.5	87.7	184.8	189.7	294.1	119.5	38.6	33.5	46.7
14	40.2	55.3	96.2	134.5	83.7	256.3	209.5	287.6	108.5	36.9	40.4	43.5
15	32.3	56.6	92.7	159.5	90.5	635.3	167.1	299.5	81.5	103.5	47.4	42.4
16	28.0	57.7	99.9	279.6	112.3	386.0	150.4	296.3	78.6	93.2	39.0	44.0
17	210.8	65.2	104.3	188.0	125.6	243.4	140.1	249.9	99.1	72.5	32.1	45.6
18	606.1	61.8	102.0	149.1	98.7	200.9	195.8	207.1	90.4	55.3	31.4	48.5
19	150.9	65.5	94.8	133.4	97.5	240.1	158.1	199.2	82.3	42.7	31.0	50.0
20	99.2	70.2	87.9	121.6	115.7	221.0	257.1	208.6	81.5	48.6	34.0	344.7
21	77.7	77.7	74.2	117.0	101.8	180.1	232.4	201.4	75.5	44.6	38.8	343.7
22	65.5	76.5	70.8	120.2	122.8	229.5	242.2	236.3	85.1	44.4	33.3	180.1
23	58.4	148.7	65.9	115.5	169.5	165.3	169.5	193.0	93.5	37.7	35.5	128.1
24	53.6	156.7	66.9	102.3	138.9	185.8	158.5	194.8	73.9	41.6	31.1	99.0
25	47.8	109.6	67.4	103.3	189.7	154.5	155.3	157.1	66.2	36.9	33.0	85.1
26	46.4	95.7	68.0	105.6	145.2	155.3	226.3	156.0	56.0	39.0	28.3	77.2
27	43.3	96.8	68.3	99.1	104.9	168.8	174.6	135.6	50.0	36.8	32.7	70.6
28	42.5	105.3	66.2	94.8	113.7	256.9	166.7	129.1	47.0	38.2	30.8	63.2
29	39.5	117.4	61.3	91.9	88.6	211.4	181.0	123.2	47.2	35.9	31.6	57.2
30	37.8		68.5	87.7	88.2	206.7	414.4	136.8	46.6	37.4	32.4	49.3
31	37.9		73.2		80.3		224.6	142.7		38.9		42.4
Average	77.4	73.3	91.9	144.8	104.0	202.7	192.7	282.5	102.8	47.7	33.5	83.5
Maximum	606.1	156.7	131.7	397.9	189.7	635.3	414.4	907.2	172.2	103.5	47.4	344.7
Minimum	15.3	35.0	61.3	78.4	76.9	82.4	126.7	123.2	46.6	35.9	27.7	28.7

Average annual discharge = 120 (m^3/sec)

Annual inflow volume = 3,794 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2009

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	41.8	68.6	103.2	75.0	120.7	91.7	80.9	109.7	161.5	44.2	26.0	22.7
2	41.2	64.9	95.8	108.5	125.9	87.3	88.3	115.2	170.2	47.0	26.3	24.7
3	41.3	65.3	97.5	185.8	117.3	93.1	87.8	144.3	214.3	44.3	25.5	22.8
4	44.5	64.6	191.6	161.5	140.5	91.8	86.2	102.7	213.2	69.4	23.4	24.7
5	48.4	69.5	139.3	146.9	145.6	91.4	78.1	113.5	140.6	54.1	25.6	23.3
6	42.9	152.8	133.6	173.3	127.7	82.9	73.8	120.5	115.1	49.4	25.7	24.8
7	38.2	120.4	117.8	343.9	103.0	60.1	55.3	163.4	100.0	45.7	25.8	25.6
8	38.1	96.8	102.2	285.8	103.9	60.9	53.8	116.9	92.3	43.8	25.9	22.0
9	41.0	93.5	88.0	306.7	103.8	51.4	59.2	99.1	88.7	43.6	31.6	21.6
10	41.1	100.2	77.8	221.9	103.2	51.6	78.7	142.3	89.2	43.1	87.9	23.3
11	41.8	128.1	79.2	193.2	101.7	54.2	77.7	112.5	112.5	40.6	46.2	23.8
12	39.2	122.9	72.2	171.1	94.7	55.5	92.4	104.6	109.3	39.9	32.5	24.4
13	39.4	118.5	74.3	158.1	90.4	56.3	188.2	132.2	88.9	38.4	29.3	24.3
14	39.5	416.2	74.9	149.5	98.9	56.6	119.7	132.6	84.8	37.8	29.6	23.6
15	40.1	216.4	78.4	135.5	107.4	54.8	91.9	344.1	79.8	36.4	30.3	21.9
16	43.6	179.4	79.5	130.1	102.4	123.3	79.3	327.3	93.4	33.9	28.1	21.9
17	50.0	157.5	75.9	137.0	105.3	115.8	75.0	264.6	81.0	33.5	28.6	21.8
18	73.6	155.7	79.4	135.5	123.5	84.2	181.2	171.0	60.8	31.8	30.1	21.9
19	149.7	138.5	79.7	136.7	133.1	68.7	111.7	133.3	59.1	31.3	28.1	20.2
20	105.3	158.6	77.4	131.9	126.9	56.4	94.6	145.7	56.6	31.4	30.1	19.7
21	75.2	136.5	78.0	133.7	134.1	51.3	122.5	105.8	54.9	31.0	26.2	20.9
22	67.2	123.1	71.2	143.2	106.2	51.7	216.5	119.0	53.7	31.9	25.9	21.2
23	60.8	129.5	69.3	123.2	96.2	53.7	198.7	99.1	50.0	31.5	25.8	20.4
24	62.6	186.9	70.7	112.2	92.5	55.3	190.2	114.6	49.5	30.8	25.8	21.3
25	67.7	146.3	102.4	103.1	93.3	61.6	123.1	97.8	46.0	30.8	25.9	20.9
26	89.4	132.0	116.2	100.9	90.3	55.6	96.7	182.5	45.6	29.0	26.0	21.1
27	121.8	120.1	80.1	104.9	85.5	64.6	115.5	123.5	44.4	27.9	26.8	21.7
28	100.8	109.1	112.9	105.0	88.3	70.5	249.5	90.3	46.8	27.7	24.8	19.6
29	77.5		102.6	117.0	86.2	76.1	255.7	87.0	46.4	28.0	26.8	19.7
30	67.5		127.4	113.8	83.3	91.9	216.0	80.7	49.6	26.8	24.8	18.5
31	67.7		89.1		85.1		119.9	127.7		26.7		19.2
Average	61.3	134.7	94.8	154.8	107.0	70.7	121.2	139.5	89.9	37.5	29.8	22.1
Maximum	149.7	416.2	191.6	343.9	145.6	123.3	255.7	344.1	214.3	69.4	87.9	25.6
Minimum	38.1	64.6	69.3	75.0	83.3	51.3	53.8	80.7	44.4	26.7	23.4	18.5

Average annual discharge = 88 (m^3/sec)

Annual inflow volume = 2,783 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2010

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.9	17.9	269.2	101.8	93.1	119.7	90.9	491.5	258.2	77.6	38.6	25.6
2	19.4	17.4	208.9	98.5	93.2	109.4	102.0	730.1	176.2	73.7	38.8	25.6
3	19.5	16.8	164.4	89.0	98.7	112.7	93.3	568.8	196.3	65.3	38.7	24.9
4	19.4	16.8	154.2	84.2	103.9	119.9	91.5	400.2	152.1	64.3	35.6	24.6
5	19.4	17.6	181.6	83.0	121.3	125.4	99.0	530.1	152.9	64.3	35.4	25.2
6	19.7	19.8	142.4	83.1	190.7	93.1	104.8	679.8	138.2	56.9	36.4	22.6
7	19.6	72.2	130.0	82.6	129.7	84.7	96.6	512.4	124.3	58.3	35.9	22.0
8	19.7	602.9	124.2	89.1	154.3	104.3	92.1	367.8	132.3	57.4	35.0	22.4
9	19.7	1,172.0	118.5	87.8	118.9	79.6	92.3	325.8	134.0	59.6	35.1	22.8
10	19.9	344.2	121.3	89.9	103.7	86.3	111.5	277.8	125.2	58.8	30.4	23.3
11	19.9	227.1	119.1	104.7	114.8	82.5	116.7	301.8	127.7	56.7	29.9	23.6
12	20.3	183.3	117.9	99.9	97.4	72.7	136.3	345.6	129.5	56.4	29.7	24.0
13	20.4	152.9	117.8	110.5	99.1	91.7	104.0	354.3	161.1	55.0	30.1	24.3
14	20.2	125.5	117.5	100.0	106.0	87.9	92.6	335.4	150.4	55.6	26.7	24.9
15	20.3	103.7	120.3	98.2	98.1	110.5	84.4	499.3	141.7	55.0	27.4	25.1
16	20.3	98.0	124.2	97.9	92.0	91.3	89.1	413.8	123.0	55.1	27.2	25.3
17	18.8	89.4	129.1	103.3	93.2	90.7	87.3	324.8	107.3	55.2	26.1	24.5
18	17.8	82.5	132.7	104.2	109.4	92.8	148.0	317.6	113.6	53.2	28.6	24.3
19	18.2	81.2	132.1	131.2	142.4	89.8	137.4	302.2	111.7	51.1	27.7	22.0
20	17.8	78.5	137.8	128.2	113.0	80.3	273.7	357.0	99.8	50.9	25.2	22.0
21	18.1	81.3	134.5	124.6	98.6	84.5	293.0	296.2	93.4	45.6	25.5	21.7
22	17.5	96.0	137.1	114.2	115.4	90.8	325.2	259.9	102.6	165.9	25.5	21.5
23	17.9	102.6	138.1	99.1	105.3	96.4	252.2	254.7	116.0	105.9	25.9	21.2
24	15.4	101.9	141.6	90.1	103.0	112.4	146.6	290.6	129.0	70.0	25.5	21.1
25	15.8	96.0	134.1	76.2	107.9	114.6	115.2	289.4	114.9	55.9	25.9	21.1
26	15.1	97.5	126.8	69.0	110.5	126.0	243.3	272.2	94.3	49.6	26.0	21.1
27	14.8	157.7	128.9	83.2	111.4	106.1	435.7	222.3	83.7	45.7	25.9	21.1
28	15.4	152.8	129.4	102.4	219.5	99.7	1,463.0	193.4	84.4	45.7	26.0	21.0
29	18.6		122.2	101.1	221.9	101.3	794.2	178.7	79.5	41.8	26.1	21.0
30	32.7		149.8	95.8	151.2	90.9	688.2	164.0	77.9	42.2	25.9	24.2
31	23.3		127.3		124.2		455.9	154.3		41.7		37.8
Average	19.2	157.3	139.8	97.4	120.7	98.3	240.5	355.2	127.7	61.0	29.9	23.6
Maximum	32.7	1,172.0	269.2	131.2	221.9	126.0	1,463.0	730.1	258.2	165.9	38.8	37.8
Minimum	14.8	16.8	117.5	69.0	92.0	72.7	84.4	154.3	77.9	41.7	25.2	21.0

Average annual discharge = 123 (m^3/sec)

Annual inflow volume = 3,868 (Mm^3)

River: Poonch **Station:** Rehman Bridge (Kotli) **Year:** 2011

Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.3	20.7	87.0	152.5	172.0	123.5	133.3	69.6	329.0	140.6	86.5	59.3
2	19.8	19.3	105.7	153.2	188.7	94.3	89.8	46.2	213.0	142.6	85.9	54.9
3	21.0	18.0	249.7	133.3	189.5	98.8	93.0	88.4	161.2	129.7	80.5	53.1
4	22.7	16.7	435.6	120.6	187.7	80.6	88.8	127.3	210.2	125.3	78.3	51.1
5	24.6	15.6	271.8	122.4	170.5	92.6	78.7	87.9	200.0	121.1	77.3	49.1
6	26.8	14.2	208.6	114.4	193.6	103.1	66.0	53.2	186.3	129.2	77.4	47.2
7	27.1	447.3	188.1	102.3	171.4	94.6	89.5	269.3	207.1	126.5	77.7	45.6
8	25.9	263.8	193.4	93.5	143.4	97.0	96.1	182.0	368.9	117.0	77.0	44.1
9	24.9	127.6	183.8	95.3	146.3	93.5	105.0	198.1	331.6	120.3	78.2	43.7
10	23.4	72.9	177.4	102.3	149.2	119.7	116.3	174.3	342.7	117.9	77.3	43.4
11	23.1	55.3	171.1	235.1	166.1	114.6	78.3	264.6	236.3	104.7	77.8	43.1
12	22.0	55.6	164.4	237.6	140.7	156.2	60.3	303.5	182.1	104.1	72.1	42.8
13	20.1	234.7	157.9	201.7	153.2	119.3	60.9	242.7	180.5	103.2	74.7	42.3
14	18.1	691.2	154.1	176.1	141.8	98.9	146.2	189.5	213.0	104.1	68.5	42.3
15	31.7	291.0	161.3	165.4	141.2	101.3	98.2	191.5	370.1	100.6	69.2	41.9
16	31.8	195.1	185.2	159.1	157.2	92.5	267.0	194.7	1,197.0	96.0	73.6	41.8
17	27.2	181.8	196.5	582.1	154.7	114.7	125.0	187.0	424.8	94.4	69.5	41.5
18	27.8	145.6	200.8	449.8	141.8	116.7	108.6	167.4	300.7	92.1	71.6	38.8
19	30.1	117.1	571.4	316.6	143.4	112.5	76.5	158.6	258.6	93.1	72.3	39.3
20	26.3	101.2	400.4	266.1	153.9	106.8	65.9	194.3	237.1	89.5	75.9	42.1
21	27.2	95.0	237.8	241.5	152.6	89.5	75.1	165.4	224.6	89.4	71.0	41.9
22	28.6	87.0	189.3	209.9	120.1	83.5	89.3	144.8	221.3	90.2	66.3	39.5
23	25.8	88.4	183.6	214.7	128.1	106.4	69.6	132.1	224.3	96.6	70.1	38.4
24	27.8	104.3	179.3	218.5	110.7	72.2	213.9	241.5	210.3	100.5	70.8	39.3
25	27.4	103.1	178.4	213.3	122.9	136.2	183.7	320.3	178.1	98.4	70.4	39.0
26	26.5	100.3	178.0	211.3	126.2	173.6	136.6	174.8	180.6	88.1	70.1	39.1
27	25.7	103.7	165.1	207.1	124.3	117.1	103.5	293.8	158.9	85.7	69.9	39.1
28	24.3	89.1	183.4	206.4	119.6	180.4	89.8	314.6	150.8	84.1	67.0	38.8
29	19.6		207.6	201.5	112.8	128.6	169.6	256.6	149.0	85.1	64.6	38.8
30	22.3		188.0	184.4	119.4	122.1	106.4	198.7	141.0	86.1	64.1	34.8
31	22.2		155.1		121.0		84.4	166.4		87.0		35.2
Average	25.1	137.7	210.0	202.9	147.2	111.4	108.5	187.1	266.3	104.6	73.5	42.9
Maximum	31.8	691.2	571.4	582.1	193.6	180.4	267.0	320.3	1,197.0	142.6	86.5	59.3
Minimum	18.1	14.2	87.0	93.5	110.7	72.2	60.3	46.2	141.0	84.1	64.1	34.8

Average annual discharge = 134 (m^3/sec)

Annual inflow volume = 4,239 (Mm^3)

APPENDIX B

SYNTHETIC MEAN DAILY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 1
(WITHOUT PROJECT)

River: Poonch **Station:** EFlow Site 1 **Year:** 1960

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.0	27.9	18.0	90.1	72.2	40.6	58.2	42.8	99.8	27.7	14.7	12.1
2	20.0	35.4	17.0	87.8	76.2	34.0	49.0	42.9	95.3	26.5	14.3	12.1
3	20.0	30.6	17.0	85.1	78.9	41.5	53.8	53.1	158.6	25.9	13.6	11.6
4	19.7	28.6	18.4	87.8	87.1	41.5	37.4	41.5	74.2	25.2	14.3	10.9
5	19.7	28.6	16.3	82.4	70.1	37.4	44.2	40.2	80.3	31.3	14.3	10.9
6	19.1	28.6	29.3	79.6	53.1	36.1	91.2	37.4	60.6	24.5	14.3	10.9
7	18.4	31.3	27.2	73.5	47.0	49.7	93.9	364.1	53.8	23.1	14.3	10.2
8	18.4	31.3	53.8	72.8	47.0	48.3	211.9	269.6	49.0	22.5	14.3	10.2
9	17.7	32.0	108.2	66.0	56.5	48.3	91.2	242.7	44.9	21.8	14.3	9.5
10	17.7	30.6	142.9	57.2	58.5	40.2	1,038.2	258.1	40.8	21.1	14.3	9.5
11	19.1	30.6	535.6	57.2	58.5	40.8	1,648.7	86.4	49.7	20.4	14.3	9.5
12	17.7	31.3	145.6	60.6	60.6	44.9	389.3	95.3	38.1	19.7	14.3	8.8
13	19.1	32.0	113.7	60.6	62.6	39.5	223.2	206.2	37.4	19.7	15.0	8.8
14	18.4	31.3	100.0	73.5	60.6	31.3	924.5	106.2	34.7	19.1	14.3	8.8
15	19.7	31.3	96.6	66.0	53.1	43.6	450.6	298.8	34.0	19.1	14.3	8.2
16	18.4	30.6	215.7	81.0	48.3	41.5	202.1	678.0	32.0	22.5	13.6	9.5
17	17.7	29.3	168.8	84.4	62.6	31.3	125.9	120.5	49.7	19.7	13.6	17.0
18	17.7	26.5	119.1	96.6	78.9	29.9	219.8	257.9	43.6	18.4	13.6	12.9
19	17.7	25.2	104.8	170.1	58.5	29.3	106.9	117.7	38.1	18.4	13.6	10.9
20	98.0	25.2	142.9	82.4	55.1	29.3	143.6	215.7	38.1	17.7	12.9	9.5
21	47.6	22.5	100.0	71.5	54.4	30.6	83.7	144.3	34.0	17.7	12.9	8.8
22	32.7	22.5	132.7	68.1	49.7	31.3	71.5	126.6	32.7	17.7	12.3	8.2
23	29.3	21.1	119.1	76.2	42.2	33.3	66.0	202.1	31.3	17.0	12.3	8.2
24	28.6	19.7	95.3	77.6	41.5	42.9	61.3	109.6	50.4	17.0	12.9	8.2
25	30.6	19.7	94.6	71.5	44.2	39.5	59.9	102.1	47.6	17.0	12.3	8.2
26	29.3	19.1	98.7	72.1	41.5	37.4	134.8	111.6	36.1	17.0	12.3	8.2
27	29.3	19.1	96.6	62.6	39.5	40.8	68.7	102.8	33.3	16.3	12.3	7.5
28	28.6	17.7	166.7	59.9	37.4	39.5	53.1	113.0	34.0	16.3	12.9	7.5
29	29.3	18.4	121.1	60.6	32.7	34.0	49.0	100.0	30.6	16.3	14.3	7.5
30	32.7		94.6	65.3	34.7	38.1	52.4	98.0	29.3	15.7	12.9	12.3
31	30.0		90.9		39.9		53.9	130.2		15.0		41.8
Average	25.9	26.8	109.7	76.7	54.9	38.2	224.4	158.6	50.4	20.2	13.6	10.9
Maximum	98.0	35.4	535.6	170.1	87.1	49.7	1,648.7	678.0	158.6	31.3	15.0	41.8
Minimum	17.7	17.7	16.3	57.2	32.7	29.3	37.4	37.4	29.3	15.0	12.3	7.5

Average annual discharge = 68 (m^3/sec)

Annual inflow volume = 2,151 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1961

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.0	98.0	54.4	59.9	65.3	40.8	113.7	194.6	266.1	121.1	47.0	32.7
2	12.9	185.8	51.7	61.9	64.7	44.9	69.4	331.4	360.0	70.1	37.4	21.8
3	11.6	116.4	48.3	66.7	67.4	47.6	83.7	184.4	108.2	63.3	34.0	29.9
4	7.5	117.7	42.9	60.6	68.7	51.0	87.1	115.0	111.6	60.6	31.3	29.3
5	6.1	96.6	43.6	85.8	64.7	51.7	147.0	104.1	76.9	57.9	30.6	28.6
6	5.4	84.4	40.2	66.7	59.9	91.2	160.6	83.0	147.0	55.8	30.6	28.6
7	4.8	81.0	36.8	53.1	56.5	146.3	136.1	73.5	368.2	53.8	29.9	27.9
8	4.8	66.0	36.8	49.7	52.4	179.0	229.4	77.6	853.5	52.4	29.3	27.2
9	4.8	55.1	34.0	50.4	56.5	128.0	150.4	529.5	639.8	66.7	29.3	26.5
10	4.8	51.0	33.3	144.3	55.8	106.2	100.0	424.0	364.1	59.9	28.6	25.9
11	4.8	49.0	40.8	641.1	55.1	88.5	92.6	181.7	234.8	49.0	27.9	25.2
12	4.8	44.9	59.2	343.0	55.1	81.0	67.4	130.0	192.6	49.0	26.5	25.2
13	4.1	40.2	55.8	616.6	54.4	66.7	58.5	107.5	204.2	40.2	25.9	25.2
14	4.1	38.8	59.9	244.3	53.8	64.7	59.9	100.0	172.2	40.2	25.9	24.5
15	4.1	37.4	66.0	181.7	136.8	56.5	139.5	115.0	336.9	38.1	26.5	23.8
16	4.1	38.1	70.1	141.6	76.9	45.6	385.2	167.4	231.4	37.4	45.6	25.9
17	4.1	51.0	76.2	125.9	47.0	42.9	231.4	131.4	175.6	35.4	38.1	57.2
18	4.1	64.0	66.7	114.3	38.1	43.6	90.5	128.6	147.7	35.4	29.3	38.8
19	4.1	61.9	88.5	107.5	37.4	48.3	66.7	73.5	128.0	36.1	27.9	30.6
20	4.1	62.6	78.9	157.2	37.4	54.4	76.2	243.0	114.3	37.4	27.2	29.3
21	4.1	57.9	67.4	166.1	39.5	46.3	100.0	94.6	110.9	38.8	26.5	27.9
22	4.1	55.1	51.0	119.8	49.7	72.1	791.5	70.8	116.4	37.4	25.9	27.2
23	4.1	49.7	47.6	87.1	57.9	66.0	589.4	104.8	129.3	35.4	24.5	25.9
24	4.1	51.0	86.4	69.4	42.2	59.9	243.0	173.6	185.8	33.3	23.1	25.2
25	4.8	44.2	85.8	64.7	25.2	64.7	260.0	231.4	248.4	32.7	22.5	25.2
26	23.1	44.9	57.9	61.9	23.8	111.6	348.5	120.5	240.9	29.9	36.1	25.2
27	16.3	51.7	54.4	72.8	19.7	98.7	204.2	110.3	118.4	28.6	99.4	24.5
28	12.9	55.1	75.5	71.5	19.7	60.6	155.9	85.1	76.9	27.2	70.1	23.8
29	360.0		59.9	76.9	27.2	80.3	289.3	71.5	72.1	49.0	40.2	22.5
30	300.1		62.6	78.9	35.4	126.6	445.1	137.5	72.8	93.9	34.7	21.1
31	166.7		68.1		36.1		285.2	334.9		82.4		19.7
Average	33.0	66.1	58.1	141.4	51.0	75.5	201.8	162.3	220.2	49.9	34.4	27.5
Maximum	360.0	185.8	88.5	641.1	136.8	179.0	791.5	529.5	853.5	121.1	99.4	57.2
Minimum	4.1	37.4	33.3	49.7	19.7	40.8	58.5	70.8	72.1	27.2	22.5	19.7

Average annual discharge = 93 (m^3/sec)

Annual inflow volume = 2,945 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1962

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.3	13.6	42.2	91.2	87.1	44.9	40.8	70.8	54.4	47.0	19.1	14.3
2	16.3	12.9	39.5	60.6	68.7	38.8	32.7	76.2	45.6	48.3	19.7	13.6
3	15.7	12.9	53.1	50.4	53.8	38.8	29.9	51.7	59.9	46.3	19.1	16.3
4	15.7	12.9	110.3	55.1	51.7	44.2	27.2	49.7	91.2	44.9	18.4	15.0
5	15.7	12.3	94.6	51.7	43.6	38.8	26.5	86.4	117.1	40.8	17.7	15.0
6	15.0	12.3	83.0	57.9	41.5	42.2	26.5	151.8	59.9	38.1	17.0	15.0
7	15.0	16.3	63.3	105.5	40.2	42.9	34.0	110.9	42.2	36.8	17.0	14.3
8	15.0	22.5	57.9	129.3	45.6	48.3	48.3	68.7	18.4	36.8	16.3	15.0
9	15.0	17.0	49.0	394.7	52.4	49.0	42.2	129.3	19.1	36.8	15.0	14.3
10	15.0	16.3	48.3	217.8	99.4	43.6	69.4	151.1	44.9	36.8	15.0	14.3
11	15.7	20.4	47.6	134.8	72.1	62.6	44.2	57.9	190.6	35.4	14.3	14.3
12	19.1	23.8	42.2	115.7	57.9	43.6	75.5	41.5	162.0	33.3	15.0	15.0
13	17.0	21.1	40.2	109.6	85.8	153.1	51.7	57.2	53.8	33.3	14.3	14.3
14	15.7	19.7	45.6	100.7	66.7	52.4	64.7	53.8	32.7	33.3	14.3	16.3
15	15.0	19.7	44.2	100.7	63.3	42.9	40.8	87.8	33.3	31.3	14.3	15.7
16	15.0	21.1	45.6	91.2	58.5	32.0	118.4	402.5	64.7	29.9	13.6	15.7
17	14.3	88.5	43.6	79.6	61.3	34.0	176.3	86.4	72.1	29.9	13.6	28.6
18	14.3	44.2	43.6	92.6	60.6	36.8	138.2	79.6	57.9	28.6	15.0	46.3
19	14.3	32.0	42.2	98.7	32.7	41.5	93.2	66.0	48.3	26.5	19.7	21.1
20	13.6	29.3	44.2	100.7	39.5	38.8	115.7	66.7	140.2	25.9	46.3	17.7
21	13.6	28.6	48.3	98.7	50.4	44.2	847.5	170.8	59.9	25.2	104.1	17.0
22	13.6	28.6	48.3	109.6	59.9	42.2	229.4	106.9	266.1	23.1	55.1	17.0
23	13.6	27.2	44.9	125.2	57.9	44.2	113.0	59.9	180.4	22.5	28.6	17.0
24	12.9	146.3	49.7	110.3	53.8	38.1	91.2	50.4	62.6	23.1	23.1	15.7
25	12.9	113.7	48.3	102.1	52.4	49.7	79.6	46.3	53.8	21.8	19.7	17.0
26	12.9	89.8	49.0	104.1	51.0	61.9	102.1	96.0	106.9	21.8	17.0	25.9
27	14.3	66.7	50.4	103.4	49.7	50.4	159.3	79.6	106.2	21.8	16.3	112.3
28	15.0	51.7	49.7	89.8	49.0	40.2	113.0	179.7	128.0	21.1	18.4	32.7
29	14.3		55.1	87.8	49.7	39.5	77.6	93.2	72.8	20.4	16.3	21.8
30	13.6		60.6	85.8	46.3	57.9	93.2	112.3	49.0	19.7	17.0	22.5
31	12.9		59.2		39.5		57.9	72.8		19.1		16.3
Average	14.8	36.5	53.0	108.5	56.2	47.9	105.2	97.2	83.1	31.0	22.3	21.5
Maximum	19.1	146.3	110.3	394.7	99.4	153.1	847.5	402.5	266.1	48.3	104.1	112.3
Minimum	12.9	12.3	39.5	50.4	32.7	32.0	26.5	41.5	18.4	19.1	13.6	13.6

Average annual discharge = 56 (m^3/sec)

Annual inflow volume = 1,782 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1963

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.0	14.3	21.8	56.5	40.8	164.0	147.0	597.1	273.6	23.1	9.5	15.7
2	14.3	13.6	21.1	52.4	110.9	76.9	132.0	181.0	92.6	19.7	10.2	14.3
3	15.0	13.6	23.1	127.3	91.2	68.1	95.3	88.5	59.2	17.0	12.3	15.0
4	16.3	13.6	45.6	128.0	77.6	72.1	76.9	92.6	71.5	15.7	10.9	14.3
5	17.0	12.9	137.5	34.7	123.2	72.8	50.4	232.8	83.0	14.3	10.2	13.6
6	17.7	12.9	168.1	47.6	139.5	75.5	47.6	154.5	102.8	15.7	8.8	12.9
7	17.0	12.9	84.4	65.3	87.8	68.1	57.9	132.0	61.9	18.4	10.2	12.9
8	17.0	12.9	93.2	70.1	85.8	66.0	76.2	211.7	38.1	18.4	10.9	10.9
9	17.0	12.9	96.0	73.5	141.6	59.9	51.0	181.7	91.2	18.4	8.8	11.6
10	17.0	12.9	163.3	57.2	146.3	42.9	57.2	90.5	86.4	17.7	7.5	11.6
11	16.3	12.9	79.6	61.9	98.7	63.3	115.7	187.8	48.3	17.0	6.8	11.6
12	15.7	12.3	61.3	67.4	92.6	64.0	177.6	213.7	30.6	16.3	6.8	11.6
13	18.4	12.9	51.7	72.1	112.3	61.9	123.9	143.6	22.5	15.0	6.8	107.5
14	19.1	12.9	44.2	74.2	215.7	61.3	142.9	88.5	36.1	14.3	6.8	75.5
15	18.4	25.2	51.0	72.1	125.9	61.9	70.1	87.1	38.1	14.3	11.6	21.8
16	17.7	100.0	123.9	70.8	136.8	67.4	38.8	78.9	30.6	15.0	21.1	19.7
17	15.7	68.7	134.8	109.6	128.0	68.1	39.5	186.5	51.7	12.3	21.8	19.7
18	15.0	45.6	93.2	88.5	102.1	73.5	257.9	304.2	42.2	11.6	23.1	18.4
19	15.7	36.1	66.0	78.9	81.7	157.2	137.5	133.4	31.3	10.9	20.4	19.1
20	14.3	26.5	50.4	74.9	103.4	86.4	128.0	266.1	57.9	10.2	19.7	17.7
21	14.3	21.1	44.9	65.3	83.0	74.2	334.9	381.1	47.6	10.2	18.4	18.4
22	14.3	24.5	62.6	79.6	72.8	73.5	152.5	325.3	34.0	10.9	17.0	17.0
23	14.3	26.5	158.6	91.2	68.1	77.6	87.1	215.7	26.5	9.5	16.3	16.3
24	14.3	23.8	243.0	126.6	63.3	74.9	47.6	204.2	25.9	8.2	15.0	16.3
25	14.3	23.1	77.6	81.7	66.0	71.5	40.2	136.1	26.5	7.5	15.0	17.0
26	14.3	22.5	61.9	72.1	68.1	76.2	43.6	164.7	40.2	7.5	14.3	17.0
27	14.3	22.5	64.0	156.5	66.7	68.1	40.8	142.2	57.9	8.2	15.0	15.0
28	15.0	21.8	66.0	317.8	66.0	153.1	139.5	108.2	55.8	8.2	19.1	14.3
29	15.0		66.0	200.8	67.4	155.2	196.7	87.8	42.2	8.8	17.0	14.3
30	15.0		67.4	152.5	66.0	130.7	886.1	53.8	34.0	8.2	18.4	15.0
31	13.6		67.4		68.7		479.8	166.7		8.8		18.4
Average	15.7	24.0	83.5	94.2	96.7	82.9	144.3	181.9	58.0	13.3	13.7	20.5
Maximum	19.1	100.0	243.0	317.8	215.7	164.0	886.1	597.1	273.6	23.1	23.1	107.5
Minimum	13.6	12.3	21.1	34.7	40.8	42.9	38.8	53.8	22.5	7.5	6.8	10.9

Average annual discharge = 69 (m^3/sec)

Annual inflow volume = 2,192 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1964

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.0	53.1	50.4	60.6	70.8	38.8	55.1	108.9	234.8	42.9	19.7	13.6
2	15.7	51.0	49.7	64.0	80.3	40.2	96.0	105.5	149.0	40.8	19.1	13.6
3	15.7	49.0	63.3	232.8	81.0	40.2	190.6	96.0	115.0	40.8	18.4	13.6
4	15.7	46.3	59.9	124.5	78.9	40.8	104.8	89.8	96.0	40.2	17.7	13.6
5	17.0	43.6	53.1	93.2	68.7	40.2	108.2	96.0	95.3	39.5	17.0	13.6
6	53.8	44.2	51.0	84.4	69.4	43.6	84.4	113.0	65.3	38.8	15.7	13.6
7	285.2	46.3	49.0	82.4	64.7	41.5	120.5	116.4	49.7	37.4	15.0	13.6
8	1,028.4	45.6	49.7	79.6	67.4	37.4	121.1	118.4	51.7	36.1	15.0	13.6
9	410.4	46.3	51.0	76.2	66.0	33.3	64.0	155.2	47.6	34.7	15.0	13.6
10	99.4	47.6	54.4	76.2	69.4	32.7	66.0	439.0	181.7	34.0	15.0	47.6
11	107.5	48.3	57.9	85.8	68.7	32.0	72.1	116.4	89.8	33.3	15.0	80.3
12	100.0	47.6	56.5	100.0	55.1	37.4	72.1	152.5	102.8	33.3	15.0	46.3
13	68.1	47.0	60.6	101.4	59.9	37.4	179.0	91.2	110.9	32.0	14.3	25.2
14	56.5	49.0	68.1	96.6	108.9	97.3	179.7	131.4	110.9	31.3	13.6	24.5
15	47.0	47.6	64.0	98.0	59.2	88.5	1,049.5	889.5	98.7	29.9	12.9	24.5
16	41.5	47.6	67.4	183.8	57.9	79.6	371.6	531.5	104.1	29.3	12.9	23.8
17	38.8	54.4	69.4	124.5	51.7	70.8	345.1	439.0	96.6	27.2	12.9	23.1
18	37.4	136.1	96.0	82.4	51.0	55.1	231.4	396.8	72.8	25.9	12.9	23.1
19	36.1	89.8	172.2	65.3	51.0	53.1	126.6	269.5	74.9	25.2	12.9	23.1
20	34.0	82.4	113.7	62.6	49.0	53.1	100.0	334.9	73.5	23.8	12.9	23.1
21	54.4	72.8	96.6	61.3	76.9	52.4	78.3	529.5	68.7	23.8	12.9	23.1
22	115.7	66.0	87.1	62.6	74.9	55.8	61.3	287.2	64.0	23.1	12.9	23.1
23	85.8	66.0	80.3	64.0	59.2	59.2	55.1	202.1	59.2	22.5	12.9	23.1
24	72.1	61.9	85.8	65.3	44.2	59.9	64.7	535.6	55.8	22.5	12.9	23.8
25	67.4	59.2	98.7	80.3	36.8	56.5	1,197.8	334.9	53.1	21.8	12.9	21.8
26	64.7	56.5	84.4	138.2	36.8	53.1	491.4	217.8	65.3	21.8	12.9	19.7
27	64.0	59.2	77.6	113.0	35.4	59.2	333.5	173.6	52.4	21.1	12.9	17.7
28	61.9	52.4	74.2	105.5	34.0	57.9	269.5	146.3	49.0	21.1	12.9	16.3
29	57.2	51.0	79.6	87.1	32.7	59.2	345.1	127.3	45.6	21.1	12.9	14.3
30	55.8		72.1	75.5	32.7	59.2	219.8	133.4	43.6	20.4	13.6	13.6
31	52.4		62.6		36.1		130.7	138.8		20.4		13.6
Average	105.7	57.5	72.8	94.2	59.0	52.2	225.3	245.7	85.9	29.6	14.4	22.5
Maximum	1,028.4	136.1	172.2	232.8	108.9	97.3	1,197.8	889.5	234.8	42.9	19.7	80.3
Minimum	15.7	43.6	49.0	60.6	32.7	32.0	55.1	89.8	43.6	20.4	12.9	13.6

Average annual discharge = 89 (m^3/sec)

Annual inflow volume = 2,821 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1965

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13.6	40.2	80.3	215.7	154.5	109.6	78.3	136.1	57.9	26.5	12.9	11.6
2	13.6	42.2	77.6	123.9	139.5	113.0	119.1	89.8	56.5	25.9	12.9	11.6
3	13.6	96.0	78.9	105.5	128.6	114.3	104.1	83.0	61.9	23.8	12.9	11.6
4	28.6	215.7	78.3	166.1	128.6	114.3	117.7	94.6	55.1	25.9	12.9	11.6
5	18.4	106.9	76.2	136.8	125.9	111.6	89.8	96.6	47.0	23.1	18.4	11.6
6	17.0	46.3	81.0	206.2	130.0	129.3	81.0	117.7	41.5	19.1	25.2	11.6
7	16.3	59.2	78.9	292.7	131.4	119.8	76.9	105.5	40.2	17.7	16.3	10.9
8	16.3	55.1	98.0	231.4	139.5	96.6	79.6	84.4	43.6	17.7	14.3	10.9
9	17.0	48.3	138.2	202.1	136.1	94.6	116.4	111.6	44.2	19.1	13.6	10.9
10	15.0	44.2	85.8	170.1	113.0	95.3	102.1	109.6	41.5	19.7	12.9	10.9
11	14.3	46.3	76.2	159.3	111.6	91.2	81.7	79.6	42.2	18.4	12.9	10.9
12	14.3	47.6	72.1	147.0	102.8	89.8	78.9	72.1	40.2	18.4	12.9	10.2
13	14.3	78.3	76.2	159.3	98.0	96.6	77.6	63.3	38.1	24.5	12.9	10.2
14	13.6	72.1	83.0	142.2	101.4	100.7	73.5	70.1	38.8	35.4	27.9	10.2
15	13.6	59.2	87.1	128.0	110.9	100.0	138.2	64.7	35.4	16.3	24.5	10.2
16	13.6	88.5	89.2	134.8	110.9	92.6	275.6	62.6	34.0	15.0	17.0	10.2
17	13.6	564.2	83.7	133.4	111.6	83.7	148.4	82.4	33.3	15.0	13.6	9.5
18	13.6	273.6	89.8	225.3	114.3	73.5	246.4	68.7	34.0	15.0	12.9	9.5
19	354.6	167.4	170.8	341.0	116.4	74.2	153.8	70.8	47.0	14.3	12.3	9.5
20	108.9	134.8	136.8	206.2	138.2	97.3	219.8	88.5	42.2	13.6	12.9	9.5
21	53.8	113.0	85.8	147.7	172.2	106.2	106.2	69.4	42.9	12.9	12.9	9.5
22	42.9	101.4	76.9	138.8	273.6	106.9	88.5	275.6	61.9	12.9	12.9	8.8
23	40.2	94.6	71.5	170.8	240.9	107.5	217.8	109.6	38.8	12.3	12.9	8.8
24	36.1	89.8	66.0	641.1	170.1	99.4	292.7	248.4	32.7	12.9	12.9	9.5
25	32.0	87.8	68.7	317.8	121.1	99.4	392.7	117.7	35.4	12.9	12.9	10.2
26	30.6	88.5	82.4	229.4	109.6	95.3	520.0	92.6	34.7	12.9	12.3	10.2
27	25.9	85.8	83.7	202.1	115.0	91.9	202.1	74.9	32.0	12.9	12.3	9.5
28	29.9	84.4	70.8	192.6	116.4	97.3	118.4	121.8	29.9	12.9	12.3	8.8
29	29.9		68.7	166.7	110.9	95.3	97.3	99.4	31.3	12.9	11.6	8.8
30	48.3		68.1	155.9	113.0	85.1	102.8	83.7	27.9	12.9	11.6	8.8
31	43.6		135.4		107.5		119.8	65.3		12.9		8.8
Average	37.3	108.3	87.6	199.7	132.1	99.4	152.2	100.3	41.4	17.6	14.6	10.2
Maximum	354.6	564.2	170.8	641.1	273.6	129.3	520.0	275.6	61.9	35.4	27.9	11.6
Minimum	13.6	40.2	66.0	105.5	98.0	73.5	73.5	62.6	27.9	12.3	11.6	8.8

Average annual discharge = 83 (m^3/sec)

Annual inflow volume = 2,621 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1966

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	8.8	8.2	59.9	109.6	100.7	67.4	105.5	691.5	89.8	85.1	27.2	19.1
2	8.8	8.2	53.8	98.7	86.4	56.5	68.7	350.5	63.3	83.0	27.9	18.4
3	8.8	8.2	52.4	102.8	79.6	52.4	78.3	277.7	334.9	85.8	27.9	18.4
4	8.8	8.2	92.6	106.9	88.5	53.1	168.1	246.4	119.8	140.9	28.6	18.4
5	8.8	8.2	111.6	93.9	95.3	61.9	98.0	254.5	105.5	106.9	27.2	18.4
6	8.8	8.2	78.3	85.8	94.6	54.4	69.4	345.1	92.6	113.0	25.9	18.4
7	8.8	8.2	65.3	142.9	101.4	53.1	49.0	662.9	125.9	83.0	26.5	18.4
8	8.2	35.4	67.4	94.6	106.2	65.3	53.8	306.3	1,467.4	78.9	40.2	17.7
9	8.2	47.6	66.7	81.7	106.2	72.8	49.7	221.2	1,902.9	74.9	32.7	17.7
10	8.2	42.2	66.0	76.2	102.1	66.7	47.0	211.7	292.7	198.1	23.8	17.7
11	8.2	38.1	76.9	73.5	211.7	47.6	38.8	206.2	221.2	138.2	23.1	17.7
12	8.2	217.8	80.3	71.5	146.3	43.6	131.4	146.3	174.2	98.7	23.1	17.7
13	8.2	255.9	81.0	85.1	123.2	53.1	157.9	155.9	167.4	86.4	23.1	17.7
14	8.2	127.3	81.0	144.3	98.0	53.8	123.2	138.2	154.5	81.0	23.1	17.0
15	8.2	66.7	83.0	113.7	81.0	53.8	61.9	198.1	147.0	79.6	22.5	17.0
16	8.2	45.6	83.7	109.6	69.4	78.3	82.4	130.0	138.8	77.6	22.5	17.0
17	8.2	33.3	80.3	118.4	71.5	78.3	60.6	119.8	151.8	76.2	22.5	17.0
18	8.2	27.2	179.7	93.9	72.1	95.3	59.2	124.5	140.2	74.2	21.8	17.0
19	8.2	25.2	107.5	78.9	74.2	162.7	55.1	192.6	161.3	72.1	21.1	17.0
20	8.2	23.8	95.3	76.9	76.9	127.3	126.6	248.4	134.8	173.6	21.1	16.3
21	8.2	140.9	76.2	81.0	74.9	96.6	59.2	123.2	128.6	67.4	21.1	16.3
22	8.2	96.6	109.6	98.7	74.9	119.8	178.3	82.4	118.4	51.0	20.4	16.3
23	8.2	42.9	198.1	80.3	77.6	187.8	271.6	74.9	126.6	51.0	19.7	16.3
24	8.2	38.1	155.9	81.7	78.3	273.6	164.0	77.6	109.6	51.7	19.7	16.3
25	8.2	36.8	125.2	72.1	77.6	192.6	583.3	76.9	100.0	53.8	19.7	29.3
26	8.2	184.4	119.8	72.1	88.5	89.2	666.3	61.3	97.3	53.8	19.7	29.9
27	8.2	121.1	292.7	87.8	94.6	70.8	166.7	66.7	96.0	48.3	19.7	25.9
28	8.2	89.2	147.7	129.3	81.7	93.2	200.1	70.8	92.6	40.2	19.7	24.5
29	8.2		114.3	134.8	97.3	113.0	145.0	52.4	88.5	38.8	19.1	22.5
30	8.2		115.0	125.9	137.5	178.3	257.9	57.9	84.4	34.0	19.1	23.8
31	8.2		108.2		100.0		664.3	69.4		27.9		30.6
Average	8.3	64.0	104.0	97.4	95.7	93.7	162.6	194.9	240.9	81.5	23.7	19.5
Maximum	8.8	255.9	292.7	144.3	211.7	273.6	666.3	691.5	1,902.9	198.1	40.2	30.6
Minimum	8.2	8.2	52.4	71.5	69.4	43.6	38.8	52.4	63.3	27.9	19.1	16.3

Average annual discharge = 99 (m^3/sec)

Annual inflow volume = 3,122 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1967

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	28.6	11.6	50.4	208.3	196.7	73.5	87.8	132.7	65.3	35.4	24.5	15.7
2	23.8	10.9	51.0	514.5	177.6	81.0	79.6	125.9	89.8	34.7	23.8	15.7
3	22.5	10.9	50.4	196.7	106.2	79.6	55.8	560.8	82.4	34.0	23.1	385.2
4	21.8	10.9	50.4	126.6	101.4	83.0	85.8	211.7	78.9	60.6	23.1	62.6
5	21.1	10.9	51.0	102.8	86.4	73.5	67.4	329.4	68.1	41.5	22.5	37.4
6	21.1	10.9	50.4	102.8	78.9	68.1	65.3	400.9	63.3	36.1	21.8	31.3
7	18.4	10.9	50.4	93.9	68.1	79.6	70.8	164.0	184.4	34.0	21.1	27.2
8	18.4	11.6	44.9	91.2	72.1	84.4	81.7	227.3	59.9	32.7	21.1	25.2
9	18.4	10.9	44.9	76.9	82.4	76.9	89.8	151.1	53.1	31.3	21.1	23.8
10	17.7	10.9	46.3	77.6	86.4	64.7	96.6	121.8	61.9	32.7	20.4	22.5
11	17.0	10.9	44.9	72.1	85.8	69.4	89.8	114.3	136.8	31.3	20.4	23.1
12	16.3	11.6	96.6	68.1	74.9	70.8	70.8	206.2	132.7	34.7	19.7	25.9
13	15.7	12.3	302.2	67.4	66.0	78.3	156.5	107.5	246.4	31.3	19.1	26.5
14	15.0	11.6	140.9	78.3	61.9	74.9	61.3	654.7	225.3	29.3	18.4	25.2
15	14.3	11.6	106.2	83.0	61.3	74.2	57.9	122.5	93.9	28.6	18.4	25.2
16	13.6	11.6	364.1	87.1	65.3	117.7	71.5	117.7	104.8	27.2	18.4	24.5
17	13.6	20.4	198.1	91.9	67.4	109.6	54.4	94.6	81.7	26.5	19.1	24.5
18	12.9	44.2	157.2	100.7	73.5	57.2	57.2	112.3	65.3	25.9	18.4	23.8
19	12.9	113.0	139.5	97.3	74.2	48.3	57.9	131.4	81.7	29.3	18.4	23.8
20	12.3	408.4	132.7	100.0	82.4	43.6	696.9	202.1	59.2	28.6	18.4	23.1
21	12.3	152.5	127.3	96.6	88.5	42.9	149.0	108.9	52.4	25.9	17.7	22.5
22	12.3	91.9	126.6	96.0	102.8	43.6	124.5	95.3	49.0	25.2	17.7	21.1
23	12.3	61.3	125.9	98.0	106.9	45.6	654.7	88.5	47.0	24.5	19.1	21.1
24	12.3	53.8	123.2	97.3	108.9	46.3	223.2	121.8	46.3	27.9	19.1	62.6
25	12.3	47.6	760.9	100.0	100.0	55.1	198.1	109.6	59.2	68.7	19.1	70.8
26	11.6	47.6	506.4	102.1	90.5	58.5	158.6	102.1	65.3	57.2	18.4	456.7
27	11.6	46.3	155.9	127.3	72.1	51.7	366.2	87.8	53.8	36.1	17.7	358.0
28	11.6	48.3	128.0	387.3	63.3	49.0	140.9	102.1	43.6	29.9	18.4	89.8
29	11.6		119.8	238.9	59.9	53.1	126.6	81.0	39.5	27.2	17.7	72.1
30	11.6		108.9	120.5	60.6	163.3	348.5	81.0	37.4	25.9	16.3	61.9
31	11.6		101.4		66.7		120.5	82.4		25.2		56.5
Average	15.7	47.0	147.0	130.0	86.7	70.6	153.7	172.6	84.3	33.5	19.7	70.5
Maximum	28.6	408.4	760.9	514.5	196.7	163.3	696.9	654.7	246.4	68.7	24.5	456.7
Minimum	11.6	10.9	44.9	67.4	59.9	42.9	54.4	81.0	37.4	24.5	16.3	15.7

Average annual discharge = 86 (m^3/sec)

Annual inflow volume = 2,724 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1968

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	53.1	85.1	97.3	70.8	91.9	54.4	53.8	127.3	70.8	32.0	72.8	17.0
2	50.4	76.2	94.6	67.4	95.3	55.1	56.5	128.6	65.3	29.9	91.2	16.3
3	48.3	72.1	93.9	64.7	77.6	55.1	54.4	98.0	61.3	29.3	43.6	15.7
4	45.6	69.4	92.6	64.7	67.4	77.6	66.0	217.8	59.9	57.2	37.4	15.7
5	41.5	65.3	93.9	70.8	65.3	67.4	61.9	181.0	56.5	49.0	36.1	15.7
6	47.0	105.5	92.6	88.5	60.6	55.1	70.1	450.6	54.4	40.8	34.0	15.7
7	45.6	88.5	91.9	88.5	56.5	55.1	57.9	125.9	53.1	148.4	31.3	15.7
8	39.5	74.9	92.6	85.1	48.3	64.7	65.3	136.1	50.4	57.2	29.3	15.0
9	36.8	68.7	92.6	83.7	41.5	65.3	145.0	185.8	55.1	38.8	27.9	15.0
10	40.2	67.4	90.5	79.6	38.8	73.5	118.4	173.6	49.7	45.6	26.5	15.7
11	44.9	66.7	93.2	74.2	41.5	70.8	91.9	583.3	46.3	38.1	25.9	21.1
12	43.6	66.7	92.6	73.5	45.6	124.5	151.8	238.9	54.4	30.6	29.9	56.5
13	45.6	66.0	89.8	72.1	52.4	69.4	100.7	189.2	47.6	28.6	28.6	27.2
14	42.2	72.1	91.2	148.4	57.9	65.3	164.7	279.0	45.6	55.8	25.2	20.4
15	39.5	68.1	85.8	255.9	50.4	66.0	85.8	213.7	43.6	53.8	25.2	19.1
16	38.8	65.3	84.4	125.9	49.0	66.0	85.8	158.6	46.3	40.2	23.8	17.7
17	38.8	66.0	87.1	105.5	47.0	66.7	68.7	159.9	44.2	34.7	23.1	17.0
18	37.4	66.7	189.9	96.6	48.3	64.7	64.7	267.5	42.9	34.7	22.5	16.3
19	36.8	72.1	285.2	95.3	51.0	66.7	89.8	356.6	42.2	29.9	22.5	15.7
20	248.4	381.1	190.6	94.6	61.3	66.7	90.5	200.1	41.5	27.9	21.1	15.7
21	211.7	120.5	153.1	96.0	81.0	64.7	138.8	138.8	38.1	27.2	21.1	15.0
22	120.5	111.6	119.8	93.9	128.6	63.3	102.8	232.8	36.8	25.9	20.4	15.7
23	85.8	104.1	109.6	114.3	115.0	62.6	134.1	151.1	35.4	25.2	20.4	15.7
24	83.7	99.4	100.7	100.0	68.1	62.6	96.0	125.9	34.0	25.2	19.1	15.7
25	81.7	97.3	93.9	93.2	53.1	92.6	67.4	130.0	34.0	24.5	18.4	17.0
26	83.7	101.4	156.5	89.8	51.7	110.9	56.5	102.8	34.0	23.8	17.7	17.0
27	136.8	206.2	106.9	92.6	55.1	76.9	62.6	88.5	33.3	23.1	17.7	16.3
28	232.8	152.5	88.5	91.9	53.1	86.4	130.0	81.0	36.8	22.5	17.7	15.7
29	149.0	112.3	76.2	91.9	51.7	73.5	809.2	76.2	35.4	21.8	17.7	15.0
30	94.6		70.8	92.6	52.4	60.6	150.4	74.9	33.3	23.1	17.7	15.0
31	90.5		72.1		55.1		114.3	74.2		23.8		14.3
Average	78.5	98.9	108.7	95.4	61.7	70.1	116.3	185.4	46.1	37.7	28.9	17.9
Maximum	248.4	381.1	285.2	255.9	128.6	124.5	809.2	583.3	70.8	148.4	91.2	56.5
Minimum	36.8	65.3	70.8	64.7	38.8	54.4	53.8	74.2	33.3	21.8	17.7	14.3

Average annual discharge = 79 (m^3/sec)

Annual inflow volume = 2,495 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1969

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14.3	173.6	59.9	86.4	106.9	114.3	71.5	68.7	47.0	49.0	21.1	14.3
2	14.3	59.2	60.6	86.4	104.1	102.1	59.2	64.7	43.6	98.7	22.5	14.3
3	14.3	40.8	64.7	82.4	100.0	92.6	59.9	91.9	42.2	44.9	21.8	14.3
4	14.3	35.4	65.3	76.2	95.3	97.3	63.3	165.4	47.0	30.6	23.1	13.6
5	14.3	36.1	67.4	70.8	94.6	81.0	78.3	390.7	39.5	27.9	22.5	13.6
6	14.3	29.9	72.1	65.3	91.2	73.5	64.7	1,072.6	81.7	25.9	22.5	13.6
7	14.3	28.6	72.8	66.7	90.5	66.7	65.3	243.0	59.9	23.8	21.1	13.6
8	14.3	27.2	73.5	75.5	91.9	64.0	87.8	157.9	45.6	22.5	20.4	13.6
9	13.6	27.9	73.5	80.3	97.3	59.9	112.3	213.7	73.5	22.5	20.4	12.9
10	13.6	27.2	71.5	81.0	117.7	57.9	98.7	285.2	43.6	21.8	19.7	12.9
11	13.6	27.2	72.8	79.6	132.0	58.5	76.9	168.8	38.8	88.5	19.7	12.9
12	14.3	25.9	76.2	77.6	204.2	57.9	62.6	162.7	38.8	61.9	19.7	12.9
13	19.1	27.9	79.6	72.1	390.7	61.9	73.5	133.4	39.5	21.8	19.7	12.9
14	19.1	45.6	81.0	75.5	289.3	59.9	179.7	121.8	48.3	32.0	19.1	12.9
15	16.3	34.0	82.4	77.6	155.2	59.2	111.6	157.2	62.6	72.1	17.7	12.3
16	15.7	29.3	79.6	97.3	114.3	59.9	97.3	166.1	51.7	49.0	17.0	12.3
17	15.0	68.7	77.6	76.9	96.0	61.9	72.1	254.5	45.6	32.0	16.3	12.3
18	14.3	59.9	96.0	66.0	91.9	68.1	68.7	217.8	44.2	29.9	16.3	12.3
19	14.3	44.2	304.2	57.2	89.8	76.9	65.3	160.6	38.8	28.6	15.7	12.3
20	14.3	37.4	208.3	232.8	81.0	83.7	117.1	144.3	36.1	27.2	15.7	11.6
21	14.3	34.7	107.5	147.0	77.6	78.3	192.6	119.8	35.4	25.2	15.7	11.6
22	14.3	32.7	100.7	93.9	83.7	72.1	126.6	139.5	32.0	23.8	15.7	11.6
23	14.3	32.0	200.1	76.9	89.8	79.6	92.6	100.0	34.0	23.8	15.7	11.6
24	14.3	32.7	116.4	67.4	88.5	69.4	762.9	84.4	35.4	22.5	15.7	10.9
25	13.6	40.8	191.9	57.9	76.9	63.3	192.6	92.6	29.9	21.8	15.0	10.9
26	42.9	43.6	368.2	53.1	76.2	61.3	178.3	95.3	25.9	22.5	15.0	10.9
27	60.6	171.5	156.5	49.0	71.5	58.5	166.1	66.0	25.9	21.8	14.3	10.2
28	34.7	69.4	113.7	70.8	68.7	89.2	269.5	60.6	25.9	36.1	14.3	10.2
29	27.2		103.4	354.6	72.1	64.0	145.0	55.8	25.2	42.9	14.3	10.2
30	22.5		95.3	148.4	76.2	85.1	98.0	51.7	25.2	31.3	14.3	10.2
31	21.1		93.9		77.6		76.2	50.4		21.8		10.9
Average	18.6	48.0	112.5	93.4	112.7	72.6	128.6	172.8	42.1	35.6	18.1	12.3
Maximum	60.6	173.6	368.2	354.6	390.7	114.3	762.9	1,072.6	81.7	98.7	23.1	14.3
Minimum	13.6	25.9	59.9	49.0	68.7	57.9	59.2	50.4	25.2	21.8	14.3	10.2

Average annual discharge = 73 (m^3/sec)

Annual inflow volume = 2,291 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1970

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	10.9	15.7	55.8	35.4	41.5	27.2	108.2	44.9	911.3	44.9	21.1	12.3
2	10.9	15.0	32.7	34.7	43.6	28.6	250.5	57.9	182.4	43.6	21.1	12.3
3	10.9	14.3	27.2	36.1	36.1	29.3	141.6	40.8	110.9	40.8	19.7	12.3
4	10.9	13.6	25.9	40.2	34.7	123.9	153.8	72.1	515.9	38.1	19.7	12.3
5	10.9	13.6	25.2	46.3	36.8	74.9	83.0	129.3	172.9	36.8	19.1	12.3
6	10.9	13.6	23.1	53.1	40.8	39.5	83.0	53.1	146.3	51.0	19.1	12.3
7	10.9	12.9	21.1	53.8	52.4	29.9	75.5	44.2	221.2	45.6	19.1	12.3
8	10.2	12.9	20.4	49.0	34.7	23.8	74.9	47.0	371.6	37.4	18.4	12.3
9	10.2	12.9	21.1	51.0	29.3	21.1	72.8	83.0	181.0	36.8	17.7	12.3
10	10.2	12.9	21.8	55.1	29.9	21.1	183.8	300.1	153.8	36.8	17.0	11.6
11	10.9	12.9	34.0	59.9	31.3	21.8	72.1	80.3	279.0	31.3	16.3	11.6
12	11.6	12.3	29.9	56.5	34.0	42.9	49.7	81.7	213.7	29.3	16.3	11.6
13	11.6	12.3	58.5	51.0	38.1	198.1	76.9	415.8	175.6	28.6	16.3	11.6
14	11.6	12.3	95.3	50.4	40.2	63.3	59.2	174.9	174.9	27.9	16.3	11.6
15	11.6	12.9	119.8	49.0	32.0	116.4	40.8	174.2	118.4	27.2	15.0	11.6
16	11.6	12.9	132.7	73.5	34.7	63.3	57.9	137.5	115.0	25.9	15.0	11.6
17	10.9	12.9	74.9	48.3	38.1	35.4	73.5	158.6	113.0	25.9	15.0	11.6
18	11.6	12.3	65.3	40.8	40.8	32.0	78.9	358.0	117.1	25.2	14.3	11.6
19	10.9	12.3	56.5	43.6	36.8	27.2	42.2	159.9	169.5	24.5	13.6	11.6
20	10.9	12.9	46.3	40.2	38.1	25.2	54.4	130.7	177.0	24.5	13.6	11.6
21	10.9	14.3	47.6	40.8	40.8	25.2	49.7	624.1	111.6	24.5	12.9	12.3
22	10.9	15.7	49.0	53.8	36.8	27.2	50.4	175.6	105.5	84.4	12.9	11.6
23	10.9	17.7	50.4	56.5	68.1	34.7	36.1	217.8	81.0	76.9	12.9	11.6
24	10.9	16.3	51.7	59.9	42.2	27.2	34.0	211.7	56.5	51.0	12.9	11.6
25	128.0	17.0	55.8	64.0	32.7	27.2	28.6	281.1	43.6	47.0	12.9	11.6
26	62.6	23.8	52.4	68.1	28.6	40.2	26.5	481.9	47.0	40.8	12.9	11.6
27	25.2	19.7	82.4	53.1	21.8	38.1	96.6	221.2	46.3	33.3	12.9	11.6
28	19.1	232.8	84.4	53.1	21.1	120.5	77.6	163.3	42.9	28.6	12.9	11.6
29	16.3		61.9	42.2	25.2	100.0	49.7	281.1	42.9	23.8	12.9	10.9
30	16.3		46.3	37.4	24.5	66.0	62.6	171.5	44.2	23.1	12.9	10.9
31	16.3		39.5		30.6		53.8	710.5		21.8		10.9
Average	17.7	22.2	51.9	49.9	36.0	51.7	77.4	202.7	174.7	36.7	15.8	11.7
Maximum	128.0	232.8	132.7	73.5	68.1	198.1	250.5	710.5	911.3	84.4	21.1	12.3
Minimum	10.2	12.3	20.4	34.7	21.1	21.1	26.5	40.8	42.9	21.8	12.9	10.9

Average annual discharge = 63 (m^3/sec)

Annual inflow volume = 1,973 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1971

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	10.9	8.8	25.2	29.9	40.8	142.9	65.3	537.7	179.0	25.9	23.1	15.0
2	10.9	8.8	21.1	32.7	41.5	97.3	408.4	799.0	137.5	25.2	41.5	15.0
3	10.2	8.8	18.4	33.3	40.2	79.6	174.2	198.1	151.8	25.2	32.7	15.0
4	10.9	8.8	23.1	40.2	41.5	69.4	139.5	141.6	120.5	23.8	25.2	14.3
5	10.9	8.8	24.5	56.5	41.5	61.9	169.5	140.2	100.7	23.8	22.5	15.0
6	10.9	8.8	27.9	45.6	34.7	56.5	108.9	118.4	69.4	23.1	21.1	15.0
7	10.9	8.8	27.2	40.8	34.7	60.6	78.9	520.0	70.1	22.5	20.4	15.0
8	10.9	8.8	27.2	38.8	35.4	64.0	89.8	302.2	56.5	21.8	20.4	14.3
9	10.2	8.8	26.5	36.8	29.3	81.0	76.9	313.8	54.4	21.8	19.1	14.3
10	10.2	9.5	27.2	36.1	32.7	389.3	58.5	185.1	50.4	21.8	19.1	14.3
11	10.2	10.2	29.9	32.0	29.3	158.6	57.2	145.0	55.1	21.1	18.4	14.3
12	9.5	10.9	32.7	25.9	27.2	101.4	70.8	123.2	52.4	21.1	17.7	14.3
13	9.5	9.5	34.7	23.1	25.2	72.8	429.5	104.1	49.7	21.1	17.0	14.3
14	9.5	8.8	34.0	29.9	33.3	219.8	147.0	98.7	43.6	21.1	17.0	14.3
15	8.8	8.8	34.0	24.5	27.2	111.6	85.1	85.8	40.2	20.4	15.7	13.6
16	8.8	8.8	33.3	29.9	32.7	106.9	132.7	75.5	40.2	21.1	15.7	14.3
17	8.8	8.8	33.3	37.4	27.2	64.0	194.6	85.1	39.5	21.1	15.7	14.3
18	8.8	8.8	34.7	32.0	29.3	63.3	108.2	68.1	35.4	20.4	15.7	13.6
19	8.8	10.2	35.4	28.6	32.0	55.1	95.3	65.3	35.4	20.4	15.7	13.6
20	8.8	10.2	34.0	27.2	42.2	53.8	83.0	99.4	34.0	20.4	15.7	13.6
21	8.8	9.5	32.7	174.2	83.0	106.9	52.4	87.1	32.7	19.7	15.7	13.6
22	8.8	9.5	28.6	67.4	83.7	333.5	67.4	70.8	32.0	19.7	15.7	14.3
23	8.8	8.8	27.2	59.2	57.9	325.3	50.4	63.3	31.3	19.7	15.7	14.3
24	8.8	8.8	25.9	49.0	59.2	174.2	47.0	63.3	29.9	19.1	15.0	13.6
25	9.5	8.8	27.2	47.0	67.4	170.8	66.0	115.7	28.6	18.4	15.7	13.6
26	9.5	10.9	27.9	47.0	62.6	150.4	190.6	652.7	27.9	17.7	15.7	13.6
27	10.2	285.2	29.3	49.0	73.5	115.7	91.2	186.5	27.9	17.7	15.7	13.6
28	10.2	42.9	29.9	57.9	88.5	162.7	66.0	125.2	27.9	17.0	15.0	13.6
29	9.5		27.9	76.2	70.8	87.8	606.4	100.7	27.2	17.0	15.0	13.6
30	9.5		25.2	51.0	59.2	66.0	202.1	292.7	26.5	17.0	15.0	13.6
31	8.8		26.5		84.4		123.2	151.8		17.0		13.6
Average	9.7	20.3	28.8	45.3	47.4	126.8	139.9	197.3	56.9	20.7	18.8	14.1
Maximum	10.9	285.2	35.4	174.2	88.5	389.3	606.4	799.0	179.0	25.9	41.5	15.0
Minimum	8.8	8.8	18.4	23.1	25.2	53.8	47.0	63.3	26.5	17.0	15.0	13.6

Average annual discharge = 61 (m^3/sec)

Annual inflow volume = 1,918 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1972

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13.6	321.9	35.4	66.7	51.0	70.1	66.0	49.0	102.1	40.2	32.7	19.3
2	13.6	137.5	40.2	64.0	43.6	66.7	45.6	45.6	75.5	36.1	30.6	18.4
3	12.9	52.4	45.6	58.5	40.2	55.8	163.3	40.8	65.3	34.7	29.3	17.0
4	13.6	36.1	49.0	55.8	39.5	51.0	96.6	33.3	77.6	32.7	28.6	16.3
5	12.9	29.3	66.0	111.6	40.8	44.2	110.9	177.6	57.2	31.3	27.9	15.7
6	12.9	27.2	47.0	73.5	46.3	37.4	102.1	1,297.9	57.2	32.7	27.2	15.7
7	12.9	24.5	40.8	60.6	57.2	32.0	107.5	27.2	83.7	34.7	26.5	15.0
8	12.9	21.1	211.7	53.1	51.7	32.7	57.2	132.0	101.4	37.4	26.5	15.0
9	12.9	18.4	151.8	64.7	58.5	28.6	949.4	183.8	204.2	29.9	26.5	15.7
10	12.9	17.0	80.3	51.0	57.9	26.5	281.1	80.3	331.4	29.9	26.5	87.1
11	12.9	17.0	64.7	44.2	61.3	29.3	379.8	66.0	83.0	29.3	25.9	59.2
12	12.9	219.8	60.6	50.4	62.6	36.1	238.9	65.3	61.9	28.6	25.2	25.2
13	12.9	114.3	189.9	53.8	67.4	36.1	132.7	76.2	53.1	25.9	24.5	21.1
14	12.9	52.4	91.9	57.9	71.5	40.8	79.6	111.6	55.8	25.2	23.1	20.4
15	12.9	39.5	75.5	58.5	66.0	43.6	74.9	70.8	45.6	23.8	22.5	21.8
16	12.9	36.1	70.1	99.4	63.3	44.2	59.2	78.3	83.0	24.5	21.8	19.7
17	12.9	34.7	75.5	163.3	64.0	47.6	91.9	140.9	119.1	24.5	21.1	21.1
18	12.9	33.3	68.7	126.6	72.1	48.3	64.7	78.3	50.4	43.6	20.4	28.6
19	12.9	34.0	74.2	106.2	70.1	42.2	77.6	192.6	168.1	108.9	19.7	25.2
20	12.9	38.8	151.1	85.1	74.9	32.7	64.0	182.4	120.5	51.0	19.7	36.8
21	15.0	42.9	113.0	64.7	74.2	32.7	50.4	103.4	73.5	37.4	18.4	25.9
22	93.2	40.8	83.0	55.8	66.7	40.2	43.6	66.7	53.1	155.2	19.7	21.8
23	30.6	38.8	81.0	51.7	145.0	45.6	38.8	59.2	47.6	75.5	21.8	20.4
24	17.0	42.9	86.4	54.4	192.6	42.2	54.4	65.3	47.0	55.8	23.1	21.8
25	15.0	41.5	96.6	55.1	77.6	48.3	48.3	81.7	43.6	44.2	23.8	25.2
26	14.3	40.8	111.6	53.1	57.9	74.2	55.8	54.4	40.8	36.8	25.9	29.9
27	13.6	38.8	180.4	53.8	51.7	51.0	40.8	50.4	40.2	32.0	25.2	66.7
28	13.6	41.5	128.6	95.3	53.1	148.4	38.1	74.9	38.8	27.9	21.8	68.1
29	13.6	34.7	121.8	102.1	53.8	71.5	42.9	180.4	38.8	25.9	21.1	51.0
30	13.6		125.9	68.7	55.8	65.3	98.0	136.8	45.6	25.2	20.4	38.8
31	72.8		81.7		69.4		66.0	126.6		23.8		32.7
Average	18.5	57.5	93.5	72.0	66.4	48.8	123.2	133.2	82.2	40.8	24.3	29.6
Maximum	93.2	321.9	211.7	163.3	192.6	148.4	949.4	1,297.9	331.4	155.2	32.7	87.1
Minimum	12.9	17.0	35.4	44.2	39.5	26.5	38.1	27.2	38.8	23.8	18.4	15.0

Average annual discharge = 66 (m^3/sec)

Annual inflow volume = 2,086 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1973

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	31.3	42.9	109.6	168.1	103.4	50.4	64.0	57.9	315.8	87.1	22.5	14.3
2	28.6	40.8	136.1	127.3	106.2	44.2	91.9	76.2	183.1	55.8	21.8	13.6
3	26.5	41.5	102.8	139.5	89.2	45.6	96.6	255.9	153.8	45.6	21.1	13.6
4	25.2	39.5	88.5	138.2	83.7	49.7	64.0	166.7	112.3	44.2	20.4	13.6
5	23.1	39.5	78.9	119.1	85.8	56.5	252.5	111.6	96.6	40.2	20.4	13.6
6	36.1	40.8	73.5	130.7	85.1	64.0	91.9	313.8	83.0	36.8	19.7	13.6
7	39.5	40.8	71.5	103.4	75.5	66.7	62.6	191.2	97.3	34.0	19.7	13.6
8	32.7	40.8	164.7	92.6	91.9	70.1	86.4	531.5	74.2	32.7	19.7	13.6
9	27.2	40.8	311.7	87.8	84.4	70.1	69.4	2,369.1	64.0	32.0	19.7	12.9
10	25.2	44.2	1,125.0	87.1	74.2	73.5	38.8	579.9	58.5	31.3	19.7	12.9
11	23.1	53.8	427.4	115.0	49.7	65.3	40.2	310.3	66.0	32.0	19.1	12.9
12	42.9	54.4	254.5	138.2	32.0	94.6	221.2	289.3	103.4	32.7	19.1	13.6
13	78.9	56.5	187.2	106.9	29.9	107.5	629.5	419.9	69.4	32.0	18.4	13.6
14	40.8	57.9	173.6	98.7	29.3	91.2	74.2	390.7	78.9	32.0	18.4	13.6
15	34.7	57.2	155.9	100.0	42.9	66.7	240.9	311.7	82.4	31.3	18.4	12.9
16	32.7	53.8	155.2	65.3	47.6	69.4	132.7	252.5	66.7	42.2	17.7	21.1
17	32.7	53.8	149.7	59.2	133.4	75.5	47.0	208.3	76.9	45.6	17.7	53.1
18	35.4	49.7	129.3	72.8	76.9	80.3	52.4	194.6	136.1	38.8	17.0	25.9
19	264.1	46.3	101.4	90.5	55.1	75.5	159.9	257.9	88.5	36.1	17.0	20.4
20	641.1	46.3	121.1	104.8	42.9	89.8	159.3	196.7	257.9	35.4	17.0	16.3
21	169.5	47.0	113.0	113.0	42.9	113.0	167.4	362.1	107.5	34.7	16.3	15.0
22	91.9	44.2	93.9	85.8	46.3	89.2	60.6	266.1	74.9	34.0	16.3	14.3
23	135.4	45.6	105.5	108.2	51.0	66.0	41.5	187.8	49.0	32.7	15.7	14.3
24	62.6	187.2	132.7	110.3	53.8	91.9	151.8	159.9	67.4	32.0	15.7	14.3
25	54.4	633.6	157.9	108.2	57.2	127.3	114.3	98.0	184.4	30.6	15.7	14.3
26	52.4	512.5	157.2	117.1	57.2	196.7	217.8	113.0	74.2	29.3	15.0	14.3
27	51.7	191.9	159.9	117.7	66.7	87.8	306.3	343.0	54.4	28.6	15.0	14.3
28	49.0	135.4	151.8	93.2	69.4	64.0	125.9	77.6	50.4	26.5	15.0	14.3
29	44.2		136.8	99.4	59.2	68.1	85.1	63.3	45.6	25.2	14.3	14.3
30	44.9		138.8	100.0	60.6	57.9	97.3	54.4	63.3	23.8	14.3	14.3
31	45.6		157.9		56.5		88.5	417.9		23.1		14.3
Average	75.0	97.8	181.4	106.6	65.8	78.9	133.3	310.6	101.2	36.1	17.9	16.0
Maximum	641.1	633.6	1,125.0	168.1	133.4	196.7	629.5	2,369.1	315.8	87.1	22.5	53.1
Minimum	23.1	39.5	71.5	59.2	29.3	44.2	38.8	54.4	45.6	23.1	14.3	12.9

Average annual discharge = 102 (m^3/sec)

Annual inflow volume = 3,218 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1974

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14.3	17.0	44.9	64.7	42.2	32.7	53.8	74.2	55.1	45.6	10.9	8.8
2	14.3	28.6	54.4	57.2	42.2	28.6	53.8	89.8	51.7	28.6	10.9	8.8
3	13.6	234.8	61.9	62.6	40.2	38.1	85.8	287.2	34.7	24.5	10.9	13.6
4	12.9	70.8	64.7	64.0	42.9	32.7	87.1	206.2	38.8	23.1	10.9	14.3
5	12.9	50.4	63.3	52.4	41.5	34.7	57.2	147.0	28.6	23.1	10.9	12.9
6	12.3	45.6	51.7	50.4	40.8	102.8	51.0	113.7	30.6	22.5	10.9	10.9
7	11.6	40.8	51.0	48.3	40.2	45.6	49.0	80.3	29.9	21.8	10.9	10.9
8	11.6	35.4	58.5	46.3	43.6	31.3	50.4	58.5	51.7	20.4	10.2	10.2
9	10.9	33.3	64.7	83.0	46.3	38.8	61.9	50.4	32.0	18.4	10.9	10.2
10	10.9	29.9	57.2	55.1	42.2	32.7	202.1	44.2	31.3	18.4	10.2	10.2
11	10.9	29.3	55.8	48.3	40.2	40.8	112.3	57.9	29.9	17.7	10.2	9.5
12	10.9	28.6	50.4	48.3	28.6	32.7	79.6	93.9	26.5	17.0	10.2	9.5
13	11.6	27.9	44.9	51.0	25.9	23.1	106.9	96.0	25.9	17.0	10.2	9.5
14	18.4	27.2	42.9	54.4	24.5	25.2	73.5	137.5	23.1	16.3	10.2	9.5
15	17.0	31.3	41.5	57.2	25.9	26.5	166.7	120.5	23.1	16.3	10.2	12.3
16	16.3	36.8	44.2	53.1	36.1	26.5	117.1	66.7	25.9	15.7	10.2	23.1
17	15.0	42.2	45.6	47.6	45.6	26.5	136.1	48.3	22.5	15.7	9.5	18.4
18	14.3	44.9	39.5	50.4	35.4	26.5	80.3	42.9	22.5	15.7	9.5	11.6
19	13.6	37.4	45.6	53.1	34.7	39.5	84.4	40.2	22.5	15.0	9.5	12.9
20	162.0	37.4	66.0	49.0	38.1	99.4	238.9	48.3	23.1	15.0	9.5	12.3
21	85.1	37.4	70.1	53.1	36.1	89.2	85.1	42.9	25.9	14.3	9.5	11.6
22	38.8	81.0	80.3	47.6	32.0	46.3	168.8	47.0	22.5	13.6	9.5	10.9
23	30.6	123.2	105.5	38.1	22.5	202.1	91.2	39.5	21.8	13.6	9.5	10.9
24	29.3	54.4	211.7	42.9	20.4	662.9	223.2	38.1	21.1	12.9	9.5	10.2
25	28.6	42.9	173.6	49.0	19.1	246.4	165.4	54.4	31.3	12.3	8.8	10.2
26	21.1	45.6	96.0	52.4	24.5	134.1	209.6	36.8	41.5	11.6	8.8	10.2
27	18.4	44.2	71.5	49.0	48.3	83.7	104.1	40.8	23.8	11.6	8.8	10.2
28	17.7	43.6	76.9	44.9	44.2	67.4	68.7	34.7	34.0	11.6	8.8	10.2
29	17.7		65.3	42.9	39.5	61.9	66.7	32.0	27.9	10.9	8.8	10.2
30	17.0		71.5	40.8	36.1	55.1	62.6	38.1	45.6	10.9	8.8	10.2
31	17.0		66.7		35.4		130.7	38.1		10.9		10.2
Average	23.8	50.1	69.0	51.9	36.0	81.1	107.2	75.7	30.8	17.5	9.9	11.4
Maximum	162.0	234.8	211.7	83.0	48.3	662.9	238.9	287.2	55.1	45.6	10.9	23.1
Minimum	10.9	17.0	39.5	38.1	19.1	23.1	49.0	32.0	21.1	10.9	8.8	8.8

Average annual discharge = 47 (m^3/sec)

Annual inflow volume = 1,484 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1975

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	10.2	40.8	73.5	98.7	64.7	66.0	59.2	73.5	229.4	66.0	24.5	16.3
2	10.2	23.8	57.9	103.4	61.9	62.6	64.7	252.5	321.9	65.3	23.8	15.7
3	9.5	18.4	54.4	123.9	64.7	67.4	51.7	181.7	217.8	47.6	23.8	15.0
4	9.5	17.0	125.2	114.3	92.6	61.3	63.3	188.5	161.3	49.0	23.8	15.0
5	9.5	15.7	105.5	101.4	92.6	59.9	66.7	398.8	206.2	47.6	23.8	14.3
6	9.5	18.4	66.7	94.6	68.1	58.5	56.5	204.2	132.0	47.6	23.1	14.3
7	9.5	17.0	57.2	91.2	61.9	60.6	64.0	181.7	243.0	45.6	22.5	14.3
8	9.5	36.1	53.8	87.8	61.3	76.2	66.0	141.6	129.3	44.2	22.5	14.3
9	9.5	50.4	51.7	73.5	46.3	72.1	61.3	125.9	140.2	42.9	23.1	14.3
10	8.8	34.7	82.4	64.7	68.1	64.0	61.3	93.9	145.0	40.8	22.5	13.6
11	9.5	27.2	200.1	66.0	64.7	53.1	57.9	111.6	543.1	39.5	20.4	13.6
12	9.5	26.5	88.5	64.7	66.7	53.8	97.3	610.5	232.8	38.8	18.4	13.6
13	9.5	248.4	70.8	64.0	72.1	55.1	77.6	204.2	185.8	38.1	19.7	13.6
14	9.5	104.1	72.1	55.8	72.8	64.7	117.1	128.0	167.4	37.4	18.4	13.6
15	9.5	59.2	74.2	49.7	67.4	64.7	473.7	110.9	202.1	36.1	17.7	13.6
16	8.8	46.3	69.4	50.4	94.6	64.7	957.6	150.4	98.0	34.7	18.4	12.9
17	8.8	42.9	70.1	64.0	204.2	70.1	252.5	159.3	211.7	34.0	18.4	12.9
18	8.8	41.5	70.1	68.7	106.9	66.0	123.2	500.9	153.8	33.3	18.4	12.9
19	8.8	40.2	70.8	73.5	72.1	70.8	171.5	598.9	171.5	32.7	19.1	12.9
20	8.2	40.8	69.4	65.3	70.8	91.2	134.8	1,367.3	164.0	32.7	19.1	12.9
21	8.2	38.8	66.0	64.7	70.8	72.1	269.5	364.1	164.7	30.6	19.1	12.9
22	10.2	36.1	98.0	78.3	61.3	59.2	123.9	535.6	168.1	29.3	19.7	12.9
23	13.6	38.8	334.9	143.6	57.2	60.6	104.1	579.9	93.2	29.3	19.1	12.9
24	10.9	37.4	159.3	87.8	61.3	57.2	136.8	264.1	77.6	28.6	19.1	12.9
25	10.9	42.2	110.9	99.4	61.9	49.7	120.5	192.6	65.3	27.2	19.1	12.9
26	10.9	47.6	98.0	200.1	65.3	51.7	107.5	134.8	60.6	26.5	18.4	12.9
27	10.9	49.0	93.9	209.6	62.6	55.8	97.3	117.7	47.6	27.2	18.4	12.9
28	10.9	84.4	93.2	98.7	66.7	119.1	121.8	1,376.8	48.3	27.2	18.4	12.9
29	10.9		93.9	73.5	80.3	110.9	175.6	422.0	53.8	25.9	18.4	12.9
30	19.7		94.6	66.7	77.6	57.2	91.2	300.1	53.8	25.9	17.7	12.9
31	56.5		94.6		62.6		77.6	254.5		25.2		12.9
Average	11.6	47.3	94.2	89.9	74.3	66.5	145.3	333.1	163.0	37.3	20.3	13.6
Maximum	56.5	248.4	334.9	209.6	204.2	119.1	957.6	1,376.8	543.1	66.0	24.5	16.3
Minimum	8.2	15.7	51.7	49.7	46.3	49.7	51.7	73.5	47.6	25.2	17.7	12.9

Average annual discharge = 92 (m^3/sec)

Annual inflow volume = 2,895 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1976

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	12.3	64.0	119.1	95.3	100.0	96.0	70.1	2,522.9	174.2	123.2	26.5	17.7
2	11.6	53.8	134.1	93.9	101.4	96.0	89.8	2,638.6	285.2	64.7	25.9	18.4
3	11.6	40.2	130.0	92.6	101.4	96.0	102.1	593.5	406.3	54.4	25.2	23.1
4	11.6	36.1	133.4	77.6	100.0	91.9	81.0	503.0	325.3	49.7	24.5	21.1
5	11.6	32.7	132.0	172.9	91.2	93.2	61.9	674.5	219.8	48.3	23.8	19.7
6	11.6	30.6	111.6	143.6	87.8	95.3	72.1	674.5	159.9	43.6	23.8	19.7
7	10.9	29.3	101.4	106.9	93.9	80.3	75.5	1,500.7	142.2	61.9	23.8	19.1
8	10.9	29.3	93.9	109.6	98.0	83.7	85.1	547.2	174.2	55.1	23.1	18.4
9	10.9	29.3	166.7	132.7	91.2	83.7	132.7	373.6	118.4	45.6	23.1	18.4
10	10.9	29.3	110.9	174.2	103.4	108.2	377.7	287.2	108.2	41.5	22.5	17.7
11	10.9	29.9	85.8	157.2	111.6	91.2	179.0	223.2	104.1	38.8	22.5	17.7
12	10.9	40.8	76.9	124.5	106.9	112.3	171.5	257.9	102.1	37.4	22.5	17.0
13	17.0	68.7	92.6	112.3	119.1	165.4	204.2	171.5	112.3	36.8	21.8	17.0
14	125.9	100.0	88.5	110.9	108.9	132.0	248.4	334.9	93.9	35.4	21.1	16.3
15	29.9	708.5	102.8	113.0	97.3	182.4	281.1	200.1	85.8	34.7	21.1	16.3
16	19.7	227.3	354.6	114.3	102.8	140.9	647.2	244.3	81.0	34.7	20.4	16.3
17	17.7	157.9	358.0	135.4	159.9	174.2	215.7	179.0	80.3	33.3	19.7	15.7
18	16.3	296.7	232.8	130.7	125.9	141.6	984.1	196.7	97.3	32.0	20.4	15.7
19	15.0	267.5	191.2	129.3	134.1	117.7	334.9	227.3	69.4	31.3	20.4	15.7
20	14.3	179.0	246.4	151.1	107.5	78.3	354.6	234.8	64.7	29.3	19.7	15.7
21	13.6	140.2	200.1	162.7	93.9	91.2	325.3	165.4	61.9	28.6	19.7	15.7
22	13.6	115.7	164.0	161.3	89.8	96.6	229.4	134.1	59.2	27.2	19.1	15.0
23	13.6	102.1	140.9	151.8	86.4	87.1	254.5	117.7	56.5	25.9	19.1	15.0
24	14.3	91.2	123.2	185.8	123.9	66.7	333.5	123.2	55.1	25.2	19.1	15.0
25	15.7	232.8	117.1	176.3	118.4	64.0	211.7	144.3	53.1	51.7	19.7	15.0
26	21.1	225.3	119.1	150.4	96.0	64.7	503.0	114.3	51.0	35.4	19.1	15.7
27	364.1	150.4	153.1	144.3	82.4	64.7	289.3	200.1	50.4	30.6	18.4	16.3
28	127.3	128.6	162.7	153.8	84.4	68.7	159.9	127.3	49.7	29.9	19.1	15.7
29	53.1	119.1	126.6	138.2	85.1	70.8	150.4	118.4	49.0	29.9	18.4	15.0
30	41.5		108.9	113.0	87.8	72.8	146.3	114.3	123.2	28.6	17.7	15.0
31	37.4		108.9		97.3		121.8	74.2		27.9		15.0
Average	35.7	129.5	148.0	133.8	102.8	100.3	241.7	452.2	120.5	41.1	21.4	16.9
Maximum	364.1	708.5	358.0	185.8	159.9	182.4	984.1	2,638.6	406.3	123.2	26.5	23.1
Minimum	10.9	29.3	76.9	77.6	82.4	64.0	61.9	74.2	49.0	25.2	17.7	15.0

Average annual discharge = 129 (m^3/sec)

Annual inflow volume = 4,080 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1977

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.3	50.4	34.0	42.2	62.6	64.7	85.1	70.8	103.4	51.0	31.3	43.6
2	16.3	53.1	32.7	40.8	64.7	64.7	192.6	225.3	101.4	53.1	28.6	27.9
3	15.7	49.7	32.7	40.2	246.4	62.6	254.5	179.0	155.9	59.2	181.0	25.9
4	15.0	44.2	34.0	42.2	145.6	64.0	138.2	1,034.5	77.6	45.6	69.4	25.2
5	15.0	42.9	34.0	57.2	87.8	60.6	135.4	433.5	137.5	45.6	39.5	25.2
6	15.0	38.8	40.2	111.6	69.4	49.0	916.8	254.5	206.2	53.8	33.3	24.5
7	14.3	36.1	43.6	77.6	59.2	45.6	142.2	191.9	72.1	42.9	29.9	23.8
8	14.3	34.0	50.4	53.8	53.8	42.2	158.6	200.1	198.1	40.8	28.6	23.8
9	15.0	35.4	49.7	48.3	108.2	42.9	112.3	147.7	64.7	38.8	28.6	22.5
10	23.8	40.8	49.7	68.1	117.1	46.3	98.7	139.5	106.9	63.3	28.6	23.1
11	80.3	42.2	45.6	54.4	108.9	42.2	404.3	147.7	97.3	37.4	27.2	24.5
12	19.7	40.8	41.5	66.7	66.7	49.0	172.9	190.6	72.1	35.4	27.9	40.8
13	15.0	40.2	42.2	58.5	78.3	60.6	243.0	135.4	98.0	34.0	27.9	26.5
14	13.6	40.8	57.9	61.3	79.6	85.8	491.4	142.2	75.5	33.3	28.6	25.9
15	13.6	40.2	42.2	56.5	70.8	57.9	909.3	103.4	69.4	33.3	27.2	24.5
16	14.3	39.5	48.3	48.3	58.5	45.6	760.9	269.5	61.3	85.1	27.2	23.8
17	14.3	39.5	38.8	54.4	55.1	48.3	408.4	125.9	74.2	48.3	25.9	23.1
18	15.0	40.8	35.4	66.0	57.2	51.0	204.2	152.5	221.2	36.1	25.9	22.5
19	16.3	42.2	33.3	192.6	60.6	45.6	194.6	211.7	134.8	33.3	25.2	23.8
20	17.0	41.5	29.9	143.6	67.4	49.0	200.1	173.6	76.9	32.7	25.9	24.5
21	16.3	38.1	29.9	80.3	62.6	53.8	238.9	136.1	74.9	33.3	25.9	25.2
22	16.3	25.2	36.1	66.7	62.6	58.5	329.4	145.6	76.2	32.7	24.5	25.2
23	18.4	32.7	41.5	67.4	60.6	68.7	250.5	151.8	75.5	32.7	26.5	23.8
24	174.2	32.0	44.2	68.7	55.1	179.0	368.2	152.5	69.4	29.3	25.9	25.2
25	334.9	29.9	47.6	61.9	100.7	89.2	343.0	127.3	62.6	394.7	25.2	217.8
26	162.7	29.9	45.6	59.9	67.4	306.3	250.5	93.9	56.5	121.8	27.2	294.7
27	111.6	36.1	48.3	56.5	70.1	116.4	198.1	72.1	55.8	59.9	27.2	113.0
28	71.5	37.4	42.9	77.6	74.9	106.2	138.8	100.7	54.4	47.0	23.8	57.2
29	54.4		42.9	72.1	75.5	257.9	87.8	82.4	58.5	38.8	21.8	36.8
30	48.3		44.2	72.8	96.6	107.5	120.5	198.1	94.6	36.8	53.8	23.1
31	51.0		44.2		72.8		71.5	130.7		33.3		21.1
Average	46.4	39.1	41.4	68.9	81.2	80.7	278.1	191.0	96.1	56.9	35.0	44.8
Maximum	334.9	53.1	57.9	192.6	246.4	306.3	916.8	1,034.5	221.2	394.7	181.0	294.7
Minimum	13.6	25.2	29.9	40.2	53.8	42.2	71.5	70.8	54.4	29.3	21.8	21.1

Average annual discharge = 89 (m^3/sec)

Annual inflow volume = 2,804 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1978

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	39.5	68.7	149.7	114.3	115.7	74.9	121.1	283.1	113.0	81.0	32.0	32.7
2	38.8	62.6	120.5	113.7	115.7	83.7	115.7	273.6	104.8	73.5	30.6	32.7
3	38.1	57.2	102.8	114.3	120.5	95.3	279.0	843.9	110.3	69.4	29.3	32.0
4	36.8	53.1	130.7	116.4	127.3	91.9	152.5	196.7	102.1	63.3	49.0	31.3
5	34.7	49.7	208.3	112.3	124.5	103.4	260.0	170.8	88.5	59.2	42.9	30.6
6	34.7	62.6	159.9	110.9	125.9	100.0	1,059.7	154.5	92.6	55.1	135.4	33.3
7	34.0	76.2	121.1	117.7	126.6	96.6	577.8	110.3	95.3	51.7	128.0	31.3
8	33.3	55.8	106.9	127.3	109.6	96.6	252.5	144.3	88.5	51.0	83.0	32.0
9	30.6	45.6	100.7	133.4	115.7	94.6	170.8	1,118.9	91.9	50.4	89.8	33.3
10	29.3	49.7	154.5	141.6	115.0	79.6	198.1	645.2	106.9	49.7	59.9	34.7
11	27.2	49.0	200.1	140.9	114.3	76.9	128.0	554.7	103.4	49.0	53.1	35.4
12	27.2	52.4	153.1	153.8	102.8	66.7	115.0	431.5	109.6	49.0	47.6	36.1
13	34.0	59.2	124.5	155.2	95.3	96.6	234.8	529.5	89.2	48.3	91.2	36.8
14	73.5	61.9	120.5	166.7	92.6	105.5	221.2	308.3	158.6	47.0	100.0	36.8
15	42.9	74.9	115.0	168.1	95.3	76.2	159.9	238.9	130.0	45.6	53.1	34.7
16	34.7	74.2	552.6	162.0	107.5	74.2	168.1	390.7	109.6	41.5	38.1	32.0
17	33.3	73.5	2,234.4	189.9	109.6	69.4	213.7	260.0	109.6	38.1	35.4	28.6
18	32.0	74.9	479.8	311.7	113.0	68.7	191.9	252.5	91.2	36.1	34.0	25.9
19	32.0	68.1	315.8	155.9	98.0	68.1	271.6	491.4	98.0	34.0	29.9	23.1
20	32.0	65.3	248.4	124.5	102.8	66.7	208.3	296.7	85.8	34.0	30.6	21.1
21	33.3	62.6	215.7	114.3	91.9	92.6	558.8	262.0	79.6	35.4	30.6	18.4
22	32.7	63.3	189.9	108.2	94.6	104.1	364.1	350.5	89.2	35.4	38.8	16.3
23	38.1	66.0	173.6	127.3	95.3	95.3	408.4	176.3	154.5	36.1	37.4	13.6
24	37.4	64.7	166.7	125.9	113.7	91.9	381.1	164.0	115.0	35.4	32.7	10.9
25	35.4	75.5	156.5	116.4	183.8	85.1	375.7	145.6	78.9	36.8	32.0	8.2
26	35.4	82.4	145.6	115.0	136.1	82.4	352.5	136.1	68.1	35.4	32.0	7.5
27	37.4	73.5	142.2	112.3	125.2	124.5	373.6	130.7	168.1	34.7	32.7	7.5
28	170.1	78.3	155.9	116.4	98.7	101.4	292.7	166.1	137.5	36.1	32.7	7.5
29	179.0		142.9	119.1	98.0	169.5	250.5	134.1	101.4	37.4	32.0	7.5
30	94.6		133.4	115.7	101.4	760.9	726.2	121.8	89.8	36.1	32.7	7.5
31	77.6		121.1		82.4		346.4	128.6		34.0		7.5
Average	48.1	64.3	246.5	136.7	111.2	113.1	307.4	310.0	105.4	45.8	50.9	24.1
Maximum	179.0	82.4	2,234.4	311.7	183.8	760.9	1,059.7	1,118.9	168.1	81.0	135.4	36.8
Minimum	27.2	45.6	100.7	108.2	82.4	66.7	115.0	110.3	68.1	34.0	29.3	7.5

Average annual discharge = 131 (m^3/sec)

Annual inflow volume = 4,136 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1979

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	6.1	23.1	43.6	119.1	64.7	40.2	69.4	41.5	68.1	64.0	37.4	32.0
2	6.1	28.6	70.1	101.4	72.8	123.2	61.3	443.1	68.1	57.9	31.3	29.9
3	6.1	23.8	156.5	129.3	69.4	54.4	69.4	49.7	68.7	54.4	31.3	29.9
4	6.1	25.9	300.1	194.6	65.3	45.6	70.1	539.0	79.6	47.6	30.6	31.3
5	6.1	25.9	541.1	145.0	57.9	44.2	80.3	139.5	83.0	44.9	30.6	31.3
6	6.1	23.8	481.9	121.1	53.8	49.7	52.4	108.9	96.6	48.3	27.9	30.6
7	6.1	23.1	308.3	127.3	47.6	48.3	52.4	104.1	88.5	44.9	27.2	29.9
8	6.1	22.5	281.1	135.4	48.3	72.1	45.6	234.8	130.0	44.2	35.4	28.6
9	6.1	23.1	213.7	130.0	66.7	85.8	75.5	211.7	55.1	43.6	64.0	28.6
10	6.1	23.8	192.6	121.8	89.8	72.1	73.5	219.8	53.8	42.9	42.9	28.6
11	6.1	23.1	145.6	118.4	70.8	68.7	51.7	213.7	144.3	42.9	36.1	28.6
12	6.8	21.1	129.3	117.7	47.0	66.7	107.5	200.1	115.7	42.9	31.3	28.6
13	8.2	19.7	130.0	112.3	53.1	248.4	449.9	185.1	55.8	53.8	29.3	28.6
14	21.8	19.1	121.1	98.0	53.1	102.8	153.8	157.9	104.8	56.5	27.9	27.9
15	41.5	17.0	112.3	96.0	60.6	57.9	61.9	192.6	85.8	51.0	28.6	27.9
16	25.9	16.3	103.4	83.7	71.5	40.8	60.6	170.1	81.0	42.9	31.3	29.3
17	17.7	19.1	596.9	84.4	52.4	40.8	53.1	97.3	62.6	40.8	34.7	27.9
18	15.0	15.7	163.3	80.3	40.8	39.5	41.5	79.6	130.0	38.8	32.0	27.9
19	15.7	183.1	134.8	74.9	39.5	59.2	38.1	117.1	162.0	36.1	32.0	27.9
20	16.3	315.8	132.0	83.7	42.9	61.9	115.7	104.8	128.6	35.4	30.6	27.9
21	19.7	65.3	139.5	68.7	61.3	71.5	77.6	62.6	138.8	36.1	29.3	27.2
22	19.7	44.9	142.2	63.3	74.9	86.4	196.7	57.9	81.7	38.1	27.9	26.5
23	18.4	38.8	140.9	59.9	61.3	84.4	66.0	131.4	85.1	37.4	27.9	26.5
24	17.7	38.8	138.2	64.7	52.4	86.4	119.1	179.7	78.9	34.0	33.3	23.8
25	17.7	54.4	139.5	66.7	72.1	86.4	49.0	126.6	151.1	33.3	91.2	21.8
26	18.4	54.4	130.0	66.0	130.7	76.2	33.3	89.8	108.9	32.7	47.6	44.2
27	17.7	53.8	134.8	66.7	106.9	72.1	31.3	72.1	86.4	32.7	39.5	42.9
28	17.0	48.3	143.6	72.1	66.7	68.1	47.6	65.3	78.9	32.7	36.1	28.6
29	19.1		128.6	70.1	50.4	64.0	33.3	83.0	63.3	32.7	32.7	26.5
30	72.8		153.8	68.7	39.5	64.0	31.3	72.8	67.4	31.3	33.3	31.3
31	24.5		164.0		33.3		64.0	66.7		32.0		43.6
Average	16.1	46.2	190.7	98.1	61.8	72.7	81.7	149.0	93.4	42.2	35.7	29.9
Maximum	72.8	315.8	596.9	194.6	130.7	248.4	449.9	539.0	162.0	64.0	91.2	44.2
Minimum	6.1	15.7	43.6	59.9	33.3	39.5	31.3	41.5	53.8	31.3	27.2	21.8

Average annual discharge = 77 (m^3/sec)

Annual inflow volume = 2,420 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1980

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	74.9	33.3	66.0	82.4	74.2	83.0	46.3	97.3	150.4	27.2	30.6	29.9
2	70.1	32.0	58.5	85.1	74.2	81.0	51.7	132.0	32.0	27.2	29.9	28.6
3	44.2	105.5	51.0	93.9	73.5	77.6	66.7	658.8	18.4	27.2	28.6	27.2
4	36.8	76.9	45.6	68.7	72.1	66.0	133.4	248.4	21.1	25.2	27.2	25.9
5	36.1	64.0	381.1	73.5	69.4	58.5	123.9	191.9	38.8	23.8	25.9	25.2
6	38.1	53.8	433.5	81.0	71.5	53.8	97.3	110.3	54.4	25.2	25.9	23.1
7	38.8	49.7	143.6	83.7	75.5	50.4	55.8	121.1	55.1	23.8	24.5	22.5
8	37.4	45.6	138.2	73.5	75.5	50.4	44.2	102.1	50.4	100.0	23.8	22.5
9	36.1	42.2	100.0	77.6	74.9	57.2	55.8	360.0	57.9	57.2	23.1	22.5
10	35.4	38.8	76.9	82.4	70.8	58.5	40.2	44.2	176.3	32.0	23.1	21.8
11	34.7	36.8	70.1	78.9	61.9	69.4	244.3	23.8	60.6	37.4	22.5	21.1
12	34.0	34.0	87.1	64.7	61.9	73.5	89.2	27.2	75.5	29.9	22.5	21.8
13	33.3	36.8	64.0	57.9	60.6	151.1	71.5	39.5	125.2	26.5	21.8	21.8
14	32.7	42.2	55.8	61.9	68.7	142.2	120.5	54.4	81.0	25.2	21.8	21.1
15	31.3	135.4	115.0	57.9	72.8	85.8	125.9	62.6	57.2	23.8	21.1	21.1
16	34.0	102.8	105.5	59.2	72.1	70.8	59.2	51.7	45.6	25.2	21.1	21.1
17	34.0	70.8	83.0	74.2	65.3	61.9	64.0	105.5	39.5	23.8	20.4	19.7
18	31.3	63.3	158.6	83.0	58.5	65.3	50.4	64.0	32.7	27.2	19.7	19.7
19	34.0	57.2	98.7	82.4	61.3	66.7	57.2	49.0	33.3	32.7	19.7	19.7
20	34.7	76.2	80.3	86.4	68.1	70.8	96.0	45.6	38.1	27.9	19.1	19.1
21	35.4	67.4	77.6	87.1	57.9	117.7	74.9	40.2	33.3	27.2	19.1	19.1
22	33.3	73.5	190.6	76.2	52.4	81.7	48.3	35.4	27.2	24.5	19.1	19.1
23	32.7	83.0	114.3	65.3	48.3	73.5	66.0	32.0	25.2	22.5	18.4	19.7
24	32.7	69.4	110.3	66.0	48.3	649.3	47.6	57.2	23.1	21.1	18.4	23.8
25	32.7	57.9	104.8	73.5	51.7	162.0	49.7	56.5	45.6	21.1	17.7	21.8
26	40.8	51.0	122.5	74.2	53.8	168.1	122.5	56.5	29.9	23.1	19.7	27.9
27	53.8	99.4	84.4	70.8	59.9	80.3	183.8	57.2	25.9	22.5	200.1	35.4
28	57.9	157.2	89.2	74.9	74.9	60.6	152.5	47.0	25.9	22.5	62.6	24.5
29	53.1	80.3	85.8	74.2	76.9	47.6	148.4	44.2	23.8	23.1	38.1	21.1
30	45.6		80.3	71.5	68.7	66.0	124.5	47.6	25.2	27.9	31.3	19.7
31	41.5		79.6		77.6		85.8	98.7		36.1		19.1
Average	40.0	66.8	114.6	74.7	66.2	100.0	90.2	102.0	51.0	29.7	30.6	22.8
Maximum	74.9	157.2	433.5	93.9	77.6	649.3	244.3	658.8	176.3	100.0	200.1	35.4
Minimum	31.3	32.0	45.6	57.9	48.3	47.6	40.2	23.8	18.4	21.1	17.7	19.1

Average annual discharge = 66 (m^3/sec)

Annual inflow volume = 2,079 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1981

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.7	61.9	170.1	208.3	84.4	112.3	97.3	187.2	40.8	38.8	18.4	14.3
2	19.7	53.1	113.0	183.1	97.3	83.0	118.4	162.0	40.2	54.4	17.7	14.3
3	21.1	53.1	88.5	240.9	117.1	62.6	57.9	148.4	45.6	37.4	18.4	15.0
4	45.6	79.6	81.7	215.7	103.4	54.4	68.7	155.2	43.6	32.7	18.4	15.0
5	81.0	279.0	81.0	159.3	162.0	47.6	145.0	319.9	42.2	30.6	18.4	15.0
6	55.8	146.3	389.3	127.3	114.3	48.3	110.9	277.7	38.1	27.2	18.4	14.3
7	35.4	108.9	343.0	130.7	85.8	57.9	52.4	315.8	34.0	26.5	18.4	14.3
8	23.8	96.0	198.1	110.3	79.6	76.9	79.6	246.4	33.3	25.9	18.4	14.3
9	25.9	91.2	156.5	122.5	83.0	89.2	264.1	352.5	33.3	25.2	18.4	13.6
10	25.2	88.5	221.2	124.5	69.4	70.8	142.2	206.2	32.0	24.5	17.7	13.6
11	23.8	83.0	169.5	121.1	62.6	60.6	100.7	180.4	31.3	23.8	17.7	13.6
12	23.1	92.6	130.7	138.8	73.5	46.3	89.2	138.8	32.0	23.1	19.7	12.9
13	22.5	112.3	126.6	145.6	77.6	38.1	246.4	151.8	32.0	22.5	21.1	12.3
14	22.5	462.1	181.7	139.5	91.9	36.1	612.5	123.9	33.3	21.8	19.7	12.9
15	22.5	215.7	172.9	155.2	87.8	36.1	97.3	179.0	30.6	21.1	19.1	12.9
16	22.5	151.8	145.0	296.7	72.8	38.1	159.9	128.0	28.6	23.8	18.4	13.6
17	22.5	122.5	132.7	177.6	74.9	33.3	55.8	91.9	29.3	25.2	18.4	14.3
18	21.8	111.6	138.8	132.0	86.4	38.8	266.1	83.7	40.2	23.8	18.4	14.3
19	21.8	121.8	141.6	115.0	95.3	45.6	148.4	74.2	40.2	23.1	18.4	13.6
20	21.1	103.4	325.3	129.3	86.4	42.2	73.5	70.8	34.0	21.8	17.0	13.6
21	21.1	98.7	491.4	246.4	83.7	47.0	48.3	64.7	32.7	21.1	17.0	13.6
22	21.1	93.9	275.6	162.7	62.6	40.8	115.7	77.6	31.3	20.4	16.3	13.6
23	42.9	81.0	204.2	106.2	57.9	39.5	139.5	68.7	31.3	19.7	16.3	13.6
24	180.4	95.3	179.7	107.5	85.1	38.8	633.6	53.8	29.9	19.7	15.7	13.6
25	182.4	151.1	174.9	118.4	93.9	53.1	535.6	46.3	29.9	19.7	15.0	13.6
26	84.4	91.2	151.8	128.6	85.8	37.4	227.3	45.6	29.3	19.1	15.0	12.9
27	57.9	77.6	141.6	107.5	68.7	47.6	166.7	80.3	34.7	18.4	15.0	12.9
28	102.1	121.1	147.0	95.3	68.7	47.6	412.4	48.3	29.9	17.0	14.3	13.6
29	86.4		190.6	84.4	64.0	55.1	308.3	94.6	38.8	19.7	14.3	13.6
30	115.7		845.3	89.8	62.6	109.6	356.6	48.3	57.9	20.4	14.3	13.6
31	87.1		327.4		208.3		260.0	42.2		19.1		13.6
Average	50.3	123.0	214.1	147.3	88.6	54.5	199.7	137.5	35.3	24.8	17.4	13.7
Maximum	182.4	462.1	845.3	296.7	208.3	112.3	633.6	352.5	57.9	54.4	21.1	15.0
Minimum	19.7	53.1	81.0	84.4	57.9	33.3	48.3	42.2	28.6	17.0	14.3	12.3

Average annual discharge = 92 (m^3/sec)

Annual inflow volume = 2,909 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1982

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	12.9	21.1	159.9	192.6	184.4	102.1	248.4	658.8	45.6	25.2	24.5	21.8
2	12.9	19.7	146.3	181.0	219.8	72.1	102.8	298.8	44.9	23.8	23.8	25.9
3	12.9	19.1	83.7	172.9	174.2	61.9	83.7	165.4	42.2	21.1	23.1	28.6
4	14.3	32.0	66.0	170.8	149.7	65.3	61.3	130.0	41.5	19.1	22.5	25.2
5	19.7	25.2	169.5	159.3	153.1	70.1	60.6	583.3	39.5	17.7	22.5	23.8
6	15.7	22.5	143.6	146.3	148.4	83.0	57.9	200.1	38.1	15.7	22.5	23.8
7	14.3	20.4	96.6	136.1	194.6	89.2	74.9	907.2	36.8	14.3	22.5	23.1
8	13.6	21.8	85.1	89.2	155.2	88.5	87.1	264.1	37.4	13.6	22.5	25.2
9	12.9	18.4	71.5	88.5	128.6	83.0	58.5	389.3	36.1	13.6	22.5	54.4
10	12.9	21.1	255.9	98.0	123.2	85.1	53.8	535.6	34.0	15.7	23.1	59.9
11	12.9	47.6	134.1	92.6	240.9	81.7	44.2	319.9	32.7	14.3	23.1	30.6
12	12.9	36.1	106.9	88.5	171.5	81.0	54.4	244.3	32.0	86.4	22.5	27.9
13	12.9	19.7	86.4	89.2	122.5	92.6	93.2	285.2	34.0	37.4	21.8	32.0
14	12.9	21.8	91.2	91.9	101.4	84.4	64.7	196.7	35.4	27.9	21.1	34.0
15	12.9	20.4	93.9	92.6	104.8	143.6	53.8	202.1	32.7	21.1	58.5	29.3
16	12.9	21.1	151.1	279.0	89.2	123.9	63.3	204.2	29.3	22.5	240.9	27.2
17	12.9	24.5	156.5	541.1	84.4	104.1	69.4	128.6	27.9	21.1	51.7	25.2
18	12.3	21.1	116.4	321.9	76.9	85.8	73.5	96.0	26.5	16.3	54.4	23.8
19	12.3	25.9	106.9	209.6	87.1	70.8	157.9	119.8	28.6	21.1	47.6	23.8
20	12.3	149.0	99.4	166.7	69.4	70.1	231.4	88.5	25.9	21.1	39.5	23.1
21	11.6	87.8	99.4	138.8	66.0	84.4	175.6	77.6	46.3	20.4	40.8	22.5
22	19.7	50.4	290.6	134.1	66.7	66.0	97.3	75.5	158.6	23.8	32.0	22.5
23	32.7	40.8	352.5	124.5	189.2	61.9	302.2	73.5	64.0	25.9	27.2	23.8
24	17.0	38.1	612.5	149.7	144.3	54.4	614.6	148.4	47.6	28.6	25.9	25.9
25	15.0	33.3	581.9	136.8	92.6	42.9	113.0	85.1	36.8	23.1	24.5	23.1
26	17.0	29.9	290.6	145.0	95.3	38.8	162.7	75.5	33.3	21.1	23.8	22.5
27	18.4	29.3	225.3	231.4	115.0	85.1	74.9	61.3	29.9	23.8	23.8	21.8
28	20.4	94.6	209.6	402.2	116.4	83.0	131.4	55.8	27.9	119.1	23.1	25.9
29	18.4		192.6	329.4	100.0	59.9	126.6	53.8	27.9	45.6	23.1	42.9
30	18.4		204.2	208.3	122.5	129.3	191.2	61.9	27.2	29.9	22.5	31.3
31	22.5		206.2		116.4		366.2	53.8		25.9		27.9
Average	15.5	36.2	183.4	180.3	129.2	81.5	133.9	220.6	40.0	27.6	35.9	28.3
Maximum	32.7	149.0	612.5	541.1	240.9	143.6	614.6	907.2	158.6	119.1	240.9	59.9
Minimum	11.6	18.4	66.0	88.5	66.0	38.8	44.2	53.8	25.9	13.6	21.1	21.8

Average annual discharge = 93 (m^3/sec)

Annual inflow volume = 2,941 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1983

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.2	61.9	198.1	151.8	191.2	115.0	283.1	196.7	151.1	38.1	29.9	19.7
2	22.5	55.8	515.9	159.9	147.7	123.2	189.9	213.7	797.7	37.4	29.3	19.7
3	21.8	51.0	248.4	140.9	144.3	124.5	234.8	145.0	298.8	38.1	29.9	19.7
4	21.1	44.2	172.9	223.2	153.8	104.1	311.7	283.1	277.7	38.1	29.3	18.4
5	21.1	41.5	140.2	188.5	153.8	89.8	194.6	170.8	196.7	37.4	29.3	18.4
6	21.1	40.2	108.2	143.6	151.8	79.6	184.4	219.8	180.4	37.4	28.6	18.4
7	23.8	38.1	97.3	192.6	161.3	77.6	93.9	327.4	162.7	38.1	27.9	17.7
8	28.6	36.1	93.9	300.1	164.7	107.5	91.2	208.3	147.7	38.1	29.3	17.7
9	25.2	33.3	97.3	198.1	163.3	115.0	77.6	229.4	134.1	38.8	28.6	17.7
10	23.1	32.0	116.4	180.4	179.7	102.8	100.0	176.3	164.7	38.8	25.2	17.0
11	21.8	30.6	211.7	180.4	198.1	138.8	80.3	138.2	105.5	38.1	25.2	17.0
12	21.1	29.9	147.0	289.3	165.4	108.2	64.7	186.5	95.3	34.0	25.2	17.0
13	19.7	29.3	114.3	782.0	141.6	96.0	70.8	142.2	85.1	69.4	24.5	17.0
14	19.1	32.0	98.0	400.9	164.0	83.0	89.2	121.1	77.6	108.9	24.5	17.0
15	19.7	157.2	106.2	652.7	153.1	110.3	64.0	119.1	154.5	49.0	24.5	17.0
16	21.1	74.9	103.4	662.9	128.0	141.6	86.4	96.6	155.9	38.1	24.5	17.0
17	19.7	54.4	91.9	390.7	106.2	121.8	97.3	116.4	91.2	34.7	24.5	17.0
18	18.4	46.3	78.3	333.5	168.8	83.7	81.0	456.7	72.1	32.7	23.8	17.0
19	17.7	42.9	624.1	260.0	177.0	78.9	81.0	234.8	66.0	32.7	23.1	16.3
20	17.0	40.8	415.8	231.4	187.8	71.5	70.1	187.2	55.8	38.1	23.8	16.3
21	17.0	40.8	194.6	211.7	191.2	65.3	71.5	187.2	52.4	44.2	23.8	16.3
22	19.1	37.4	152.5	198.1	168.8	64.7	104.8	163.3	50.4	36.1	23.8	16.3
23	18.4	36.8	115.0	206.2	177.6	78.9	377.7	183.1	49.0	32.7	23.1	17.7
24	17.7	191.9	107.5	191.2	109.6	73.5	168.1	234.8	61.3	33.3	23.1	16.3
25	17.7	106.2	311.7	176.3	98.7	68.7	191.9	460.1	55.1	32.7	23.1	17.0
26	17.7	70.1	422.0	196.7	132.7	77.6	302.2	424.0	46.3	31.3	22.5	17.0
27	128.6	61.9	273.6	238.9	124.5	101.4	427.4	238.9	44.2	31.3	21.1	16.3
28	298.8	56.5	176.3	211.7	116.4	90.5	187.2	177.0	42.2	29.9	21.1	16.3
29	204.2		156.5	190.6	117.1	106.2	121.8	110.3	42.2	29.3	21.1	16.3
30	134.8		144.3	202.1	116.4	115.7	130.7	103.4	38.8	28.6	20.4	16.3
31	78.3		140.2		102.8		130.7	140.2		27.2		16.3
Average	44.5	56.2	192.7	269.5	150.2	97.2	153.5	206.2	131.7	39.1	25.1	17.3
Maximum	298.8	191.9	624.1	782.0	198.1	141.6	427.4	460.1	797.7	108.9	29.9	19.7
Minimum	17.0	29.3	78.3	140.9	98.7	64.7	64.0	96.6	38.8	27.2	20.4	16.3

Average annual discharge = 116 (m^3/sec)

Annual inflow volume = 3,646 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1984

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.3	13.6	28.6	204.2	32.7	45.6	66.0	134.1	383.3	60.6	27.9	23.8
2	16.3	12.9	28.6	221.2	40.2	47.0	66.7	79.6	362.1	59.2	26.5	23.8
3	15.7	13.6	29.3	183.1	46.3	41.5	51.7	62.6	414.1	56.5	25.2	23.1
4	15.7	13.6	29.3	106.2	48.3	53.1	62.6	55.1	300.5	55.1	24.5	22.5
5	15.0	13.6	26.5	102.8	46.3	38.8	64.7	358.2	227.3	53.1	23.8	21.8
6	15.0	13.6	24.5	64.7	51.0	53.1	76.9	123.9	227.3	51.0	23.1	21.1
7	15.7	13.6	24.5	65.3	53.8	46.3	64.7	104.1	269.6	50.4	22.5	21.1
8	15.7	14.3	23.8	53.8	53.8	37.4	117.1	473.8	215.7	49.0	22.5	20.4
9	15.7	13.6	23.8	53.8	56.5	27.2	100.0	290.6	180.4	47.0	23.8	20.4
10	15.7	13.6	23.8	51.0	51.0	40.2	68.7	166.7	162.7	47.0	26.5	19.7
11	15.7	12.9	24.5	46.3	54.4	74.2	78.3	352.5	147.0	45.6	23.8	19.7
12	15.7	12.9	23.1	48.3	56.5	53.1	68.7	236.8	136.8	44.9	23.1	19.1
13	14.3	12.9	25.2	50.4	60.6	42.9	56.5	313.9	111.6	44.2	23.1	41.5
14	14.3	12.3	23.8	60.6	49.0	37.4	44.2	419.9	159.3	42.9	23.1	36.1
15	13.6	12.3	23.8	70.8	50.4	38.8	93.2	236.9	126.6	39.5	23.1	28.6
16	13.6	12.3	26.5	60.6	40.8	35.4	77.6	496.9	101.4	40.8	23.1	25.9
17	13.6	12.3	19.7	59.9	36.8	38.8	83.7	223.2	98.0	40.2	23.1	24.5
18	13.6	28.6	104.8	49.7	38.8	260.0	100.0	172.9	106.9	40.2	23.1	24.5
19	12.9	42.2	72.8	52.4	44.2	149.0	111.6	447.1	98.0	38.8	23.8	23.1
20	12.9	76.2	39.5	51.7	38.8	89.8	129.3	262.0	83.7	38.8	23.8	23.1
21	12.9	36.1	36.1	49.7	33.3	72.8	83.7	236.8	91.2	38.1	23.8	22.5
22	12.3	27.2	36.1	42.9	38.1	59.2	126.6	427.4	104.1	36.8	39.5	22.5
23	12.3	23.8	38.8	38.8	42.9	55.8	79.6	232.8	78.3	36.1	66.0	21.8
24	12.3	23.1	42.2	40.2	40.8	59.2	68.1	356.6	110.3	34.7	40.2	21.8
25	12.3	24.5	85.1	47.0	46.3	91.2	66.0	313.8	79.6	36.1	33.3	21.1
26	12.3	23.8	63.3	47.6	51.7	102.1	54.4	215.7	71.5	36.1	27.2	21.1
27	12.3	23.1	47.6	51.0	41.5	92.6	74.2	287.2	70.1	34.0	26.5	21.1
28	11.6	22.5	47.6	55.1	54.4	91.2	217.6	223.2	68.7	32.7	25.2	21.1
29	12.3	23.1	51.0	52.4	57.9	76.2	135.4	204.2	69.4	32.0	24.5	21.1
30	12.3		51.0	39.5	43.6	75.5	147.0	172.9	63.3	31.3	24.5	21.8
31	12.3		66.7		42.2		104.8	235.0		28.6		36.1
Average	13.9	20.6	39.1	70.7	46.5	67.5	88.4	255.4	157.3	42.6	27.0	23.7
Maximum	16.3	76.2	104.8	221.2	60.6	260.0	217.6	496.9	414.1	60.6	66.0	41.5
Minimum	11.6	12.3	19.7	38.8	32.7	27.2	44.2	55.1	63.3	28.6	22.5	19.1

Average annual discharge = 71 (m^3/sec)

Annual inflow volume = 2,253 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1985

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	47.0	33.3	42.9	39.5	49.0	39.5	47.0	138.2	42.9	34.7	31.3	30.6
2	32.7	32.0	41.5	38.1	130.7	40.8	36.8	138.2	41.5	34.7	31.3	30.6
3	27.2	32.0	43.6	38.1	53.8	44.2	29.3	188.6	40.2	35.4	31.3	30.6
4	26.5	32.7	40.8	47.6	43.6	41.5	27.2	308.2	38.8	34.7	31.3	29.9
5	36.8	61.9	39.5	40.2	39.5	44.2	27.9	281.1	49.7	55.1	31.3	29.9
6	35.4	42.2	42.9	47.0	38.8	44.9	32.7	219.8	41.5	50.4	30.6	29.9
7	29.9	38.8	44.2	78.3	42.2	44.2	112.3	1,022.9	38.8	48.3	29.9	29.9
8	28.6	38.1	36.1	110.9	48.3	68.1	155.2	277.7	41.5	42.2	29.9	49.7
9	27.2	36.8	35.4	128.6	64.7	42.9	57.9	185.1	40.2	107.5	29.9	47.0
10	25.9	35.4	32.7	104.8	104.8	55.8	75.5	166.7	39.5	89.8	30.6	33.3
11	25.2	35.4	32.7	78.3	62.6	96.6	50.4	149.0	40.2	54.4	31.3	31.3
12	25.2	34.7	32.0	64.0	59.2	37.4	92.6	148.4	42.9	47.6	31.3	29.9
13	25.2	35.4	31.3	55.1	52.4	40.2	164.0	110.3	42.9	44.2	31.3	30.6
14	25.2	35.4	29.9	53.8	50.4	41.5	120.5	97.3	44.2	42.2	30.6	29.9
15	25.2	35.4	29.3	48.3	41.5	46.3	119.8	91.9	45.6	42.9	30.6	32.0
16	25.2	35.4	29.3	46.3	38.8	42.2	271.6	82.4	39.5	44.9	30.6	63.3
17	25.2	35.4	27.9	47.0	36.1	40.2	219.8	76.2	45.6	40.8	30.6	63.3
18	24.5	35.4	32.0	52.4	35.4	38.1	132.0	71.5	70.8	40.2	29.9	42.9
19	29.9	35.4	29.9	49.7	34.0	39.5	128.0	65.3	46.3	38.1	29.9	36.8
20	29.9	35.4	27.9	47.6	47.0	40.2	173.6	67.4	38.8	37.4	29.9	34.0
21	45.6	36.1	29.3	50.4	55.8	41.5	93.9	63.3	38.1	36.1	29.9	31.3
22	35.4	34.0	29.3	49.0	51.0	37.4	198.1	59.2	51.7	35.4	30.6	31.3
23	31.3	34.0	32.0	45.6	49.7	42.2	80.3	185.8	49.0	34.7	30.6	30.6
24	29.9	36.1	37.4	40.8	56.5	40.2	125.9	60.6	55.1	34.7	31.3	30.6
25	29.3	38.8	34.0	37.4	80.3	36.1	733.7	64.7	42.2	34.7	31.3	217.8
26	61.3	37.4	37.4	34.0	56.5	38.1	379.8	54.4	38.1	34.0	31.3	603.0
27	64.0	37.4	62.6	35.4	44.2	66.7	229.4	51.7	36.8	33.3	31.3	148.4
28	45.6	38.8	66.0	38.1	44.2	70.8	179.7	46.3	36.1	32.7	31.3	72.1
29	41.5		59.2	37.4	44.2	54.4	191.2	44.2	36.1	32.0	31.3	60.6
30	37.4		47.0	41.5	43.6	48.3	313.8	49.7	36.1	31.3	31.3	55.1
31	35.4		41.5		41.5		277.7	47.0		31.3		49.0
Average	33.4	36.8	38.0	54.2	52.9	46.8	157.3	148.8	43.0	43.1	30.8	66.6
Maximum	64.0	61.9	66.0	128.6	130.7	96.6	733.7	1,022.9	70.8	107.5	31.3	603.0
Minimum	24.5	32.0	27.9	34.0	34.0	36.1	27.2	44.2	36.1	31.3	29.9	29.9

Average annual discharge = 63 (m^3/sec)

Annual inflow volume = 1,989 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1986

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	44.2	25.9	67.4	153.8	125.2	102.8	112.3	560.8	70.8	46.3	37.4	72.1
2	41.5	25.9	66.7	129.3	114.3	83.0	69.4	264.1	67.4	43.6	37.4	72.1
3	38.8	25.9	66.7	125.2	111.6	86.4	65.3	256.2	66.7	41.5	36.8	72.8
4	37.4	25.9	66.0	119.1	102.8	86.4	77.6	1,178.8	64.7	41.5	37.4	74.9
5	36.1	25.2	66.7	128.0	102.8	85.1	79.6	545.2	61.9	44.2	36.8	74.9
6	35.4	25.2	67.4	142.9	109.6	79.6	74.2	323.6	60.6	39.5	36.8	70.8
7	35.4	25.2	68.1	153.1	116.4	76.9	252.5	333.2	57.2	36.8	36.8	68.7
8	35.4	24.5	66.7	157.2	121.1	80.3	108.9	240.9	55.8	37.4	37.4	66.0
9	34.0	25.2	66.0	153.8	208.3	87.1	108.9	240.9	59.9	61.9	37.4	63.3
10	34.0	27.2	67.4	159.3	178.9	93.2	95.3	208.3	75.5	36.1	37.4	60.6
11	33.3	32.7	118.4	168.8	113.7	100.0	94.6	175.6	65.3	51.7	37.4	162.7
12	32.7	35.4	390.7	174.2	125.2	88.5	107.5	153.8	56.5	50.4	38.1	756.8
13	31.3	194.5	515.9	159.9	130.7	107.5	68.7	159.9	66.0	42.9	38.1	360.0
14	29.3	96.3	1,022.9	170.1	130.7	104.8	66.7	132.7	57.9	42.2	38.1	171.5
15	27.2	88.2	413.8	151.1	123.9	91.2	74.2	215.7	51.7	61.3	417.9	124.5
16	25.9	78.3	296.7	133.4	119.8	89.2	155.2	142.2	49.7	54.4	211.7	116.4
17	25.9	76.9	269.5	117.1	109.6	80.3	145.0	114.3	47.6	149.0	85.1	107.5
18	25.2	153.8	377.7	116.4	104.1	87.8	334.9	187.8	46.3	78.3	71.5	104.8
19	27.2	87.1	281.1	118.4	111.6	91.2	225.3	135.4	46.3	59.2	63.3	95.3
20	27.2	76.2	223.2	122.5	123.2	83.0	121.8	104.8	45.6	51.7	59.2	88.5
21	26.5	113.7	213.7	123.2	133.4	92.6	102.8	93.2	44.9	48.3	57.9	85.8
22	27.2	120.5	223.2	125.9	113.7	106.2	155.9	89.2	46.3	46.3	56.5	83.7
23	40.2	91.2	177.0	109.8	91.2	115.0	135.4	85.8	44.9	44.2	55.8	81.0
24	31.3	85.1	151.1	150.0	85.1	124.5	117.7	83.7	56.5	41.5	53.8	79.6
25	29.9	80.3	133.4	321.7	84.4	192.6	113.7	111.6	42.2	40.2	53.1	78.3
26	29.3	76.9	123.9	506.6	84.4	140.2	113.0	111.6	53.1	38.1	130.7	77.6
27	28.6	73.5	152.5	503.0	81.0	135.0	485.3	155.2	47.6	36.8	219.8	74.2
28	27.2	70.1	200.1	231.4	92.6	85.8	308.3	87.1	83.7	37.4	101.4	72.1
29	26.5		166.1	166.1	116.4	106.2	149.7	77.6	85.8	37.4	85.1	69.4
30	26.5		146.3	146.3	100.0	144.3	266.1	77.6	70.8	36.8	76.9	68.1
31	25.9		137.5		110.3		333.2	76.2		37.4		63.3
Average	31.5	67.4	206.6	174.6	115.3	100.9	152.2	216.9	58.3	48.8	77.4	116.7
Maximum	44.2	194.5	1,022.9	506.6	208.3	192.6	485.3	1,178.8	85.8	149.0	417.9	756.8
Minimum	25.2	24.5	66.0	109.8	81.0	76.9	65.3	76.2	42.2	36.1	36.8	60.6

Average annual discharge = 114 (m^3/sec)

Annual inflow volume = 3,607 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1987

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	53.8	40.8	70.1	119.8	103.4	130.7	68.1	64.7	82.4	23.1	28.6	23.1
2	51.7	40.2	67.4	148.4	86.4	130.0	69.4	60.6	44.2	25.2	27.9	23.1
3	51.7	40.2	63.3	174.2	74.9	179.0	66.7	52.4	38.1	33.9	28.6	23.8
4	51.7	38.8	66.0	155.9	68.1	185.1	66.0	138.8	37.4	27.9	27.9	23.8
5	55.1	37.4	69.4	119.1	70.8	138.8	69.4	132.7	47.6	24.7	27.9	23.8
6	53.8	37.4	55.1	110.9	98.0	137.5	82.4	66.7	38.1	23.3	27.9	23.1
7	51.7	37.4	92.6	108.9	77.6	127.3	82.4	76.2	43.6	22.7	27.2	23.1
8	51.0	38.1	113.0	109.6	200.1	137.5	70.8	63.3	39.5	22.7	27.9	23.1
9	50.4	40.2	89.8	229.4	175.6	275.6	69.4	70.1	85.1	22.5	27.9	23.1
10	50.4	38.1	77.6	140.9	264.1	225.3	68.7	65.3	74.9	162.9	27.2	23.1
11	49.7	36.1	70.8	110.3	164.7	138.2	74.9	69.4	55.8	115.6	27.2	23.1
12	49.7	36.1	73.5	101.4	134.1	114.3	74.9	98.0	40.8	142.5	26.5	23.1
13	49.7	36.8	77.6	89.8	120.5	98.0	67.4	105.5	37.4	100.7	25.9	23.1
14	49.0	36.8	70.1	81.0	113.0	98.0	60.6	72.1	36.8	97.3	25.9	22.5
15	48.3	37.4	71.5	81.0	104.8	103.4	59.2	63.3	36.1	68.0	25.2	22.5
16	47.6	37.4	133.4	79.6	102.8	96.0	96.6	59.9	37.4	53.5	25.2	22.5
17	49.7	106.2	102.8	81.0	96.6	83.0	68.1	61.9	33.3	44.5	25.2	22.5
18	48.3	82.4	83.0	89.8	96.0	76.2	74.2	111.6	32.0	93.4	24.5	22.5
19	45.6	89.8	81.0	88.5	101.4	74.9	64.7	59.9	31.3	94.0	24.5	21.8
20	45.6	45.6	80.3	89.8	115.0	79.6	66.7	83.0	31.3	67.0	23.8	21.8
21	44.2	43.6	132.7	98.0	142.0	84.4	61.3	158.6	31.3	54.1	23.8	21.8
22	44.2	45.6	248.4	103.4	188.8	71.5	66.0	111.6	37.4	48.3	23.8	21.8
23	42.9	47.6	275.6	107.5	547.0	69.4	73.5	93.2	34.0	42.8	23.8	21.8
24	42.9	252.5	183.1	105.5	267.7	70.8	91.9	143.6	30.6	41.6	23.8	21.8
25	42.9	209.6	153.1	83.0	170.5	69.4	102.8	81.7	28.6	38.7	23.8	21.1
26	42.9	91.2	296.7	82.4	159.7	68.7	162.7	53.1	27.2	36.6	23.8	21.1
27	42.9	89.2	191.9	82.4	145.6	69.4	83.0	48.3	25.9	35.1	23.1	21.1
28	42.9	76.2	98.0	87.1	143.6	69.4	67.4	59.9	25.2	32.2	23.1	21.1
29	42.9		138.2	97.3	132.0	70.1	61.3	64.7	24.5	31.6	23.1	21.1
30	42.9		123.2	107.5	128.6	68.7	61.3	48.3	23.8	30.6	23.1	21.1
31	42.2		114.3		128.0		78.3	71.5		30.0		21.8
Average	47.7	63.9	115.0	108.8	145.8	111.3	75.2	81.0	39.7	54.4	25.6	22.4
Maximum	55.1	252.5	296.7	229.4	547.0	275.6	162.7	158.6	85.1	162.9	28.6	23.8
Minimum	42.2	36.1	55.1	79.6	68.1	68.7	59.2	48.3	23.8	22.5	23.1	21.1

Average annual discharge = 74 (m^3/sec)

Annual inflow volume = 2,345 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1988

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.8	23.3	56.2	130.9	78.9	55.9	75.9	903.3	70.1	56.8	30.6	28.7
2	21.8	23.1	53.4	118.3	67.2	52.7	74.7	479.6	62.0	53.8	52.0	28.7
3	21.6	22.9	57.2	96.8	54.7	37.2	132.3	398.7	63.4	51.2	30.4	28.5
4	21.6	23.1	60.8	84.7	52.4	34.8	178.2	331.3	61.5	63.6	30.4	28.5
5	21.4	23.3	68.4	75.9	51.0	32.9	122.7	279.3	57.4	53.8	30.4	28.5
6	21.4	23.3	72.0	70.8	53.4	29.7	104.9	248.5	56.2	49.7	30.4	28.3
7	21.2	23.3	135.6	75.9	50.1	29.3	66.6	223.4	55.9	48.7	30.4	27.9
8	21.2	23.1	96.8	79.4	42.2	23.7	41.4	352.5	64.9	47.4	30.6	27.5
9	21.0	29.7	68.9	84.4	39.3	23.7	32.7	396.8	79.6	46.8	30.4	27.2
10	20.8	25.5	59.5	81.7	46.8	26.2	35.8	223.4	61.5	47.4	30.6	26.8
11	20.8	24.3	745.4	77.8	51.6	26.2	77.0	240.8	58.0	47.0	30.4	26.8
12	21.2	24.3	710.7	87.0	54.1	25.8	47.8	182.6	55.9	45.7	30.4	26.6
13	21.4	23.1	211.9	89.8	52.7	26.0	493.1	281.2	54.9	44.7	30.4	26.4
14	22.0	22.9	136.7	94.9	54.7	26.4	475.7	186.6	53.6	44.1	30.2	25.8
15	21.2	23.1	111.7	95.4	46.0	29.3	1,097.9	350.5	78.6	43.6	30.0	25.4
16	21.0	22.3	155.2	94.4	46.6	31.2	2,330.5	192.6	94.6	42.7	29.9	25.0
17	20.6	22.1	146.6	84.7	47.0	31.4	627.9	202.2	64.9	42.7	29.9	24.8
18	20.4	21.6	147.1	94.0	42.4	45.6	379.4	204.2	53.9	42.0	29.9	25.4
19	20.0	21.6	120.6	111.7	38.3	36.2	375.6	188.9	50.1	41.0	29.7	26.8
20	19.8	22.0	113.3	114.6	39.3	39.3	832.1	162.8	49.9	40.1	29.5	30.4
21	20.6	47.0	108.4	81.7	42.4	41.8	456.5	170.8	48.2	63.4	29.5	30.0
22	34.3	38.9	110.7	76.3	44.3	53.0	695.3	152.9	53.9	37.8	29.7	78.2
23	27.0	30.4	115.2	74.7	42.5	48.9	527.7	143.3	46.4	36.8	29.5	143.3
24	23.3	25.2	118.3	67.2	41.4	47.4	485.4	133.7	156.8	36.0	29.5	59.5
25	22.7	28.3	115.6	64.0	41.4	45.8	319.7	206.1	319.7	35.3	29.5	45.1
26	22.3	27.8	279.3	68.9	42.7	49.9	254.3	124.8	125.2	34.6	29.5	40.1
27	22.1	32.0	165.9	70.5	47.0	87.4	300.5	127.1	86.3	33.7	29.5	33.5
28	22.5	206.1	138.5	76.6	45.7	64.3	339.0	106.3	71.5	33.1	29.5	27.9
29	24.8	79.8	144.3	84.0	46.6	333.2	1,111.3	93.2	66.1	32.3	29.5	24.8
30	23.7		154.6	77.8	46.0	100.9	375.6	86.6	64.1	31.8	29.3	23.3
31	23.9		152.9		45.1		893.7	78.9		31.0		23.3
Average	22.2	33.9	159.1	86.2	48.2	51.2	431.0	240.4	76.2	43.8	30.7	34.6
Maximum	34.3	206.1	745.4	130.9	78.9	333.2	2,330.5	903.3	319.7	63.6	52.0	143.3
Minimum	19.8	21.6	53.4	64.0	38.3	23.7	32.7	78.9	46.4	31.0	29.3	23.3

Average annual discharge = 106 (m^3/sec)

Annual inflow volume = 3,341 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1989

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.6	30.6	41.5	402.8	60.0	65.3	78.1	441.3	71.5	36.7	27.4	25.0
2	26.2	27.4	41.7	204.2	88.1	67.1	93.3	324.6	72.0	35.5	27.0	24.0
3	28.4	27.7	40.8	156.7	131.2	71.3	60.6	207.4	68.2	34.5	26.7	23.1
4	25.6	29.0	38.9	132.4	116.3	71.8	55.9	145.1	60.6	34.2	30.8	22.5
5	32.1	33.1	40.8	114.1	81.5	109.0	78.1	169.7	58.9	34.3	73.0	21.9
6	271.5	36.8	41.6	101.5	69.5	77.9	78.8	132.4	60.3	33.9	40.6	21.3
7	105.4	32.2	42.1	100.5	63.0	66.8	59.6	106.9	57.2	33.6	31.8	20.8
8	77.5	30.3	45.7	99.2	63.7	58.3	47.7	100.6	52.1	32.2	29.7	20.1
9	68.5	29.9	49.8	183.0	63.2	61.5	55.9	150.5	50.6	31.0	28.7	20.6
10	58.7	29.5	57.7	190.0	69.1	58.3	39.9	85.1	50.2	29.8	28.3	21.0
11	53.2	29.2	51.2	119.4	70.8	67.3	55.9	95.0	49.5	28.7	28.0	23.7
12	50.3	29.1	51.3	104.9	72.0	64.3	34.6	110.5	63.6	76.3	27.9	24.0
13	48.0	29.5	50.7	95.8	75.7	67.8	86.8	110.2	53.5	118.2	27.4	23.0
14	46.8	29.5	53.6	94.5	80.0	67.4	108.8	93.6	58.3	52.8	26.8	22.8
15	45.8	29.6	69.2	92.6	81.3	58.4	231.6	82.9	52.8	37.2	26.6	22.8
16	44.9	30.3	55.0	85.7	79.6	63.2	117.5	89.8	54.4	33.5	26.6	23.1
17	43.6	32.5	54.3	90.1	79.8	59.2	67.9	87.6	51.3	32.2	26.5	23.3
18	43.6	36.6	79.6	88.5	80.2	53.8	61.4	94.8	50.7	32.0	26.7	23.5
19	42.4	33.8	93.5	86.3	79.6	52.7	61.4	109.3	59.1	31.8	27.1	24.3
20	41.5	31.9	106.5	83.6	81.0	48.2	69.6	240.3	67.4	31.2	26.9	29.9
21	40.8	30.4	85.2	82.8	82.7	47.1	46.5	126.0	64.7	30.8	26.5	46.1
22	40.2	29.3	321.0	75.5	80.9	45.7	36.0	97.7	74.1	30.4	26.2	35.4
23	39.6	27.8	313.8	75.8	71.5	43.6	55.1	116.0	85.9	29.9	26.1	51.7
24	39.1	26.5	165.8	78.5	67.2	46.0	127.0	91.7	76.2	29.7	33.1	49.9
25	37.6	30.6	141.7	110.3	59.4	46.8	108.0	106.6	52.5	29.4	40.0	40.6
26	37.3	32.4	127.0	102.4	53.2	54.9	78.9	79.8	42.5	29.1	31.4	37.7
27	37.2	35.7	153.4	81.4	58.1	59.8	68.7	167.4	40.2	28.5	27.2	34.7
28	37.1	40.8	153.0	69.8	64.9	64.0	66.4	153.0	38.0	28.1	26.6	33.9
29	35.9		140.9	72.4	71.7	59.1	994.3	99.2	38.3	27.9	26.3	34.0
30	34.8		123.7	70.3	66.8	77.9	1,186.5	84.1	37.9	27.8	25.9	34.5
31	34.0		172.7		57.6		1,411.8	75.5		27.6		34.6
Average	51.3	31.1	96.9	114.8	74.8	61.8	184.6	134.7	57.1	36.4	30.1	28.8
Maximum	271.5	40.8	321.0	402.8	131.2	109.0	1,411.8	441.3	85.9	118.2	73.0	51.7
Minimum	22.6	26.5	38.9	69.8	53.2	43.6	34.6	75.5	37.9	27.6	25.9	20.1

Average annual discharge = 76 (m^3/sec)

Annual inflow volume = 2,386 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1990

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	34.3	37.4	97.3	143.2	84.1	73.8	130.1	67.8	112.0	48.3	25.8	16.0
2	33.9	32.9	78.7	135.1	86.1	68.5	77.6	521.2	96.8	40.7	26.9	16.7
3	33.9	28.9	67.9	128.6	85.7	69.1	96.5	96.4	91.2	38.9	25.5	17.2
4	34.4	26.7	62.1	126.7	84.7	68.4	320.8	188.3	117.5	37.0	24.4	17.2
5	35.2	25.5	57.3	129.8	93.9	63.2	109.1	209.8	170.5	34.4	23.5	17.2
6	35.5	26.8	55.0	174.6	81.8	57.1	127.7	187.1	126.8	33.0	22.6	17.2
7	38.0	54.4	51.6	301.7	85.8	51.7	232.5	166.2	99.5	32.3	21.6	17.1
8	36.5	203.7	51.0	213.2	90.7	52.6	98.1	296.1	108.2	31.3	20.8	17.0
9	35.3	151.3	52.5	145.2	97.1	56.2	238.7	754.8	67.0	30.8	20.1	16.9
10	34.4	83.4	77.0	123.1	103.0	50.3	122.8	360.8	68.9	30.2	19.5	17.0
11	33.6	62.8	211.3	107.8	92.8	50.1	78.9	239.1	62.7	29.3	18.9	16.9
12	33.1	53.8	95.8	99.0	105.2	75.1	64.7	180.6	59.3	28.7	18.6	16.9
13	32.3	118.4	72.8	105.1	99.6	88.7	62.8	211.9	82.1	33.1	18.3	16.8
14	32.3	141.5	81.1	111.7	100.3	54.2	55.5	251.6	99.6	29.1	18.2	17.2
15	31.6	76.6	87.6	97.0	114.4	59.0	71.8	159.4	73.4	28.0	18.0	37.2
16	30.6	65.2	98.3	96.4	126.5	47.3	91.4	137.5	72.0	27.2	17.8	96.6
17	30.6	57.2	308.3	117.5	107.5	47.4	103.1	126.4	59.5	34.0	17.6	78.7
18	36.5	48.7	284.6	122.3	112.2	48.5	77.0	116.0	55.9	87.6	17.5	41.0
19	32.7	44.0	289.2	113.3	117.4	54.6	83.2	106.2	124.8	37.2	17.4	29.7
20	29.2	41.6	524.6	99.2	94.1	65.3	148.8	83.2	66.5	30.6	17.2	27.0
21	29.4	40.7	866.4	98.7	83.4	61.5	102.8	76.9	56.6	29.1	17.0	25.5
22	31.6	37.3	1,334.6	89.5	76.7	61.8	78.1	76.4	60.0	28.5	24.0	25.5
23	30.9	35.3	511.8	92.3	81.5	69.4	55.5	95.9	56.1	28.3	19.3	24.8
24	30.8	58.7	313.9	100.7	93.0	97.9	63.6	77.9	65.5	28.4	18.4	29.1
25	28.9	105.2	261.6	107.4	100.4	246.9	53.4	69.8	58.5	28.2	17.8	28.9
26	27.5	155.8	219.7	112.2	100.4	84.7	189.5	68.1	47.1	27.9	17.0	26.3
27	91.5	144.6	195.7	109.2	102.6	71.3	180.6	65.7	45.7	27.7	16.5	27.2
28	81.5	121.0	179.9	99.7	99.4	91.9	85.0	118.8	42.3	27.4	16.0	630.3
29	44.1		181.1	93.9	99.9	69.5	52.5	252.6	50.2	27.3	15.9	1,551.7
30	38.0		206.2	88.5	92.9	104.8	73.6	208.9	48.0	27.0	15.4	360.2
31	35.4		159.1		92.2		80.1	161.6		26.7		176.8
Average	36.9	74.3	230.1	122.7	96.3	72.0	109.9	184.9	78.1	33.2	19.6	111.4
Maximum	91.5	203.7	1,334.6	301.7	126.5	246.9	320.8	754.8	170.5	87.6	26.9	1,551.7
Minimum	27.5	25.5	51.0	88.5	76.7	47.3	52.5	65.7	42.3	26.7	15.4	16.0

Average annual discharge = 98 (m^3/sec)

Annual inflow volume = 3,088 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1991

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	125.2	58.5	87.4	194.6	119.7	48.3	49.7	73.2	156.7	43.7	24.6	16.7
2	109.9	62.8	104.9	277.6	121.7	55.2	49.6	59.7	131.5	42.7	24.1	16.7
3	99.1	69.0	108.2	301.3	111.9	64.7	61.0	56.0	104.9	41.4	23.7	16.7
4	91.7	76.9	502.3	205.7	100.3	61.7	55.9	72.5	98.5	40.9	23.3	16.7
5	85.0	78.3	274.4	191.5	98.1	63.7	52.5	108.6	142.1	39.9	22.9	16.6
6	81.9	86.0	184.8	195.9	98.2	67.6	99.8	64.3	127.8	39.2	22.6	16.6
7	78.7	91.1	161.1	182.9	107.2	66.2	68.6	58.9	65.4	38.5	22.6	16.5
8	76.8	86.3	215.9	325.9	102.0	67.2	64.2	74.5	57.3	37.4	22.6	16.5
9	73.2	93.2	195.9	588.3	86.0	69.5	70.4	62.5	52.0	36.3	22.5	16.4
10	69.4	265.5	143.6	365.9	80.8	89.3	82.8	75.0	50.4	35.6	22.4	16.4
11	65.0	447.2	133.8	228.6	62.0	100.1	122.2	65.3	82.4	33.3	22.3	16.2
12	64.6	470.2	142.1	203.4	51.5	75.2	147.9	51.8	75.7	34.5	22.2	16.2
13	58.0	181.1	148.5	270.8	50.3	75.8	168.5	48.2	73.1	34.0	21.8	16.1
14	51.6	145.0	140.0	810.5	57.1	76.3	308.4	46.0	224.1	31.4	21.3	16.0
15	47.0	166.2	135.1	449.1	63.3	104.3	180.9	44.6	296.8	31.6	20.8	16.0
16	43.4	110.6	134.7	245.1	70.6	102.4	114.8	42.2	312.7	32.5	20.3	15.8
17	40.7	97.4	133.3	200.0	72.5	99.9	80.5	65.7	269.4	32.5	19.8	15.8
18	38.4	89.2	178.0	171.7	75.9	111.1	86.8	63.0	132.6	32.5	19.2	15.7
19	36.5	84.1	256.6	157.1	79.3	143.7	99.0	61.2	106.3	32.5	18.9	16.0
20	34.9	80.5	156.6	144.8	95.9	104.3	177.4	68.3	92.6	32.5	18.1	16.2
21	33.2	76.5	154.8	137.6	127.1	95.1	283.2	66.5	76.4	32.4	17.8	25.0
22	32.4	75.3	173.9	129.2	113.2	73.4	189.6	56.2	84.7	30.8	17.5	72.4
23	30.5	75.9	230.1	141.4	91.2	82.2	125.5	121.6	70.4	32.0	17.2	31.1
24	28.6	82.8	167.0	120.1	83.5	68.6	86.4	69.6	54.3	31.6	17.1	27.5
25	27.1	166.6	140.4	117.3	86.4	67.6	149.8	66.2	50.8	30.2	17.0	26.0
26	39.2	135.3	140.0	115.8	74.6	62.7	76.4	65.1	88.5	27.8	17.0	26.1
27	82.7	118.1	148.2	114.1	57.0	58.4	69.5	68.0	61.3	27.0	16.8	26.4
28	84.2	116.0	158.3	103.3	55.5	56.7	62.7	188.0	52.8	26.5	16.8	27.9
29	85.6		170.6	111.9	52.4	54.0	75.3	272.0	49.4	26.0	16.7	27.9
30	56.4		182.8	111.8	47.7	49.8	103.5	205.5	45.3	25.5	16.7	25.0
31	55.9		189.6		43.2		78.5	181.5		25.1		21.0
Average	62.2	131.6	174.0	230.4	81.8	77.2	111.0	84.6	109.5	33.5	20.2	21.4
Maximum	125.2	470.2	502.3	810.5	127.1	143.7	308.4	272.0	312.7	43.7	24.6	72.4
Minimum	27.1	58.5	87.4	103.3	43.2	48.3	49.6	42.2	45.3	25.1	16.7	15.7

Average annual discharge = 94 (m^3/sec)

Annual inflow volume = 2,974 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1992

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	23.8	149.8	72.8	189.2	172.7	94.4	103.3	99.4	243.5	173.4	131.1	95.2
2	18.7	101.6	59.3	181.9	164.6	103.9	100.1	133.4	344.3	170.5	128.3	95.5
3	18.0	86.9	54.8	178.4	241.9	124.5	107.7	628.9	307.1	166.6	125.6	95.5
4	17.3	76.6	47.1	175.5	197.8	107.3	108.2	213.7	216.9	160.3	122.8	95.4
5	16.9	69.0	42.3	184.9	165.9	98.7	93.3	223.9	208.2	154.4	120.1	94.9
6	17.4	91.7	40.3	287.5	146.4	108.5	88.4	271.7	243.1	155.2	118.2	94.8
7	22.1	159.7	31.1	567.5	146.5	105.0	89.8	148.6	237.2	156.2	115.3	95.0
8	29.6	93.1	37.5	200.3	152.4	105.4	100.5	158.0	206.8	150.3	112.8	95.1
9	23.1	83.6	38.4	191.8	151.3	99.8	102.1	364.8	3,641.5	147.1	110.9	95.1
10	21.3	76.9	38.1	500.4	143.2	99.3	100.3	215.8	4,458.5	144.3	109.1	95.3
11	30.8	72.5	39.7	183.0	143.1	124.1	137.4	168.5	926.1	144.2	106.9	95.6
12	28.8	69.6	43.1	172.4	149.6	114.7	107.5	154.9	590.8	141.4	104.6	98.9
13	25.0	339.0	87.3	172.2	162.8	109.9	99.2	141.7	512.9	140.2	102.8	102.4
14	22.9	163.3	89.1	166.8	164.9	99.8	128.1	177.9	478.3	140.0	101.4	99.5
15	20.9	120.7	57.4	165.5	164.4	104.6	110.6	184.8	448.9	139.7	100.0	98.5
16	23.4	104.9	50.1	165.3	161.3	101.7	104.8	573.5	376.8	139.3	98.6	97.8
17	18.0	96.2	48.0	164.2	159.1	103.1	130.4	552.8	387.4	137.8	97.2	97.8
18	17.1	91.8	55.5	207.9	138.6	93.3	153.6	318.5	327.7	137.0	95.6	98.1
19	17.3	86.5	62.5	157.3	122.3	95.4	123.5	282.1	304.8	271.2	117.3	98.4
20	17.1	78.6	69.7	170.2	113.3	98.8	146.3	251.5	285.3	166.9	202.8	98.7
21	17.0	70.2	79.3	458.6	112.9	112.0	142.6	256.1	271.4	146.1	123.7	99.0
22	16.9	63.9	115.5	272.2	107.5	91.7	145.0	266.5	256.8	141.0	102.4	99.4
23	18.3	60.5	792.7	176.8	120.0	87.7	107.9	190.2	244.4	138.2	99.8	99.2
24	21.1	56.4	435.8	177.4	127.3	92.3	186.1	186.8	232.4	135.9	99.2	98.7
25	28.3	52.7	620.9	182.9	128.9	83.5	239.8	223.6	219.4	134.7	97.0	98.4
26	38.0	51.4	1,023.4	182.8	163.7	82.0	180.8	221.8	209.4	134.2	96.6	98.1
27	106.6	51.5	662.0	182.1	177.2	87.1	102.5	180.0	201.2	133.9	96.9	97.8
28	174.4	51.9	300.8	184.9	140.2	93.0	102.1	172.9	193.0	133.5	96.7	97.5
29	390.6	89.2	344.6	236.1	118.0	119.0	163.9	165.5	184.0	133.2	95.8	97.2
30	898.9		218.8	204.1	111.4	96.1	136.4	241.7	177.2	133.4	95.1	96.7
31	238.0		194.1		102.4		119.9	319.1		133.7		124.5
Average	76.7	95.2	188.8	221.3	147.5	101.2	124.6	248.0	564.5	149.5	110.8	98.2
Maximum	898.9	339.0	1,023.4	567.5	241.9	124.5	239.8	628.9	4,458.5	271.2	202.8	124.5
Minimum	16.9	51.4	31.1	157.3	102.4	82.0	88.4	99.4	177.2	133.2	95.1	94.8

Average annual discharge = 177 (m^3/sec)

Annual inflow volume = 5,592 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1993

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	166.3	55.4	77.9	105.8	136.5	136.6	133.0	132.7	164.1	31.5	20.8	18.9
2	124.3	54.8	71.0	102.4	146.9	94.2	112.6	103.2	117.7	30.9	20.5	18.9
3	124.9	53.4	69.4	98.1	134.5	128.8	83.0	161.6	142.9	30.3	20.1	18.8
4	120.3	53.5	66.4	97.4	125.3	102.9	86.0	122.1	87.3	29.7	19.7	18.5
5	96.1	50.4	66.9	102.2	126.1	91.9	150.8	98.3	68.4	29.1	18.6	18.3
6	120.1	49.5	67.7	109.8	125.7	93.0	114.6	108.5	80.9	28.1	140.5	18.1
7	125.1	52.7	66.6	116.9	128.4	94.6	114.9	139.4	82.9	26.9	91.7	17.9
8	125.1	59.8	65.9	115.1	123.1	98.9	245.0	81.9	121.1	26.2	32.5	17.8
9	117.4	57.1	68.1	116.7	132.7	101.0	289.3	77.7	121.6	25.7	60.4	17.5
10	96.2	53.8	72.7	129.4	155.9	98.0	550.3	108.3	97.0	25.4	26.6	17.3
11	95.8	51.0	201.3	140.6	133.1	105.0	394.4	95.1	131.4	25.3	22.5	17.4
12	93.4	50.7	399.5	151.0	103.2	108.1	284.4	98.3	80.0	25.4	22.2	17.4
13	94.1	48.8	248.1	146.2	93.4	108.9	161.6	80.2	99.4	25.5	22.0	17.3
14	88.3	44.7	169.4	151.1	92.6	114.1	127.9	74.5	55.6	25.6	20.6	17.4
15	83.2	43.7	145.1	158.6	92.9	117.0	175.7	132.0	46.9	25.7	19.8	17.4
16	103.0	48.6	122.1	125.2	119.0	121.9	214.7	83.0	42.3	25.2	20.2	17.4
17	181.2	97.7	109.6	126.5	104.4	134.9	107.3	91.6	40.6	24.5	20.6	17.4
18	119.3	73.2	107.9	128.4	98.2	133.5	200.2	73.4	39.5	23.9	21.0	17.3
19	99.3	61.7	96.6	128.7	84.1	130.4	122.9	61.7	37.5	23.3	30.7	17.2
20	87.7	61.0	89.0	128.6	77.8	95.0	95.9	131.1	35.6	22.7	23.6	17.1
21	83.0	50.8	88.1	129.9	76.2	93.4	99.9	74.5	35.1	22.0	21.5	17.3
22	77.7	47.3	84.1	132.3	88.7	104.1	211.1	50.3	36.0	21.4	20.9	17.4
23	75.1	46.2	320.1	131.3	98.4	132.5	429.9	45.3	70.7	20.7	20.5	17.5
24	71.7	44.3	1,178.1	132.2	95.6	327.2	421.6	58.7	75.0	20.1	20.3	17.6
25	69.8	98.3	334.9	135.9	99.6	238.5	750.0	56.4	41.3	19.5	20.0	17.7
26	67.9	172.9	164.0	143.4	102.2	155.8	298.0	50.7	38.2	19.9	19.7	17.7
27	65.1	106.2	117.3	135.3	100.9	121.4	209.8	59.7	36.6	20.3	19.6	17.7
28	63.8	91.5	138.1	145.0	97.9	96.8	177.1	49.5	35.0	20.7	19.4	17.7
29	62.4		131.6	140.5	115.6	86.2	150.3	43.7	34.6	21.1	19.2	17.7
30	61.0		125.3	144.1	113.7	78.3	164.7	42.4	33.0	21.6	19.0	17.7
31	59.1		117.1		96.0		146.4	109.9		21.2		17.7
Average	97.4	63.5	167.1	128.3	110.3	121.4	220.1	87.0	70.9	24.5	29.2	17.7
Maximum	181.2	172.9	1,178.1	158.6	155.9	327.2	750.0	161.6	164.1	31.5	140.5	18.9
Minimum	59.1	43.7	65.9	97.4	76.2	78.3	83.0	42.4	33.0	19.5	18.6	17.1

Average annual discharge = 95 (m^3/sec)

Annual inflow volume = 3,000 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1994

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.6	23.0	44.1	80.7	91.1	77.3	355.1	218.0	309.9	53.1	34.5	27.5
2	17.5	20.9	42.6	54.8	115.2	66.7	116.9	187.8	296.6	31.7	32.6	28.5
3	17.4	18.5	43.0	48.3	100.8	60.0	555.5	161.9	143.3	32.1	32.2	29.5
4	17.3	17.2	56.9	176.1	90.7	54.8	224.8	258.6	193.5	54.9	31.8	34.6
5	17.2	16.4	53.1	642.6	82.6	49.2	117.6	216.7	248.9	57.2	31.6	40.1
6	17.1	24.7	51.9	672.9	84.6	47.1	96.6	225.7	224.3	60.2	31.3	80.1
7	17.1	30.5	52.7	231.8	85.6	50.0	595.1	807.9	174.1	56.6	31.0	102.0
8	17.0	24.8	55.0	134.7	138.3	62.9	190.7	269.0	139.2	52.7	31.0	384.5
9	16.8	27.4	55.8	122.5	188.7	69.5	163.1	185.9	137.3	50.5	30.6	136.8
10	16.7	24.8	55.9	106.9	108.2	111.1	449.1	416.1	139.6	48.4	30.2	80.7
11	17.3	24.2	53.2	95.5	135.8	91.3	235.5	198.9	160.2	46.3	29.9	55.9
12	18.6	23.3	50.5	87.1	94.6	113.7	161.1	172.7	143.6	44.2	29.5	52.4
13	31.7	22.1	43.5	83.9	83.9	111.7	141.6	148.6	145.8	42.2	29.1	49.0
14	29.6	22.5	50.0	71.1	96.5	74.6	258.2	434.9	139.9	40.4	28.7	45.9
15	29.7	23.1	67.3	95.9	130.0	64.2	164.7	208.5	136.4	38.3	28.3	47.4
16	28.8	23.9	48.0	72.3	89.8	56.5	112.3	215.4	125.6	36.1	27.8	42.6
17	28.4	24.7	37.1	70.1	80.9	60.6	141.0	819.4	119.8	35.1	27.5	39.8
18	28.1	25.5	35.1	68.2	79.5	62.3	464.1	343.8	114.4	34.5	26.7	40.9
19	27.5	26.6	39.4	68.8	83.3	64.7	125.0	243.5	106.2	33.9	25.8	41.5
20	27.9	30.2	125.7	63.7	85.7	82.1	879.1	232.3	96.9	33.2	25.4	42.1
21	24.9	361.2	69.9	55.3	82.4	83.2	240.7	316.5	82.4	32.4	25.0	43.0
22	22.4	118.9	55.6	58.0	83.3	77.5	788.2	401.2	70.2	31.7	24.6	46.7
23	19.3	73.6	48.1	59.1	98.1	98.8	464.8	387.7	62.2	31.0	24.2	54.7
24	17.6	64.6	45.3	55.2	84.6	93.5	829.0	239.5	53.9	29.5	23.9	66.7
25	16.9	62.1	50.2	46.3	84.2	156.3	167.1	218.8	53.8	47.0	23.0	72.5
26	19.0	56.7	55.7	54.7	81.7	278.6	144.4	434.4	53.8	101.8	23.2	63.0
27	66.4	49.3	56.3	60.5	84.7	116.8	150.8	247.1	52.9	81.7	22.8	104.0
28	52.7	44.9	55.8	62.4	84.1	104.1	578.2	218.1	52.3	68.7	23.6	219.5
29	33.9		51.2	84.6	85.8	89.8	258.4	200.5	52.3	57.7	25.8	116.3
30	29.3		51.5	99.1	84.0	188.2	742.3	195.6	52.8	50.3	26.6	71.0
31	25.8		100.2		77.8		313.9	191.2		42.6		65.4
Average	24.8	46.6	54.9	122.8	96.0	90.6	329.8	290.9	129.4	47.0	27.9	75.0
Maximum	66.4	361.2	125.7	672.9	188.7	278.6	879.1	819.4	309.9	101.8	34.5	384.5
Minimum	16.7	16.4	35.1	46.3	77.8	47.1	96.6	148.6	52.3	29.5	22.8	27.5

Average annual discharge = 112 (m^3/sec)

Annual inflow volume = 3,533 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1995

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	58.5	43.7	99.4	149.6	111.1	74.0	80.4	480.2	164.4	41.6	23.7	30.9
2	61.4	43.7	98.1	130.5	102.1	75.5	63.4	489.5	133.6	41.2	23.5	27.1
3	58.1	44.1	94.9	122.7	99.6	74.3	76.9	390.3	115.9	46.5	23.3	25.5
4	55.6	45.0	95.8	108.3	93.9	75.5	77.8	466.7	93.7	44.2	22.6	24.7
5	54.9	44.9	99.3	102.0	98.3	78.3	86.6	381.3	83.5	35.7	21.8	23.5
6	54.0	44.5	98.7	97.1	92.2	82.1	96.4	323.9	80.5	34.8	21.6	22.2
7	52.0	44.3	98.1	99.2	98.3	92.2	87.2	280.3	80.4	34.2	21.5	20.7
8	50.6	44.1	91.7	96.7	99.2	89.2	126.3	226.2	81.0	33.6	21.4	21.9
9	48.8	44.0	84.5	123.9	102.8	88.5	137.2	192.0	103.9	33.3	21.2	30.6
10	53.3	44.3	83.3	174.0	108.6	90.7	104.3	222.8	86.0	33.1	21.1	30.5
11	51.9	180.8	82.3	129.4	110.4	81.4	110.3	161.8	83.6	30.1	21.0	25.7
12	48.9	289.9	77.7	167.1	111.3	83.3	86.0	148.4	82.7	22.8	20.9	24.9
13	44.0	94.2	70.7	140.3	110.6	82.6	80.3	168.0	77.2	22.6	20.8	25.2
14	44.5	123.1	74.8	138.2	109.9	81.9	86.7	203.4	67.1	22.7	20.7	25.3
15	47.4	167.4	70.9	161.3	107.9	81.3	95.6	185.3	65.7	28.7	20.3	24.9
16	48.5	111.1	70.8	199.7	99.5	87.3	112.2	160.8	61.2	45.3	20.1	24.9
17	46.6	98.3	70.8	165.7	91.3	92.6	143.1	168.3	49.5	34.4	19.7	24.9
18	44.3	123.4	70.9	153.9	99.2	97.0	135.6	151.5	48.3	36.4	19.4	24.3
19	45.0	92.0	80.0	154.0	90.9	136.6	305.8	147.9	45.7	29.1	19.2	24.0
20	47.2	92.2	89.6	145.1	82.2	140.3	300.0	385.0	44.7	28.7	19.0	23.6
21	47.5	89.3	103.0	146.9	79.6	187.1	225.5	286.4	43.8	28.4	19.0	23.1
22	45.1	74.8	106.7	149.9	86.5	140.0	319.3	244.4	43.4	28.1	18.8	22.6
23	45.2	66.2	148.5	155.4	87.5	104.8	440.5	166.9	42.9	27.8	18.5	22.2
24	45.7	65.0	161.8	168.3	78.6	91.1	398.1	203.5	60.5	27.5	18.2	21.9
25	44.6	66.6	136.7	160.5	74.3	72.3	728.9	135.0	48.3	27.1	19.1	21.5
26	43.8	66.6	274.2	161.8	75.5	69.8	1,048.8	127.0	42.5	26.7	20.0	21.2
27	43.3	144.2	166.1	162.4	74.3	65.2	1,191.7	165.5	42.6	26.0	21.0	20.8
28	43.4	124.4	296.3	144.6	74.5	72.7	1,643.6	151.8	42.5	25.3	24.8	21.2
29	42.6		308.7	134.4	75.3	71.2	822.8	168.8	42.5	24.7	47.1	20.1
30	42.9		208.6	120.4	73.0	77.4	535.6	180.7	42.0	24.2	36.5	19.7
31	43.8		173.3		72.7		466.9	261.9		23.8		18.4
Average	48.5	89.7	122.1	142.1	92.6	91.2	329.5	239.5	70.0	31.3	22.2	23.8
Maximum	61.4	289.9	308.7	199.7	111.3	187.1	1,643.6	489.5	164.4	46.5	47.1	30.9
Minimum	42.6	43.7	70.7	96.7	72.7	65.2	63.4	127.0	42.0	22.6	18.2	18.4

Average annual discharge = 109 (m^3/sec)

Annual inflow volume = 3,437 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1996

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.9	31.3	114.4	219.0	144.9	109.7	246.2	155.3	108.6	62.3	27.3	19.1
2	18.5	31.1	83.6	184.1	121.4	102.0	161.6	129.1	110.6	63.2	26.6	18.6
3	18.2	41.4	90.5	157.4	107.0	89.6	130.6	195.7	126.4	187.4	25.8	18.1
4	18.0	48.7	68.7	131.9	104.2	88.8	231.0	177.0	106.5	207.0	25.3	21.5
5	17.8	44.2	73.5	138.2	101.1	86.1	192.2	189.6	109.2	92.1	24.6	22.1
6	17.7	40.7	87.6	148.9	97.7	80.6	163.5	267.6	111.1	43.4	24.4	19.6
7	17.5	42.6	117.8	174.0	87.9	85.6	116.9	178.5	114.9	41.1	24.9	18.2
8	17.2	46.8	129.2	236.5	90.4	91.9	103.6	172.2	93.4	45.9	25.5	18.1
9	16.6	87.9	106.1	138.0	88.4	107.3	102.0	164.3	92.0	51.9	26.3	17.9
10	16.0	87.7	103.7	126.6	86.7	91.0	104.0	168.3	88.9	49.7	27.0	17.9
11	24.4	50.5	109.3	124.4	83.4	91.0	121.6	175.9	77.9	47.4	27.7	17.6
12	33.9	54.9	204.8	123.2	83.6	94.5	123.1	304.2	71.0	43.0	28.4	17.5
13	44.2	59.9	191.7	120.0	80.5	154.9	129.2	626.8	65.4	36.6	26.1	17.4
14	56.0	89.4	190.4	118.8	76.4	128.8	161.4	650.3	104.2	31.8	22.5	17.2
15	397.7	384.6	290.1	126.8	95.1	154.5	118.2	434.1	77.8	26.9	20.4	16.9
16	218.8	158.7	410.2	125.9	100.2	215.2	101.8	358.2	61.2	22.1	19.8	16.8
17	104.1	119.4	622.3	143.9	89.3	167.2	91.2	307.0	52.7	18.1	19.6	16.6
18	74.4	86.8	816.4	142.4	67.7	133.2	80.4	251.1	52.5	15.2	19.3	16.5
19	51.6	94.7	531.5	142.3	63.4	209.9	81.7	218.5	50.0	14.5	18.3	16.4
20	44.0	112.1	356.5	132.5	58.0	422.7	161.8	157.8	46.9	18.8	17.5	16.3
21	36.7	130.0	307.5	126.5	115.1	738.2	166.5	124.0	44.4	29.9	21.0	16.2
22	30.5	148.6	249.9	120.8	176.4	312.8	109.0	151.1	82.1	44.2	24.7	16.0
23	45.5	168.1	205.7	115.5	184.9	235.5	119.0	670.6	73.0	39.0	23.3	15.7
24	43.9	461.5	180.5	107.8	153.0	225.3	110.3	446.8	64.4	34.2	20.7	15.4
25	34.5	300.5	148.2	121.0	286.3	177.5	92.3	336.3	62.9	32.2	19.0	15.2
26	33.0	220.5	167.6	110.7	212.2	157.0	84.5	232.0	61.1	31.3	18.9	15.2
27	33.4	211.1	204.2	110.1	168.1	168.4	70.9	185.1	60.0	30.5	18.9	15.3
28	33.6	172.5	269.3	111.7	154.3	156.8	134.1	153.6	58.5	29.7	19.1	15.3
29	33.0	148.2	522.8	114.4	141.3	200.3	178.5	132.5	58.0	28.9	19.3	15.3
30	32.2		336.0	136.8	132.9	288.7	111.5	146.6	59.2	28.4	19.7	15.2
31	31.5		250.2		105.6		175.0	121.1		27.9		15.2
Average	52.0	126.7	243.2	137.7	118.0	178.8	131.4	257.5	78.2	47.6	22.7	17.1
Maximum	397.7	461.5	816.4	236.5	286.3	738.2	246.2	670.6	126.4	207.0	28.4	22.1
Minimum	16.0	31.1	68.7	107.8	58.0	80.6	70.9	121.1	44.4	14.5	17.5	15.2

Average annual discharge = 118 (m^3/sec)

Annual inflow volume = 3,721 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1997

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.0	15.7	22.2	231.4	66.8	67.5	89.8	131.9	237.3	70.0	60.4	65.9
2	15.1	15.5	54.8	310.8	61.3	70.2	73.7	157.2	232.7	86.6	57.7	62.6
3	15.1	18.0	64.8	264.8	75.4	71.9	64.7	112.8	208.5	79.7	55.4	60.2
4	15.0	17.7	50.1	377.0	70.8	76.6	92.4	78.6	145.0	79.6	52.4	57.8
5	15.0	25.7	40.2	201.9	69.8	67.3	83.1	76.5	151.5	109.7	50.1	55.3
6	14.9	21.7	38.5	141.3	61.5	71.8	79.1	81.7	192.8	84.7	47.6	52.9
7	14.8	20.6	35.7	95.4	130.9	81.9	99.8	100.2	226.0	77.5	45.2	50.6
8	14.6	19.9	31.6	88.7	130.1	93.2	110.5	99.9	384.7	79.8	42.1	54.3
9	14.4	19.1	37.1	88.9	111.3	113.9	222.4	105.8	225.4	75.1	69.8	164.4
10	14.2	18.6	37.8	89.4	79.6	81.7	141.8	112.4	177.4	67.7	98.9	98.7
11	14.1	24.8	32.8	88.5	73.6	73.0	114.7	153.6	139.9	83.4	61.4	82.8
12	14.0	21.6	30.1	100.3	75.6	70.1	87.1	414.8	123.2	67.8	60.9	77.1
13	13.9	16.5	24.8	90.5	69.9	75.4	85.9	237.5	142.4	69.8	62.9	74.7
14	13.8	15.3	17.1	107.5	66.5	76.0	108.1	205.6	131.1	68.7	65.6	73.4
15	13.7	13.8	17.0	159.3	62.7	77.5	98.4	161.4	113.2	62.8	61.2	72.9
16	13.6	13.1	76.5	109.1	59.7	74.2	122.9	150.6	102.4	74.9	57.3	72.6
17	13.5	12.4	58.2	91.0	59.0	73.9	107.6	131.6	91.7	66.1	53.4	67.5
18	13.0	12.3	52.0	82.2	56.7	78.8	113.7	120.7	84.9	61.9	49.2	61.8
19	13.3	12.2	202.6	73.5	54.9	73.1	298.4	108.8	80.9	58.4	45.0	57.6
20	34.8	12.2	99.5	63.3	54.0	75.9	122.6	153.5	79.5	90.0	40.5	52.8
21	42.4	12.2	76.7	62.1	62.2	83.0	127.3	126.2	96.6	129.9	36.6	48.0
22	34.6	12.3	67.7	63.5	61.6	73.4	161.4	259.2	94.5	81.9	34.9	43.3
23	18.2	11.6	47.8	56.1	54.3	81.4	127.7	182.0	79.8	66.2	35.6	38.5
24	15.6	10.9	39.0	59.8	50.2	81.2	127.5	150.8	77.9	63.3	37.3	37.4
25	14.9	21.7	33.5	70.6	50.1	82.8	128.8	166.2	73.0	58.6	48.4	36.1
26	13.9	46.4	28.6	71.7	47.4	78.4	240.8	293.6	64.9	73.2	108.0	35.1
27	13.9	26.5	43.7	72.9	55.4	121.9	501.1	3,872.6	63.0	87.5	113.9	34.5
28	17.2	20.4	97.3	67.6	64.1	134.6	179.0	1,057.0	64.6	66.5	87.0	33.2
29	15.7		354.5	64.3	61.1	160.1	228.1	516.0	86.1	75.2	74.6	37.6
30	16.6		201.3	65.0	57.5	112.7	194.4	356.4	72.8	77.8	69.8	37.0
31	16.6		186.7		54.6		167.5	298.5		67.8		35.2
Average	16.9	18.2	71.0	117.0	68.0	85.1	145.2	328.2	134.8	76.2	59.4	59.1
Maximum	42.4	46.4	354.5	377.0	130.9	160.1	501.1	3,872.6	384.7	129.9	113.9	164.4
Minimum	13.0	10.9	17.0	56.1	47.4	67.3	64.7	76.5	63.0	58.4	34.9	33.2

Average annual discharge = 99 (m^3/sec)

Annual inflow volume = 3,119 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1998

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	35.1	36.1	247.8	141.8	198.2	78.8	176.3	66.0	69.1	31.5	19.3	13.3
2	33.3	43.4	275.0	160.7	195.6	75.8	133.2	54.1	58.6	31.1	19.1	13.7
3	33.1	42.6	320.4	191.9	190.5	64.3	97.5	51.9	67.7	30.7	19.2	14.2
4	32.2	40.9	1,538.1	195.2	181.9	70.6	136.7	48.3	71.3	32.3	19.1	14.7
5	33.0	40.4	722.8	192.9	174.6	62.2	89.0	63.4	70.6	30.7	18.8	15.2
6	32.0	42.0	414.0	193.2	152.9	59.4	145.4	96.2	54.0	30.3	19.3	15.7
7	31.1	43.6	322.8	183.9	109.5	62.8	89.2	67.2	48.7	28.8	18.5	16.2
8	34.8	46.5	305.0	797.7	151.5	58.9	72.0	50.4	47.0	23.5	17.7	16.3
9	35.9	48.4	268.4	451.6	129.9	51.2	70.6	46.6	69.9	23.4	17.0	15.8
10	38.0	52.3	230.9	257.9	93.0	51.9	148.4	59.8	57.1	23.5	16.5	15.9
11	40.9	57.1	206.4	238.8	85.1	63.6	134.9	67.0	61.2	23.7	17.1	16.4
12	43.7	63.2	219.8	202.7	78.0	169.5	259.4	72.6	70.6	24.1	16.7	15.8
13	53.2	69.8	215.3	175.3	74.6	90.0	250.8	81.3	54.8	23.6	17.3	15.7
14	65.9	106.8	177.3	165.3	87.0	63.5	261.9	114.5	47.6	23.3	16.8	15.6
15	145.6	520.0	154.4	163.5	84.7	49.8	294.7	139.3	47.4	23.2	17.4	15.5
16	91.5	247.5	154.7	161.9	88.5	43.1	364.3	70.5	45.3	22.2	17.0	15.9
17	64.9	363.8	157.5	157.5	99.0	43.0	224.5	64.0	42.8	23.8	17.0	15.8
18	56.4	621.2	151.8	153.0	91.4	50.0	139.9	56.8	43.4	23.8	16.1	15.7
19	51.6	286.0	162.3	162.5	87.8	50.5	106.3	55.7	42.6	23.2	15.6	15.1
20	47.7	230.1	166.7	170.3	88.4	42.7	76.4	67.4	41.5	23.9	15.2	15.0
21	45.0	197.4	151.1	184.2	88.2	47.4	76.9	56.8	41.3	22.7	14.3	14.6
22	42.4	216.6	186.7	193.4	86.7	55.3	76.6	56.5	41.1	21.6	14.2	14.0
23	39.9	224.2	172.5	203.0	84.4	56.1	77.4	58.9	39.1	20.9	13.7	14.0
24	37.6	471.9	149.7	213.4	78.9	57.7	71.1	58.8	37.3	20.1	13.6	13.7
25	35.3	429.1	146.7	229.8	80.7	58.4	68.0	55.7	36.0	20.4	13.6	13.7
26	33.2	307.6	133.3	490.9	77.5	56.8	101.6	65.8	36.1	20.0	13.9	13.8
27	33.7	270.3	127.5	270.5	83.8	60.1	65.8	59.4	33.8	20.0	13.9	13.4
28	35.1	254.9	130.1	221.6	94.9	63.5	58.9	53.5	32.7	18.8	13.4	13.5
29	34.7		145.7	214.6	119.7	79.3	56.1	53.2	31.3	18.8	13.3	14.0
30	34.2		136.1	206.9	83.9	84.9	76.6	77.7	31.2	18.8	13.2	14.0
31	34.7		132.9		79.3		99.0	83.7		19.2		14.8
Average	45.3	191.9	258.8	231.5	109.7	64.0	132.2	66.9	49.0	23.9	16.3	14.9
Maximum	145.6	621.2	1,538.1	797.7	198.2	169.5	364.3	139.3	71.3	32.3	19.3	16.4
Minimum	31.1	36.1	127.5	141.8	74.6	42.7	56.1	46.6	31.2	18.8	13.2	13.3

Average annual discharge = 100 (m^3/sec)

Annual inflow volume = 3,145 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 1999

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.0	39.8	40.5	70.2	58.4	24.9	79.4	202.5	81.2	81.2	18.0	17.8
2	14.6	37.6	41.9	68.3	48.3	26.2	71.5	142.1	124.2	65.4	19.1	17.9
3	14.8	35.4	44.8	51.8	47.8	26.6	70.2	134.1	70.1	51.9	20.0	18.2
4	14.4	33.3	51.3	53.4	43.0	26.4	41.2	117.5	58.9	48.0	25.4	18.4
5	14.5	31.3	63.8	57.8	43.7	37.4	34.5	130.6	66.2	52.5	42.2	17.8
6	15.4	30.2	56.8	53.6	44.1	25.8	34.6	172.7	113.7	45.5	38.3	17.5
7	25.7	28.3	158.8	58.5	45.2	26.9	31.0	395.4	68.7	43.3	42.4	17.2
8	24.2	26.2	204.0	59.6	42.3	33.6	26.9	186.5	62.7	42.0	34.6	17.9
9	23.5	28.1	188.0	63.3	41.7	35.3	26.7	142.4	106.4	41.0	30.7	17.6
10	22.3	30.6	124.3	53.1	38.9	38.7	26.7	191.0	59.7	41.4	30.0	17.5
11	20.9	34.4	91.8	66.1	32.5	34.1	76.6	140.3	62.4	41.1	29.8	17.5
12	19.4	40.0	78.3	74.3	36.8	41.7	70.6	145.0	54.4	41.1	27.0	17.7
13	17.2	40.9	65.3	82.4	39.4	37.3	65.1	177.1	51.3	39.4	27.0	17.2
14	15.0	45.7	57.0	65.9	32.3	33.1	48.5	114.8	51.2	38.4	26.5	17.0
15	13.7	42.0	50.9	56.5	27.4	32.6	35.1	90.0	111.3	36.8	26.4	16.8
16	12.7	37.1	45.0	51.3	25.2	32.3	35.0	73.0	91.8	36.9	26.4	16.8
17	13.5	36.3	40.3	51.7	31.5	31.6	135.9	60.8	99.0	36.3	26.3	16.8
18	14.4	52.0	35.9	58.8	39.5	46.2	243.8	54.6	69.1	34.1	26.4	16.3
19	15.4	86.9	32.5	54.9	38.7	51.6	203.2	53.3	163.4	32.3	26.3	16.1
20	18.8	71.3	39.6	52.2	38.3	78.5	147.3	72.5	115.6	30.8	24.8	16.1
21	84.8	43.3	45.7	49.4	49.5	75.7	105.9	56.6	65.1	29.9	24.5	16.0
22	85.6	42.0	29.9	45.5	52.5	44.7	85.8	51.1	49.7	26.6	23.9	16.1
23	60.8	41.5	26.5	50.0	44.3	38.6	62.2	74.4	71.7	24.1	23.5	16.2
24	174.7	43.2	27.4	49.5	43.1	37.0	52.6	47.7	101.8	22.2	23.2	16.1
25	116.2	46.7	32.3	51.0	47.7	60.1	67.8	56.9	81.2	21.8	22.9	16.2
26	68.3	44.4	38.3	50.0	37.0	40.5	42.0	89.8	62.0	21.5	25.6	16.2
27	50.2	45.0	39.6	58.0	40.1	42.3	35.0	103.0	54.1	16.9	21.5	16.2
28	42.4	41.1	42.3	50.6	34.2	37.8	34.1	75.9	66.4	16.3	18.7	16.3
29	40.0		45.5	50.0	34.8	43.7	90.0	51.4	95.4	15.8	18.1	16.3
30	38.7		50.2	58.8	32.7	45.4	94.5	57.4	159.1	17.0	18.0	15.8
31	40.4		60.8		29.0		113.1	74.3		17.1		15.9
Average	37.0	41.2	62.9	57.2	40.0	39.6	73.8	114.0	82.9	35.8	26.3	16.9
Maximum	174.7	86.9	204.0	82.4	58.4	78.5	243.8	395.4	163.4	81.2	42.4	18.4
Minimum	12.7	26.2	26.5	45.5	25.2	24.9	26.7	47.7	49.7	15.8	18.0	15.8

Average annual discharge = 52 (m^3/sec)

Annual inflow volume = 1,652 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2000

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.0	144.0	34.0	63.8	40.9	32.3	104.5	1,172.0	103.4	39.5	28.9	18.6
2	14.9	109.3	33.2	63.3	48.9	31.2	130.3	588.8	101.5	38.1	28.2	19.4
3	14.3	68.1	30.9	68.2	53.1	29.7	119.8	305.4	76.0	38.7	28.8	19.1
4	13.2	56.3	32.6	63.7	52.3	31.6	94.1	231.3	80.5	38.1	28.2	18.3
5	12.1	50.1	67.9	49.7	43.7	32.9	46.2	189.9	70.6	37.3	26.3	19.1
6	12.1	47.1	45.5	50.3	43.4	26.3	39.7	178.5	74.0	35.0	24.6	18.0
7	12.1	41.9	42.7	52.1	41.0	34.7	43.4	176.5	91.5	34.5	24.2	18.8
8	11.7	36.4	43.3	42.1	43.9	36.0	89.8	159.3	70.0	33.8	23.8	17.7
9	12.0	34.9	44.7	40.9	49.2	74.1	113.0	247.7	100.9	33.8	23.4	19.2
10	11.8	83.2	48.1	48.2	51.7	43.5	68.1	217.1	74.9	33.8	22.6	19.0
11	12.1	79.9	46.0	53.4	56.1	47.1	71.6	188.4	76.7	32.6	20.5	20.7
12	114.8	72.6	42.4	58.1	57.8	35.6	59.9	166.9	54.9	31.3	20.7	20.4
13	162.3	54.5	40.8	63.2	104.1	26.5	70.8	140.6	44.9	32.3	18.5	22.0
14	116.0	44.8	37.8	55.1	68.0	23.0	90.6	148.6	38.5	30.9	18.5	20.8
15	54.8	43.7	37.2	59.8	62.9	55.7	95.0	155.6	38.0	29.5	18.6	22.3
16	40.8	42.4	37.3	47.4	77.8	44.7	55.7	161.6	36.6	29.3	18.5	23.0
17	31.4	39.9	37.0	49.4	59.3	39.1	102.0	126.6	34.1	30.3	17.6	24.7
18	29.5	38.8	34.2	50.9	58.7	47.1	53.3	121.8	28.8	28.6	18.4	32.3
19	31.4	37.8	30.8	49.4	72.1	48.8	45.2	97.1	35.4	26.8	17.3	31.9
20	38.5	34.8	28.6	49.0	55.0	81.9	90.2	98.5	139.4	25.4	18.4	25.7
21	34.6	34.8	26.7	50.9	48.7	58.2	87.7	98.8	91.7	25.6	17.5	22.0
22	31.0	34.4	27.8	58.8	49.3	42.9	419.7	86.0	82.5	25.8	16.9	19.2
23	28.7	33.6	27.8	46.3	51.9	61.0	495.7	85.5	59.0	24.8	17.7	17.9
24	27.1	30.1	29.3	45.5	45.2	46.1	246.6	78.5	53.5	23.7	18.6	15.7
25	25.6	28.8	31.1	54.4	42.7	44.7	179.1	73.5	59.0	23.8	18.0	16.2
26	26.5	30.0	50.5	54.3	39.2	49.6	177.9	69.3	133.5	24.0	18.0	15.4
27	25.9	30.7	76.6	53.2	35.4	83.3	124.4	67.6	75.9	23.3	19.2	16.4
28	24.5	30.3	66.4	41.5	31.6	142.0	131.6	77.6	59.3	23.7	18.3	16.1
29	23.8	30.3	79.8	39.1	30.2	65.2	127.3	115.2	48.9	25.6	18.5	15.3
30	23.5		76.3	39.1	34.2	215.1	109.6	125.0	43.2	28.8	19.7	15.7
31	24.1		60.3		42.4		435.0	94.4		29.5		14.9
Average	34.1	49.8	43.5	52.0	51.3	54.3	132.8	188.5	69.2	30.3	21.0	19.9
Maximum	162.3	144.0	79.8	68.2	104.1	215.1	495.7	1,172.0	139.4	39.5	28.9	32.3
Minimum	11.7	28.8	26.7	39.1	30.2	23.0	39.7	67.6	28.8	23.3	16.9	14.9

Average annual discharge = 62 (m^3/sec)

Annual inflow volume = 1,974 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2001

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.2	13.5	16.4	31.5	34.3	33.5	70.3	197.6	80.2	30.1	17.2	12.8
2	15.7	14.5	16.2	25.4	34.4	81.9	48.6	175.0	88.6	31.3	18.8	13.5
3	17.4	14.0	15.6	26.5	34.3	112.9	57.8	180.8	78.5	34.7	23.2	12.9
4	17.6	13.4	15.4	32.8	33.8	76.9	49.4	308.4	86.0	44.1	30.3	12.3
5	17.2	14.2	15.1	28.3	34.8	92.4	51.8	215.3	64.7	37.2	25.4	12.9
6	16.9	13.4	15.1	27.4	40.6	83.5	35.2	223.5	70.6	33.5	28.2	12.3
7	16.0	12.7	14.3	28.9	45.8	91.7	40.5	265.2	57.4	31.6	28.2	13.0
8	14.8	12.8	14.2	31.4	47.1	83.3	70.2	171.2	69.4	29.5	25.0	12.4
9	14.8	12.8	14.1	34.1	44.6	91.2	58.9	152.3	55.1	29.7	22.7	13.0
10	14.1	12.7	14.0	34.3	46.3	95.6	53.3	158.6	53.5	29.8	22.0	12.3
11	15.1	13.3	12.9	32.3	48.1	55.7	427.3	131.7	55.2	29.7	22.6	11.7
12	14.5	14.2	12.8	34.1	50.2	48.8	105.5	109.7	104.9	30.4	21.1	11.9
13	14.3	13.5	14.4	35.4	48.8	44.3	143.9	100.7	77.5	29.1	20.7	12.3
14	15.5	12.9	15.7	32.9	46.7	79.4	91.1	249.3	138.4	29.9	19.9	12.2
15	15.0	13.6	15.1	35.3	53.0	79.2	97.1	230.2	127.1	28.0	19.2	11.8
16	15.4	14.5	16.8	40.6	42.6	121.1	257.6	191.7	76.3	27.2	19.4	13.0
17	14.5	13.9	16.2	73.8	56.9	301.7	181.1	127.5	67.2	27.7	18.7	13.8
18	14.0	14.0	14.1	103.3	41.3	117.1	114.3	111.3	60.3	25.5	17.1	14.4
19	14.4	13.7	13.4	57.7	41.6	73.0	94.8	109.4	55.2	25.0	15.9	17.0
20	14.6	14.2	16.2	60.3	98.3	58.4	89.2	111.4	51.4	24.0	16.8	15.8
21	14.4	15.1	31.5	43.0	72.5	94.0	88.5	125.6	48.2	23.3	17.1	15.5
22	14.9	14.3	25.7	36.5	52.0	121.9	276.4	119.9	43.9	22.7	15.7	14.8
23	14.7	14.2	20.4	29.9	50.2	101.7	432.4	145.9	41.3	21.6	14.7	14.4
24	14.1	15.8	17.9	31.0	41.2	109.0	354.5	109.6	39.3	21.5	15.3	14.3
25	14.8	18.3	17.0	32.4	36.1	69.8	204.2	93.7	37.5	19.8	14.4	13.6
26	14.8	18.3	17.2	30.4	33.0	82.4	133.3	89.4	40.0	19.9	13.8	13.5
27	14.7	18.4	16.2	30.7	29.7	73.3	125.8	84.0	37.1	18.9	14.2	13.4
28	13.9	18.0	18.3	28.9	30.7	43.9	105.7	86.1	34.1	17.7	13.6	13.3
29	13.9		31.5	34.9	42.6	38.6	411.1	79.6	32.0	16.6	12.8	12.4
30	14.0		40.4	31.5	32.9	158.6	359.1	76.1	30.4	16.5	13.4	13.0
31	13.3		30.3		36.8		244.1	97.5		16.7		12.6
Average	15.0	14.4	18.2	37.9	44.6	90.5	157.2	149.3	63.4	26.6	19.2	13.3
Maximum	17.6	18.4	40.4	103.3	98.3	301.7	432.4	308.4	138.4	44.1	30.3	17.0
Minimum	13.3	12.7	12.8	25.4	29.7	33.5	35.2	76.1	30.4	16.5	12.8	11.7

Average annual discharge = 54 (m^3/sec)

Annual inflow volume = 1,718 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2002

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	12.7	18.2	29.3	62.1	31.8	38.1	54.9	56.0	129.0	29.1	19.4	14.4
2	12.9	19.0	30.6	60.6	32.5	33.1	45.0	68.7	164.9	28.9	18.9	14.3
3	13.2	17.8	34.4	56.0	33.6	48.8	39.6	52.7	111.7	28.6	18.9	14.2
4	12.6	17.6	27.8	55.7	40.3	37.5	42.4	68.1	213.0	28.2	18.1	14.6
5	12.0	17.1	26.6	55.7	58.7	35.2	38.5	83.3	148.3	28.6	18.5	13.9
6	11.6	17.5	25.7	55.3	61.7	39.7	34.6	158.6	106.0	29.6	19.3	13.8
7	11.8	19.5	26.4	82.4	57.6	35.6	28.3	119.1	88.6	29.7	18.7	13.2
8	12.0	22.8	26.0	73.8	52.3	34.1	26.9	92.5	107.7	29.0	18.5	13.1
9	11.7	20.5	35.5	62.6	55.1	38.2	23.5	77.8	80.4	28.6	17.7	13.2
10	12.1	18.5	145.7	56.8	56.1	54.2	28.9	62.8	71.0	28.2	17.7	13.6
11	11.5	17.4	98.1	54.0	62.6	53.5	29.5	68.1	62.0	27.6	17.9	13.5
12	11.5	17.3	74.0	54.7	64.2	51.0	24.1	390.6	71.5	27.7	18.1	12.9
13	10.7	17.3	69.1	57.9	60.9	55.0	23.4	590.3	65.5	31.1	17.2	13.6
14	13.1	17.2	64.7	62.2	59.1	121.5	22.5	353.1	104.7	31.5	16.6	14.3
15	36.6	17.3	60.9	59.2	65.2	86.2	25.8	275.4	106.4	28.9	16.6	14.0
16	82.1	18.1	57.7	57.8	71.5	79.8	27.5	160.1	89.4	27.4	16.8	13.8
17	59.4	20.6	61.5	54.8	64.3	131.3	44.4	118.3	131.8	26.2	15.9	13.3
18	40.1	23.6	59.8	54.5	64.0	107.6	56.6	94.3	105.1	25.4	16.0	13.8
19	32.8	25.3	62.4	55.9	59.8	83.2	55.1	81.3	82.2	25.1	15.8	13.5
20	27.6	22.8	67.3	57.5	51.6	66.5	100.7	89.5	66.1	28.2	15.5	15.4
21	25.6	34.8	66.4	56.5	48.1	77.6	182.8	78.2	57.0	26.1	15.3	15.9
22	25.7	54.8	72.8	50.7	47.1	55.8	84.3	105.8	47.3	25.5	15.1	15.7
23	24.0	365.0	58.4	49.1	48.0	61.4	124.9	95.6	39.6	24.8	15.2	14.8
24	24.1	135.8	68.9	49.4	45.6	163.8	71.4	122.4	49.2	24.2	15.8	14.6
25	22.5	92.6	148.7	49.7	44.7	128.0	77.5	159.8	39.7	23.1	15.2	15.1
26	22.7	61.0	102.0	49.1	40.8	74.0	62.7	146.7	37.7	22.1	15.0	15.0
27	21.1	42.1	82.7	40.9	43.9	60.3	76.9	142.7	34.5	21.5	15.6	14.2
28	20.2	30.5	71.9	36.4	46.7	75.8	63.8	103.4	32.1	21.1	15.1	14.5
29	20.6		70.3	32.1	64.8	105.3	62.1	86.8	30.0	20.2	14.3	14.6
30	19.1		68.3	29.4	49.3	68.3	76.8	192.9	29.8	19.3	14.5	14.3
31	18.9		64.5		37.8		50.1	132.4		19.0		13.7
Average	22.3	42.9	63.2	54.4	52.3	70.0	55.0	142.8	83.4	26.3	16.8	14.2
Maximum	82.1	365.0	148.7	82.4	71.5	163.8	182.8	590.3	213.0	31.5	19.4	15.9
Minimum	10.7	17.1	25.7	29.4	31.8	33.1	22.5	52.7	29.8	19.0	14.3	12.9

Average annual discharge = 54 (m^3/sec)

Annual inflow volume = 1,693 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2003

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	12.9	17.7	306.9	114.5	201.0	19.0	51.7	133.7	52.0	49.4	18.8	12.5
2	12.9	18.1	787.4	111.1	103.7	23.2	46.0	193.4	55.2	41.0	17.9	14.0
3	13.0	15.9	399.1	106.0	66.9	20.3	46.1	140.8	73.0	37.5	17.6	13.1
4	13.1	14.1	285.0	111.3	59.3	17.6	50.2	86.1	119.5	32.4	18.6	14.5
5	12.6	14.7	227.2	97.3	50.9	17.6	98.3	61.5	89.6	29.8	17.8	15.8
6	12.4	14.2	206.2	86.1	42.8	17.8	107.2	49.6	76.3	29.6	17.8	14.5
7	12.1	14.7	192.4	95.4	44.1	63.5	117.3	46.1	60.2	28.7	16.1	15.8
8	12.7	14.9	168.2	105.5	41.6	64.6	62.6	54.8	69.2	26.6	16.7	14.6
9	13.6	14.5	151.7	112.9	40.2	75.0	117.9	42.2	85.6	29.8	16.5	14.8
10	12.7	13.8	137.3	119.2	37.7	70.7	76.8	37.9	63.6	28.2	15.6	16.5
11	11.9	13.5	120.9	123.9	35.8	57.5	86.3	37.7	58.1	25.9	16.4	17.3
12	11.5	13.3	110.7	128.0	35.4	52.6	71.2	37.6	55.7	26.7	15.4	16.7
13	10.7	12.7	113.8	129.2	33.2	46.6	71.9	35.0	76.2	24.0	16.9	19.3
14	10.6	12.4	120.8	131.8	33.8	46.5	57.8	31.3	61.3	22.9	15.9	38.4
15	10.3	13.0	120.9	127.6	34.2	47.2	75.8	29.7	63.6	22.8	17.5	50.1
16	10.7	16.1	136.9	188.8	34.9	48.0	111.9	28.7	51.0	22.2	16.5	37.2
17	10.2	236.7	129.4	152.7	35.6	49.3	58.2	36.5	47.0	20.8	25.4	30.5
18	10.8	2,375.9	118.8	136.1	38.1	46.8	56.0	87.5	45.7	20.1	33.0	25.6
19	10.5	1,103.9	119.2	139.3	33.0	47.3	48.6	139.0	42.0	20.1	21.8	23.5
20	10.6	281.6	123.1	154.4	38.3	61.6	77.7	158.5	41.1	20.0	18.6	20.8
21	10.3	190.6	134.8	118.2	38.1	85.3	95.6	129.1	38.9	19.8	17.3	22.1
22	10.6	163.1	146.8	107.6	36.7	64.9	87.9	82.1	36.8	18.4	17.0	20.9
23	10.2	174.0	131.7	115.5	33.3	58.3	82.5	77.9	43.6	18.5	15.5	21.5
24	10.7	162.3	132.6	125.0	27.6	56.0	164.5	60.6	126.0	18.2	16.6	20.1
25	10.0	145.4	143.3	120.1	25.9	65.1	94.9	50.6	249.7	16.6	15.3	18.5
26	9.4	142.5	134.6	119.2	25.0	63.3	97.3	50.9	186.1	17.5	13.8	19.7
27	9.7	141.0	137.5	120.8	26.6	59.1	108.8	52.0	107.3	17.2	12.4	18.3
28	9.2	234.3	137.4	99.7	25.7	54.4	85.2	50.8	78.9	16.3	13.8	19.5
29	14.3		191.3	94.7	19.1	50.4	81.1	58.1	63.3	16.2	15.2	18.2
30	15.1		158.4	105.3	18.1	45.1	106.6	88.6	54.0	17.4	13.8	18.7
31	18.8		125.6		18.6		76.0	56.8		17.8		17.0
Average	11.7	199.5	182.3	119.9	43.1	49.8	82.9	71.8	75.7	24.3	17.4	20.6
Maximum	18.8	2,375.9	787.4	188.8	201.0	85.3	164.5	193.4	249.7	49.4	33.0	50.1
Minimum	9.2	12.4	110.7	86.1	18.1	17.6	46.0	28.7	36.8	16.2	12.4	12.5

Average annual discharge = 74 (m^3/sec)

Annual inflow volume = 2,333 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2004

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.1	85.1	50.4	24.8	228.1	30.4	38.8	115.5	39.0	24.4	24.1	58.6
2	19.6	65.4	43.1	23.9	124.2	35.4	47.7	66.3	59.8	25.0	23.1	43.8
3	19.4	63.6	38.1	23.0	84.8	31.7	41.0	135.3	40.6	26.0	23.0	35.6
4	19.5	54.5	36.1	23.9	77.0	28.1	55.1	88.2	34.9	27.2	22.4	30.7
5	19.5	47.0	34.4	26.2	68.2	27.8	45.7	58.3	31.5	26.5	20.3	28.8
6	19.3	41.8	35.6	29.6	59.8	27.1	43.8	70.8	35.4	25.4	20.2	28.0
7	19.3	36.7	34.5	30.0	58.8	57.4	41.6	205.7	30.5	25.6	21.5	25.1
8	18.8	35.3	35.1	26.8	56.0	43.5	62.7	157.7	30.9	28.2	20.4	24.6
9	18.3	51.9	44.9	34.0	54.5	56.4	138.1	104.5	30.1	30.9	22.0	23.0
10	17.3	70.6	48.2	32.9	51.7	45.3	71.3	77.7	29.2	34.6	20.2	22.9
11	18.0	58.0	45.4	29.0	49.6	34.8	59.4	90.9	27.5	82.1	22.2	22.6
12	18.7	53.4	41.7	28.2	49.4	35.2	100.7	59.7	28.7	66.4	20.5	22.0
13	19.8	56.1	39.2	26.8	47.1	33.5	58.6	42.9	31.9	53.8	19.0	22.0
14	20.7	53.1	39.4	24.9	47.8	35.1	102.6	39.7	34.3	47.2	20.6	21.7
15	21.5	57.0	39.6	26.2	48.4	52.5	57.7	49.5	65.1	40.3	19.2	20.7
16	22.0	52.8	44.3	27.9	49.3	41.9	54.9	54.4	100.3	38.2	20.8	18.8
17	43.4	51.5	45.6	25.9	49.6	40.3	33.5	150.2	60.8	33.6	19.2	19.3
18	77.2	82.7	44.9	24.9	52.1	65.9	59.7	108.8	46.2	32.8	20.8	18.8
19	41.2	72.4	44.1	25.1	45.7	47.2	39.8	73.7	39.3	32.3	19.2	19.0
20	32.5	58.3	39.8	27.8	51.1	53.8	32.8	68.0	38.0	31.9	19.7	71.3
21	31.4	57.0	39.2	25.7	50.2	60.7	35.6	52.6	65.8	32.7	20.0	40.8
22	130.7	51.8	32.7	23.3	48.0	72.2	30.8	49.3	45.7	33.6	19.2	29.2
23	161.8	51.7	30.7	28.6	44.2	51.9	27.9	57.0	36.3	35.9	18.0	25.6
24	105.9	54.9	29.6	27.7	37.5	72.8	23.8	56.9	33.1	34.1	19.3	26.8
25	71.5	54.9	25.0	28.1	35.9	105.6	19.9	64.9	34.5	35.1	21.9	26.5
26	60.6	54.2	25.6	29.7	35.4	66.4	18.4	62.4	36.6	37.0	21.6	25.0
27	52.5	53.5	24.1	33.9	38.0	61.8	31.9	41.6	39.0	43.0	21.3	25.9
28	47.9	59.7	22.9	49.9	37.3	43.0	43.9	49.2	33.5	37.1	24.4	24.5
29	48.6	53.7	22.4	61.0	29.9	37.0	53.3	38.9	28.9	32.0	26.9	25.0
30	78.3		22.1	229.6	29.0	32.2	106.4	43.4	25.2	27.3	125.7	25.4
31	117.5		23.0		30.1		100.7	39.7		26.4		29.6
Average	45.5	56.5	36.2	36.0	57.1	47.6	54.1	76.6	40.4	35.7	24.5	28.4
Maximum	161.8	85.1	50.4	229.6	228.1	105.6	138.1	205.7	100.3	82.1	125.7	71.3
Minimum	17.1	35.3	22.1	23.0	29.0	27.1	18.4	38.9	25.2	24.4	18.0	18.8

Average annual discharge = 45 (m^3/sec)

Annual inflow volume = 1,420 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2005

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	235.2	44.2	130.2	132.6	111.1	56.4	155.1	67.4	31.9	26.7	34.8	26.0
2	99.5	43.4	131.2	140.5	108.4	51.9	158.5	65.1	29.8	26.8	33.2	27.4
3	66.5	42.9	132.9	143.7	128.8	50.6	130.9	69.6	29.6	27.6	31.3	25.3
4	57.1	39.1	140.0	147.0	120.6	50.2	106.8	64.8	28.6	27.6	33.6	26.7
5	49.4	47.4	153.5	153.1	127.1	53.0	113.7	79.1	32.2	28.4	31.7	24.5
6	43.3	48.3	155.6	147.3	124.2	50.8	110.6	63.3	38.2	28.1	30.0	22.3
7	37.1	116.1	151.2	150.9	117.3	54.0	81.2	64.9	88.1	29.0	32.0	23.7
8	31.5	107.0	142.4	153.5	120.5	56.4	105.7	66.5	65.9	28.4	30.4	21.6
9	29.8	413.0	148.0	144.9	119.9	53.8	123.3	71.7	72.1	32.9	32.1	23.2
10	28.5	255.4	138.3	120.7	107.7	53.9	127.1	72.8	48.6	33.8	30.2	21.8
11	26.7	438.2	142.8	106.0	94.0	58.9	203.9	71.3	45.7	38.4	28.2	21.9
12	27.3	473.5	139.7	106.2	87.0	59.9	283.6	67.7	53.5	68.5	30.0	21.1
13	27.1	273.3	146.9	106.9	87.2	59.3	272.3	105.0	46.5	43.0	28.1	22.8
14	27.9	219.1	142.5	111.8	80.0	50.8	200.3	66.4	36.2	37.5	29.8	20.9
15	26.3	205.0	156.5	115.0	70.8	50.2	188.7	58.7	36.5	34.6	27.9	22.6
16	26.9	206.3	182.0	119.5	74.5	58.4	224.3	84.7	33.2	41.5	29.7	20.9
17	24.6	169.2	207.5	112.4	71.3	60.2	146.5	81.3	48.2	51.8	27.8	19.7
18	26.1	182.1	239.6	116.6	68.7	69.2	121.3	68.1	205.4	43.5	25.8	21.1
19	24.0	249.8	411.6	128.0	71.2	74.7	115.2	56.0	107.9	40.4	27.5	19.7
20	25.5	176.3	328.0	130.7	64.3	82.9	119.0	57.2	63.9	39.9	25.7	20.1
21	23.5	144.9	294.3	122.8	66.0	86.3	136.1	50.3	47.9	37.2	27.4	20.0
22	34.4	146.5	378.5	132.6	58.4	94.0	131.4	47.3	38.8	37.5	25.5	21.6
23	57.9	148.8	285.6	152.1	58.4	103.4	105.8	44.6	52.9	34.8	27.2	20.8
24	41.3	142.4	256.8	138.0	63.6	111.7	102.7	41.0	36.6	35.5	25.3	19.9
25	30.7	133.6	212.3	141.1	59.3	112.6	95.1	52.2	34.0	33.1	27.3	21.8
26	27.0	129.4	193.3	159.5	55.4	122.6	92.5	44.1	31.3	33.5	25.7	19.8
27	24.2	129.1	200.3	138.6	55.6	122.9	127.3	62.2	34.4	33.4	27.6	21.6
28	45.3	126.3	195.3	129.9	52.8	114.1	81.3	49.0	30.9	33.5	27.4	20.1
29	45.9		169.9	111.2	57.5	125.7	76.8	41.4	27.2	34.8	28.0	20.1
30	40.6		150.2	104.9	65.2	129.0	99.2	35.2	26.7	33.0	28.2	20.6
31	37.6		140.1		65.4		67.2	31.2		33.8		18.7
Average	43.5	173.2	193.5	130.6	84.3	75.9	135.6	61.3	50.1	35.8	29.0	21.9
Maximum	235.2	473.5	411.6	159.5	128.8	129.0	283.6	105.0	205.4	68.5	34.8	27.4
Minimum	23.5	39.1	130.2	104.9	52.8	50.2	67.2	31.2	26.7	26.7	25.3	18.7

Average annual discharge = 86 (m^3/sec)

Annual inflow volume = 2,701 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2006

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.4	34.2	94.9	84.2	73.2	44.8	59.0	169.6	184.5	42.4	20.9	38.5
2	40.3	34.8	82.6	85.8	71.1	42.6	36.4	151.9	255.6	39.3	20.1	33.2
3	52.6	34.7	70.9	84.8	67.6	41.7	56.7	183.4	325.5	36.9	21.0	29.9
4	46.8	35.5	61.4	70.4	69.7	67.4	43.1	760.2	276.7	35.2	19.5	51.1
5	36.4	35.3	52.7	78.7	83.2	59.7	52.2	654.0	194.5	31.9	18.6	948.7
6	31.1	35.0	43.3	81.5	82.3	60.2	51.2	475.1	154.1	32.5	19.0	417.3
7	28.8	34.7	42.7	84.5	88.8	42.6	98.1	348.5	133.1	31.3	18.7	203.2
8	29.7	37.1	42.2	81.1	88.7	34.3	97.5	466.3	117.9	29.9	18.9	161.2
9	26.9	37.9	42.4	80.0	96.2	35.2	96.5	326.4	114.6	29.8	20.4	144.6
10	24.0	37.4	42.6	162.0	88.1	36.5	125.8	272.8	105.4	30.1	22.0	144.1
11	24.8	35.8	43.4	89.0	86.2	38.3	110.9	200.8	109.1	29.2	22.2	143.8
12	22.7	36.4	45.4	71.2	84.1	39.7	188.9	169.8	111.7	29.0	33.5	128.6
13	22.9	35.5	60.6	58.8	86.5	41.4	315.6	168.4	107.7	31.2	97.9	118.1
14	20.1	43.7	84.4	57.1	86.8	40.8	162.0	182.1	87.8	30.1	62.4	110.3
15	22.4	116.6	85.7	53.7	74.5	45.3	115.0	202.7	79.7	30.5	46.8	105.0
16	109.1	99.7	96.0	50.1	85.5	103.9	81.5	172.7	83.8	27.9	49.0	97.5
17	173.7	69.6	66.2	48.6	112.7	114.0	60.9	165.1	78.1	25.4	61.4	90.8
18	133.2	52.4	60.2	51.0	80.6	77.9	48.4	149.3	74.4	25.7	135.9	91.1
19	65.6	59.2	59.9	48.3	72.6	59.9	43.6	130.7	67.8	31.0	115.9	85.2
20	46.7	44.1	106.9	49.2	70.0	47.5	49.7	232.1	84.5	51.6	78.9	83.2
21	42.6	44.1	141.7	50.4	87.6	42.9	54.7	179.3	67.6	36.4	61.4	82.9
22	38.4	42.3	93.5	55.6	76.4	42.6	80.0	151.4	63.0	31.3	58.3	96.4
23	35.9	43.7	89.6	68.9	84.5	40.5	215.0	166.0	57.6	28.9	66.3	74.5
24	32.8	43.8	82.3	61.4	81.7	44.1	334.9	137.8	56.4	27.1	53.9	65.4
25	31.7	56.3	87.2	66.1	83.5	50.4	161.5	141.2	52.6	25.1	44.5	58.4
26	29.6	237.0	102.4	74.4	75.3	69.9	208.3	136.1	49.9	23.9	42.2	59.3
27	30.0	173.2	89.6	83.0	76.0	88.3	345.1	160.1	50.7	25.5	43.0	66.7
28	31.5	113.2	84.3	83.4	70.6	129.3	415.4	184.2	49.6	23.2	41.4	60.9
29	32.0		78.3	76.4	62.2	109.0	264.8	152.0	47.5	22.5	42.3	55.4
30	32.0		77.1	78.9	55.7	121.1	216.2	163.1	43.4	21.3	40.5	52.0
31	32.9		77.7		51.1		166.7	141.4		19.5		49.7
Average	43.4	60.8	73.8	72.3	79.1	60.4	140.5	235.3	109.5	30.2	46.6	127.3
Maximum	173.7	237.0	141.7	162.0	112.7	129.3	415.4	760.2	325.5	51.6	135.9	948.7
Minimum	19.4	34.2	42.2	48.3	51.1	34.3	36.4	130.7	43.4	19.5	18.6	29.9

Average annual discharge = 90 (m^3/sec)

Annual inflow volume = 2,850 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2007

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	46.1	24.8	139.7	279.3	110.9	72.3	151.0	80.1	57.3	32.0	15.5	14.3
2	44.0	24.2	115.2	249.0	109.2	77.7	200.1	75.1	54.3	31.4	17.9	14.3
3	41.2	23.7	99.8	225.8	107.7	86.2	139.5	63.3	50.1	31.1	15.7	14.3
4	42.7	24.1	101.8	197.6	109.9	99.4	112.3	66.0	44.8	29.4	17.2	14.0
5	45.3	25.9	114.9	182.6	111.3	105.5	84.4	64.2	57.0	29.1	15.8	12.8
6	43.7	23.8	106.9	174.2	107.1	86.3	98.3	84.1	50.4	26.8	16.1	12.7
7	42.5	23.8	106.5	169.5	101.6	87.9	98.7	70.2	49.9	26.7	16.2	12.9
8	43.1	24.6	108.1	159.9	115.2	90.0	274.1	59.3	56.4	25.4	16.2	13.1
9	40.5	24.1	109.0	158.4	119.4	98.1	146.4	52.3	58.7	24.4	17.8	12.8
10	42.0	27.0	103.5	153.7	114.7	100.5	103.2	47.8	52.7	24.1	15.9	12.9
11	38.4	86.6	100.5	151.1	106.0	102.9	84.5	45.6	59.4	24.3	14.6	13.1
12	37.1	129.4	335.3	150.7	96.8	107.4	124.3	45.9	50.4	21.4	15.7	13.1
13	35.4	82.8	426.7	150.3	103.5	114.3	91.3	72.8	42.4	22.2	14.6	14.2
14	31.8	67.7	261.3	149.2	109.3	138.4	60.5	323.6	42.8	21.3	14.7	15.6
15	31.3	64.8	204.7	152.9	119.2	138.3	112.6	195.3	45.9	19.1	15.4	13.3
16	28.6	55.1	184.2	152.2	132.7	114.1	79.1	111.9	47.1	21.2	14.9	13.5
17	28.4	54.2	172.1	151.7	130.5	116.4	58.0	95.9	55.8	19.9	14.3	13.4
18	27.2	51.0	172.4	165.9	126.3	113.2	59.4	86.3	52.0	20.6	13.8	13.2
19	26.9	44.3	186.5	154.8	174.6	88.7	61.1	60.9	44.0	18.5	14.2	13.5
20	26.8	41.1	1,568.8	155.3	159.3	86.5	126.9	92.0	61.6	17.9	13.8	12.6
21	26.0	38.9	869.1	148.4	132.0	78.8	157.4	77.6	80.0	18.0	13.2	14.1
22	27.0	65.4	450.8	138.4	111.9	79.9	141.9	86.2	63.7	17.9	13.7	12.6
23	27.4	50.3	315.8	136.7	106.6	103.9	130.8	91.5	57.2	15.8	13.0	14.1
24	27.6	40.7	281.5	140.3	99.7	88.4	156.4	147.1	56.3	17.0	14.2	13.3
25	25.6	40.4	266.0	123.4	89.3	101.7	106.8	80.3	41.7	17.1	12.9	12.5
26	27.7	39.4	257.9	113.3	83.1	110.3	87.0	96.3	39.8	16.2	13.2	13.2
27	27.8	117.0	255.7	123.4	82.6	92.4	89.2	72.8	38.6	16.9	13.4	13.4
28	25.1	203.3	257.1	123.4	85.6	146.5	75.7	59.9	38.5	16.1	12.9	11.9
29	25.9		265.0	118.5	85.8	211.1	136.9	66.7	38.1	17.0	13.3	11.6
30	24.0		272.2	118.6	75.4	153.1	101.1	60.5	33.1	16.9	14.0	11.7
31	24.9		274.4		77.7		81.7	56.8		16.9		11.5
Average	33.3	54.2	273.7	158.9	109.5	106.3	113.9	86.7	50.7	21.7	14.8	13.2
Maximum	46.1	203.3	1,568.8	279.3	174.6	211.1	274.1	323.6	80.0	32.0	17.9	15.6
Minimum	24.0	23.7	99.8	113.3	75.4	72.3	58.0	45.6	33.1	15.8	12.9	11.5

Average annual discharge = 87 (m^3/sec)

Annual inflow volume = 2,735 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2008

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	11.9	23.8	87.3	53.4	56.9	56.1	134.6	193.1	94.7	29.9	25.2	19.6
2	11.5	23.8	89.6	57.6	62.7	79.4	108.6	201.7	92.8	27.9	24.0	21.4
3	12.1	26.3	83.3	68.3	65.4	77.0	88.0	617.4	101.5	28.6	22.7	21.5
4	10.4	31.9	69.7	83.3	74.5	74.9	96.0	371.4	113.0	25.4	22.5	19.6
5	11.4	47.8	72.0	133.7	66.0	73.8	86.2	341.5	101.4	25.1	23.1	20.2
6	10.5	46.8	70.5	270.8	64.1	94.7	209.3	271.6	94.3	42.6	19.5	20.1
7	12.2	36.6	80.0	109.2	61.1	123.9	171.0	224.4	117.2	34.7	22.7	21.4
8	20.6	55.9	70.9	86.8	57.1	115.0	131.3	221.5	101.1	42.9	24.3	23.3
9	88.6	45.0	72.4	82.5	57.7	127.9	106.0	254.9	99.0	32.8	21.2	172.3
10	122.4	38.7	71.7	88.3	53.3	100.8	92.5	197.0	83.0	32.3	22.0	69.6
11	77.8	34.4	66.8	144.0	57.0	123.3	112.8	224.7	78.8	28.9	19.2	47.7
12	41.2	34.8	66.3	160.8	52.3	177.9	135.2	222.1	80.4	26.7	18.8	39.3
13	33.5	36.3	66.7	118.8	59.7	125.8	129.1	200.2	81.3	26.2	22.8	31.8
14	27.4	37.6	65.5	91.5	57.0	174.4	142.6	195.7	73.8	25.1	27.5	29.6
15	22.0	38.5	63.1	108.6	61.6	432.4	113.7	203.8	55.5	70.4	32.3	28.8
16	19.0	39.2	68.0	190.3	76.4	262.7	102.4	201.7	53.5	63.4	26.5	29.9
17	143.5	44.4	71.0	128.0	85.5	165.7	95.4	170.1	67.5	49.3	21.8	31.0
18	412.5	42.1	69.4	101.5	67.2	136.7	133.3	141.0	61.5	37.6	21.3	33.0
19	102.7	44.6	64.5	90.8	66.4	163.4	107.6	135.6	56.0	29.1	21.1	34.0
20	67.5	47.8	59.8	82.8	78.7	150.4	175.0	142.0	55.5	33.1	23.1	234.6
21	52.9	52.9	50.5	79.6	69.3	122.6	158.2	137.1	51.4	30.3	26.4	233.9
22	44.6	52.0	48.2	81.8	83.6	156.2	164.8	160.8	57.9	30.2	22.7	122.6
23	39.7	101.2	44.8	78.6	115.4	112.5	115.4	131.4	63.6	25.6	24.2	87.2
24	36.5	106.6	45.5	69.6	94.5	126.5	107.9	132.6	50.3	28.3	21.2	67.4
25	32.5	74.6	45.9	70.3	129.1	105.2	105.7	106.9	45.1	25.1	22.4	57.9
26	31.6	65.1	46.3	71.9	98.8	105.7	154.0	106.2	38.1	26.5	19.2	52.5
27	29.5	65.9	46.5	67.4	71.4	114.9	118.8	92.3	34.0	25.1	22.3	48.0
28	28.9	71.7	45.1	64.5	77.4	174.8	113.5	87.9	32.0	26.0	21.0	43.0
29	26.9	79.9	41.7	62.5	60.3	143.9	123.2	83.8	32.1	24.4	21.5	38.9
30	25.8		46.6	59.7	60.0	140.7	282.0	93.1	31.7	25.5	22.1	33.5
31	25.8		49.8		54.6		152.9	97.1		26.4		28.8
Average	52.7	49.9	62.6	98.6	70.8	138.0	131.2	192.3	69.9	32.4	22.8	56.9
Maximum	412.5	106.6	89.6	270.8	129.1	432.4	282.0	617.4	117.2	70.4	32.3	234.6
Minimum	10.4	23.8	41.7	53.4	52.3	56.1	86.2	83.8	31.7	24.4	18.8	19.6

Average annual discharge = 82 (m^3/sec)

Annual inflow volume = 2,582 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2009

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	28.4	46.7	70.2	51.0	82.1	62.4	55.0	74.7	109.9	30.1	17.7	15.5
2	28.1	44.1	65.2	73.8	85.7	59.4	60.1	78.4	115.8	32.0	17.9	16.8
3	28.1	44.5	66.3	126.5	79.8	63.4	59.7	98.2	145.9	30.2	17.4	15.5
4	30.3	44.0	130.4	109.9	95.6	62.5	58.7	69.9	145.1	47.2	15.9	16.8
5	33.0	47.3	94.8	100.0	99.1	62.2	53.1	77.2	95.7	36.8	17.4	15.9
6	29.2	104.0	90.9	117.9	86.9	56.4	50.2	82.0	78.3	33.6	17.5	16.8
7	26.0	81.9	80.2	234.1	70.1	40.9	37.7	111.2	68.1	31.1	17.5	17.4
8	26.0	65.9	69.6	194.5	70.7	41.4	36.6	79.6	62.8	29.8	17.6	15.0
9	27.9	63.7	59.9	208.7	70.6	35.0	40.3	67.4	60.4	29.6	21.5	14.7
10	28.0	68.2	53.0	151.0	70.2	35.1	53.5	96.8	60.7	29.4	59.8	15.9
11	28.4	87.2	53.9	131.5	69.2	36.9	52.9	76.6	76.6	27.7	31.4	16.2
12	26.7	83.6	49.2	116.4	64.5	37.8	62.9	71.2	74.4	27.1	22.1	16.6
13	26.8	80.6	50.5	107.6	61.5	38.3	128.1	90.0	60.5	26.1	19.9	16.5
14	26.9	283.3	51.0	101.7	67.3	38.5	81.5	90.2	57.7	25.7	20.1	16.1
15	27.3	147.3	53.3	92.2	73.1	37.3	62.5	234.2	54.3	24.8	20.6	14.9
16	29.6	122.1	54.1	88.5	69.7	83.9	54.0	222.8	63.6	23.1	19.1	14.9
17	34.0	107.2	51.7	93.2	71.7	78.8	51.0	180.1	55.1	22.8	19.5	14.8
18	50.1	106.0	54.1	92.2	84.1	57.3	123.3	116.4	41.3	21.6	20.5	14.9
19	101.9	94.3	54.2	93.0	90.6	46.8	76.0	90.7	40.2	21.3	19.1	13.8
20	71.7	107.9	52.7	89.8	86.4	38.4	64.4	99.2	38.5	21.4	20.5	13.4
21	51.2	92.9	53.1	91.0	91.3	34.9	83.4	72.0	37.4	21.1	17.8	14.3
22	45.7	83.8	48.4	97.5	72.3	35.2	147.3	81.0	36.6	21.7	17.6	14.4
23	41.4	88.1	47.2	83.8	65.5	36.5	135.2	67.5	34.0	21.4	17.6	13.9
24	42.6	127.2	48.1	76.4	63.0	37.6	129.4	78.0	33.7	21.0	17.6	14.5
25	46.0	99.6	69.7	70.2	63.5	41.9	83.8	66.6	31.3	21.0	17.7	14.3
26	60.9	89.8	79.1	68.7	61.5	37.9	65.8	124.2	31.0	19.7	17.7	14.3
27	82.9	81.7	54.5	71.4	58.2	43.9	78.6	84.1	30.2	19.0	18.3	14.8
28	68.6	74.3	76.8	71.5	60.1	48.0	169.8	61.4	31.9	18.8	16.9	13.3
29	52.8		69.8	79.6	58.7	51.8	174.0	59.2	31.6	19.1	18.3	13.4
30	46.0		86.7	77.5	56.7	62.5	147.0	54.9	33.8	18.2	16.9	12.6
31	46.1		60.6		57.9		81.6	86.9		18.2		13.0
Average	41.7	91.7	64.5	105.4	72.8	48.1	82.5	94.9	61.2	25.5	20.3	15.0
Maximum	101.9	283.3	130.4	234.1	99.1	83.9	174.0	234.2	145.9	47.2	59.8	17.4
Minimum	26.0	44.0	47.2	51.0	56.7	34.9	36.6	54.9	30.2	18.2	15.9	12.6

Average annual discharge = 60 (m^3/sec)

Annual inflow volume = 1,894 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2010

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13.6	12.2	183.2	69.3	63.3	81.5	61.8	334.5	175.7	52.8	26.3	17.5
2	13.2	11.8	142.2	67.0	63.4	74.5	69.4	496.9	119.9	50.2	26.4	17.4
3	13.2	11.4	111.9	60.6	67.2	76.7	63.5	387.1	133.6	44.4	26.3	17.0
4	13.2	11.4	104.9	57.3	70.7	81.6	62.3	272.4	103.5	43.8	24.2	16.7
5	13.2	12.0	123.6	56.5	82.6	85.3	67.4	360.8	104.1	43.8	24.1	17.2
6	13.4	13.5	96.9	56.5	129.8	63.3	71.3	462.7	94.1	38.7	24.8	15.4
7	13.3	49.2	88.5	56.2	88.3	57.7	65.7	348.7	84.6	39.7	24.4	15.0
8	13.4	410.3	84.5	60.7	105.0	71.0	62.7	250.3	90.0	39.0	23.8	15.2
9	13.4	797.7	80.6	59.8	80.9	54.2	62.8	221.7	91.2	40.5	23.9	15.5
10	13.6	234.3	82.6	61.2	70.6	58.8	75.9	189.1	85.2	40.0	20.7	15.9
11	13.6	154.6	81.1	71.3	78.1	56.2	79.4	205.4	86.9	38.6	20.4	16.1
12	13.8	124.8	80.2	68.0	66.3	49.5	92.8	235.2	88.1	38.4	20.2	16.3
13	13.9	104.1	80.2	75.2	67.4	62.4	70.8	241.1	109.6	37.5	20.5	16.6
14	13.8	85.4	80.0	68.0	72.1	59.9	63.0	228.3	102.4	37.8	18.2	16.9
15	13.8	70.6	81.9	66.8	66.8	75.2	57.4	339.8	96.4	37.4	18.7	17.1
16	13.8	66.7	84.5	66.6	62.6	62.1	60.7	281.6	83.7	37.5	18.5	17.2
17	12.8	60.8	87.9	70.3	63.5	61.7	59.4	221.1	73.0	37.6	17.7	16.7
18	12.1	56.1	90.3	70.9	74.5	63.2	100.7	216.2	77.3	36.2	19.5	16.6
19	12.4	55.2	89.9	89.3	96.9	61.1	93.5	205.7	76.0	34.8	18.8	15.0
20	12.1	53.4	93.8	87.3	76.9	54.7	186.3	243.0	67.9	34.6	17.1	15.0
21	12.3	55.3	91.5	84.8	67.1	57.5	199.4	201.6	63.6	31.1	17.4	14.8
22	11.9	65.4	93.3	77.7	78.5	61.8	221.3	176.9	69.8	112.9	17.3	14.6
23	12.1	69.8	94.0	67.5	71.7	65.6	171.6	173.3	78.9	72.1	17.6	14.4
24	10.4	69.4	96.4	61.3	70.1	76.5	99.8	197.8	87.8	47.6	17.4	14.4
25	10.7	65.3	91.3	51.9	73.4	78.0	78.4	197.0	78.2	38.0	17.6	14.4
26	10.3	66.4	86.3	46.9	75.2	85.8	165.6	185.3	64.2	33.8	17.7	14.4
27	10.1	107.3	87.7	56.6	75.8	72.2	296.5	151.3	57.0	31.1	17.7	14.3
28	10.5	104.0	88.1	69.7	149.4	67.9	995.7	131.6	57.5	31.1	17.7	14.3
29	12.6		83.2	68.8	151.0	68.9	540.5	121.6	54.1	28.5	17.8	14.3
30	22.2		102.0	65.2	102.9	61.9	468.4	111.6	53.0	28.7	17.6	16.5
31	15.8		86.6		84.5		310.3	105.0		28.4		25.7
Average	13.1	107.1	95.1	66.3	82.1	66.9	163.7	241.8	86.9	41.5	20.3	16.1
Maximum	22.2	797.7	183.2	89.3	151.0	85.8	995.7	496.9	175.7	112.9	26.4	25.7
Minimum	10.1	11.4	80.0	46.9	62.6	49.5	57.4	105.0	53.0	28.4	17.1	14.3

Average annual discharge = 83 (m^3/sec)

Annual inflow volume = 2,632 (Mm^3)

River: Poonch **Station:** EFlow Site 1 **Year:** 2011

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.2	14.1	59.2	103.8	117.1	84.1	90.7	47.4	223.9	95.7	58.8	40.4
2	13.5	13.1	71.9	104.3	128.4	64.2	61.1	31.4	145.0	97.1	58.4	37.3
3	14.3	12.3	169.9	90.7	129.0	67.2	63.3	60.2	109.7	88.3	54.8	36.1
4	15.5	11.4	296.5	82.1	127.7	54.9	60.5	86.6	143.1	85.3	53.3	34.8
5	16.7	10.6	185.0	83.3	116.0	63.0	53.5	59.8	136.1	82.4	52.6	33.4
6	18.2	9.7	142.0	77.9	131.8	70.2	44.9	36.2	126.8	87.9	52.7	32.1
7	18.5	304.4	128.0	69.6	116.7	64.3	60.9	183.3	141.0	86.1	52.9	31.1
8	17.6	179.5	131.6	63.6	97.6	66.0	65.4	123.9	251.1	79.6	52.4	30.0
9	16.9	86.8	125.1	64.8	99.6	63.6	71.5	134.8	225.7	81.9	53.2	29.7
10	15.9	49.6	120.7	69.6	101.5	81.5	79.2	118.6	233.2	80.2	52.6	29.6
11	15.7	37.6	116.4	160.0	113.0	78.0	53.3	180.1	160.8	71.3	52.9	29.3
12	15.0	37.8	111.9	161.7	95.8	106.3	41.0	206.6	123.9	70.8	49.1	29.1
13	13.7	159.7	107.5	137.3	104.3	81.2	41.4	165.2	122.8	70.2	50.8	28.8
14	12.3	470.4	104.9	119.9	96.5	67.3	99.5	129.0	145.0	70.8	46.6	28.8
15	21.6	198.1	109.8	112.6	96.1	68.9	66.8	130.3	251.9	68.5	47.1	28.5
16	21.7	132.8	126.0	108.3	107.0	63.0	181.7	132.5	814.7	65.4	50.1	28.4
17	18.5	123.7	133.7	396.2	105.3	78.1	85.1	127.3	289.1	64.3	47.3	28.3
18	18.9	99.1	136.7	306.1	96.5	79.4	73.9	113.9	204.7	62.7	48.7	26.4
19	20.5	79.7	388.9	215.5	97.6	76.6	52.0	107.9	176.0	63.3	49.2	26.8
20	17.9	68.9	272.5	181.1	104.7	72.7	44.8	132.2	161.4	60.9	51.7	28.7
21	18.5	64.7	161.8	164.4	103.9	60.9	51.1	112.6	152.9	60.9	48.3	28.5
22	19.4	59.2	128.8	142.9	81.7	56.8	60.8	98.5	150.6	61.4	45.1	26.9
23	17.5	60.2	125.0	146.1	87.2	72.4	47.4	89.9	152.7	65.7	47.7	26.1
24	18.9	71.0	122.0	148.7	75.3	49.1	145.6	164.4	143.1	68.4	48.2	26.7
25	18.7	70.2	121.4	145.2	83.6	92.7	125.0	218.0	121.2	67.0	47.9	26.5
26	18.0	68.3	121.1	143.8	85.9	118.2	93.0	119.0	122.9	60.0	47.7	26.6
27	17.5	70.6	112.4	141.0	84.6	79.7	70.4	200.0	108.1	58.3	47.6	26.6
28	16.5	60.6	124.8	140.5	81.4	122.8	61.1	214.1	102.6	57.2	45.6	26.4
29	13.4		141.3	137.1	76.8	87.5	115.4	174.6	101.4	57.9	44.0	26.4
30	15.2		128.0	125.5	81.3	83.1	72.4	135.2	96.0	58.6	43.6	23.7
31	15.1		105.6		82.4		57.4	113.3		59.2		24.0
Average	17.1	93.7	142.9	138.1	100.2	75.8	73.9	127.3	181.2	71.2	50.0	29.2
Maximum	21.7	470.4	388.9	396.2	131.8	122.8	181.7	218.0	814.7	97.1	58.8	40.4
Minimum	12.3	9.7	59.2	63.6	75.3	49.1	41.0	31.4	96.0	57.2	43.6	23.7

Average annual discharge = 91 (m^3/sec)

Annual inflow volume = 2,885 (Mm^3)

APPENDIX C

SYNTHETIC MEAN DAILY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 2
(WITHOUT PROJECT)

River: Poonch **Station:** EFlow Site 2 **Year:** 1960

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.5	41.1	26.4	132.7	106.4	59.8	85.7	63.0	146.9	40.8	21.7	17.8
2	29.5	52.1	25.1	129.3	112.2	50.1	72.2	63.1	140.3	39.1	21.0	17.8
3	29.5	45.1	25.1	125.3	116.3	61.1	79.2	78.2	233.5	38.1	20.0	17.0
4	29.1	42.1	27.1	129.3	128.3	61.1	55.1	61.1	109.2	37.1	21.0	16.0
5	29.1	42.1	24.1	121.3	103.2	55.1	65.1	59.1	118.3	46.1	21.0	16.0
6	28.1	42.1	43.1	117.3	78.2	53.1	134.3	55.1	89.2	36.1	21.0	16.0
7	27.1	46.1	40.1	108.2	69.1	73.2	138.3	536.2	79.2	34.1	21.0	15.0
8	27.1	46.1	79.2	107.2	69.1	71.2	312.0	397.1	72.2	33.1	21.0	15.0
9	26.1	47.1	159.3	97.2	83.2	71.2	134.3	357.4	66.1	32.1	21.0	14.0
10	26.1	45.1	210.5	84.2	86.2	59.1	1,528.7	380.0	60.1	31.1	21.0	14.0
11	28.1	45.1	788.7	84.2	86.2	60.1	2,427.7	127.3	73.2	30.1	21.0	14.0
12	26.1	46.1	214.5	89.2	89.2	66.1	573.2	140.3	56.1	29.1	21.0	13.0
13	28.1	47.1	167.4	89.2	92.2	58.1	328.7	303.7	55.1	29.1	22.0	13.0
14	27.1	46.1	147.3	108.2	89.2	46.1	1,361.3	156.3	51.1	28.1	21.0	13.0
15	29.1	46.1	142.3	97.2	78.2	64.1	663.4	440.0	50.1	28.1	21.0	12.0
16	27.1	45.1	317.7	119.3	71.2	61.1	297.6	998.3	47.1	33.1	20.0	14.0
17	26.1	43.1	248.5	124.3	92.2	46.1	185.4	177.4	73.2	29.1	20.0	25.1
18	26.1	39.1	175.4	142.3	116.3	44.1	323.7	379.8	64.1	27.1	20.0	19.0
19	26.1	37.1	154.3	250.5	86.2	43.1	157.3	173.4	56.1	27.1	20.0	16.0
20	144.3	37.1	210.5	121.3	81.2	43.1	211.5	317.7	56.1	26.1	19.0	14.0
21	70.2	33.1	147.3	105.2	80.2	45.1	123.3	212.5	50.1	26.1	19.0	13.0
22	48.1	33.1	195.4	100.2	73.2	46.1	105.2	186.4	48.1	26.1	18.0	12.0
23	43.1	31.1	175.4	112.2	62.1	49.1	97.2	297.6	46.1	25.1	18.0	12.0
24	42.1	29.1	140.3	114.2	61.1	63.1	90.2	161.3	74.2	25.1	19.0	12.0
25	45.1	29.1	139.3	105.2	65.1	58.1	88.2	150.3	70.2	25.1	18.0	12.0
26	43.1	28.1	145.3	106.2	61.1	55.1	198.4	164.4	53.1	25.1	18.0	12.0
27	43.1	28.1	142.3	92.2	58.1	60.1	101.2	151.3	49.1	24.1	18.0	11.0
28	42.1	26.1	245.5	88.2	55.1	58.1	78.2	166.4	50.1	24.1	19.0	11.0
29	43.1	27.1	178.4	89.2	48.1	50.1	72.2	147.3	45.1	24.1	21.0	11.0
30	48.1		139.3	96.2	51.1	56.2	77.2	144.3	43.1	23.0	19.0	18.0
31	44.2		133.9		58.7		79.4	191.7		22.1		61.5
Average	38.1	39.5	161.6	112.9	80.9	56.3	330.5	233.5	74.2	29.8	20.1	16.1
Maximum	144.3	52.1	788.7	250.5	128.3	73.2	2,427.7	998.3	233.5	46.1	22.0	61.5
Minimum	26.1	26.1	24.1	84.2	48.1	43.1	55.1	55.1	43.1	22.1	18.0	11.0

Average annual discharge = 100 (m^3/sec)

Annual inflow volume = 3,167 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1961

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.4	144.3	80.2	88.2	96.2	60.1	167.4	286.6	391.8	178.4	69.1	48.1
2	19.0	273.6	76.2	91.2	95.2	66.1	102.2	488.1	530.1	103.2	55.1	32.1
3	17.0	171.4	71.2	98.2	99.2	70.2	123.3	271.6	159.3	93.2	50.1	44.1
4	11.0	173.4	63.1	89.2	101.2	75.2	128.3	169.4	164.4	89.2	46.1	43.1
5	9.0	142.3	64.1	126.3	95.2	76.2	216.5	153.3	113.2	85.2	45.1	42.1
6	8.0	124.3	59.1	98.2	88.2	134.3	236.5	122.3	216.5	82.2	45.1	42.1
7	7.0	119.3	54.1	78.2	83.2	215.5	200.4	108.2	542.2	79.2	44.1	41.1
8	7.0	97.2	54.1	73.2	77.2	263.6	337.7	114.2	1,256.7	77.2	43.1	40.1
9	7.0	81.2	50.1	74.2	83.2	188.4	221.5	779.7	942.0	98.2	43.1	39.1
10	7.0	75.2	49.1	212.5	82.2	156.3	147.3	624.4	536.2	88.2	42.1	38.1
11	7.0	72.2	60.1	944.0	81.2	130.3	136.3	267.6	345.7	72.2	41.1	37.1
12	7.0	66.1	87.2	505.1	81.2	119.3	99.2	191.4	283.6	72.2	39.1	37.1
13	6.0	59.1	82.2	908.0	80.2	98.2	86.2	158.3	300.7	59.1	38.1	37.1
14	6.0	57.1	88.2	359.8	79.2	95.2	88.2	147.3	253.5	59.1	38.1	36.1
15	6.0	55.1	97.2	267.6	201.4	83.2	205.4	169.4	496.1	56.1	39.1	35.1
16	6.0	56.1	103.2	208.5	113.2	67.1	567.2	246.5	340.7	55.1	67.1	38.1
17	6.0	75.2	112.2	185.4	69.1	63.1	340.7	193.4	258.6	52.1	56.1	84.2
18	6.0	94.2	98.2	168.4	56.1	64.1	133.3	189.4	217.5	52.1	43.1	57.1
19	6.0	91.2	130.3	158.3	55.1	71.2	98.2	108.2	188.4	53.1	41.1	45.1
20	6.0	92.2	116.3	231.5	55.1	80.2	112.2	357.8	168.4	55.1	40.1	43.1
21	6.0	85.2	99.2	244.5	58.1	68.1	147.3	139.3	163.4	57.1	39.1	41.1
22	6.0	81.2	75.2	176.4	73.2	106.2	1,165.5	104.2	171.4	55.1	38.1	40.1
23	6.0	73.2	70.2	128.3	85.2	97.2	867.9	154.3	190.4	52.1	36.1	38.1
24	6.0	75.2	127.3	102.2	62.1	88.2	357.8	255.6	273.6	49.1	34.1	37.1
25	7.0	65.1	126.3	95.2	37.1	95.2	382.8	340.7	365.8	48.1	33.1	37.1
26	34.1	66.1	85.2	91.2	35.1	164.4	513.1	177.4	354.8	44.1	53.1	37.1
27	24.1	76.2	80.2	107.2	29.1	145.3	300.7	162.4	174.4	42.1	146.3	36.1
28	19.0	81.2	111.2	105.2	29.1	89.2	229.5	125.3	113.2	40.1	103.2	35.1
29	530.1		88.2	113.2	40.1	118.3	425.9	105.2	106.2	72.2	59.1	33.1
30	442.0		92.2	116.3	52.1	186.4	655.4	202.4	107.2	138.3	51.1	31.1
31	245.5		100.2		53.1		419.9	493.1		121.3		29.1
Average	48.6	97.3	85.5	208.2	75.1	111.2	297.2	238.9	324.2	73.5	50.6	40.5
Maximum	530.1	273.6	130.3	944.0	201.4	263.6	1,165.5	779.7	1,256.7	178.4	146.3	84.2
Minimum	6.0	55.1	49.1	73.2	29.1	60.1	86.2	104.2	106.2	40.1	33.1	29.1

Average annual discharge = 138 (m^3/sec)

Annual inflow volume = 4,337 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1962

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.1	20.0	62.1	134.3	128.3	66.1	60.1	104.2	80.2	69.1	28.1	21.0
2	24.1	19.0	58.1	89.2	101.2	57.1	48.1	112.2	67.1	71.2	29.1	20.0
3	23.0	19.0	78.2	74.2	79.2	57.1	44.1	76.2	88.2	68.1	28.1	24.1
4	23.0	19.0	162.4	81.2	76.2	65.1	40.1	73.2	134.3	66.1	27.1	22.0
5	23.0	18.0	139.3	76.2	64.1	57.1	39.1	127.3	172.4	60.1	26.1	22.0
6	22.0	18.0	122.3	85.2	61.1	62.1	39.1	223.5	88.2	56.1	25.1	22.0
7	22.0	24.1	93.2	155.3	59.1	63.1	50.1	163.4	62.1	54.1	25.1	21.0
8	22.0	33.1	85.2	190.4	67.1	71.2	71.2	101.2	27.1	54.1	24.1	22.0
9	22.0	25.1	72.2	581.3	77.2	72.2	62.1	190.4	28.1	54.1	22.0	21.0
10	22.0	24.1	71.2	320.7	146.3	64.1	102.2	222.5	66.1	54.1	22.0	21.0
11	23.0	30.1	70.2	198.4	106.2	92.2	65.1	85.2	280.6	52.1	21.0	21.0
12	28.1	35.1	62.1	170.4	85.2	64.1	111.2	61.1	238.5	49.1	22.0	22.0
13	25.1	31.1	59.1	161.3	126.3	225.5	76.2	84.2	79.2	49.1	21.0	21.0
14	23.0	29.1	67.1	148.3	98.2	77.2	95.2	79.2	48.1	49.1	21.0	24.1
15	22.0	29.1	65.1	148.3	93.2	63.1	60.1	129.3	49.1	46.1	21.0	23.0
16	22.0	31.1	67.1	134.3	86.2	47.1	174.4	592.8	95.2	44.1	20.0	23.0
17	21.0	130.3	64.1	117.3	90.2	50.1	259.6	127.3	106.2	44.1	20.0	42.1
18	21.0	65.1	64.1	136.3	89.2	54.1	203.4	117.3	85.2	42.1	22.0	68.1
19	21.0	47.1	62.1	145.3	48.1	61.1	137.3	97.2	71.2	39.1	29.1	31.1
20	20.0	43.1	65.1	148.3	58.1	57.1	170.4	98.2	206.4	38.1	68.1	26.1
21	20.0	42.1	71.2	145.3	74.2	65.1	1,247.9	251.5	88.2	37.1	153.3	25.1
22	20.0	42.1	71.2	161.3	88.2	62.1	337.7	157.3	391.8	34.1	81.2	25.1
23	20.0	40.1	66.1	184.4	85.2	65.1	166.4	88.2	265.6	33.1	42.1	25.1
24	19.0	215.5	73.2	162.4	79.2	56.1	134.3	74.2	92.2	34.1	34.1	23.0
25	19.0	167.4	71.2	150.3	77.2	73.2	117.3	68.1	79.2	32.1	29.1	25.1
26	19.0	132.3	72.2	153.3	75.2	91.2	150.3	141.3	157.3	32.1	25.1	38.1
27	21.0	98.2	74.2	152.3	73.2	74.2	234.5	117.3	156.3	32.1	24.1	165.4
28	22.0	76.2	73.2	132.3	72.2	59.1	166.4	264.6	188.4	31.1	27.1	48.1
29	21.0		81.2	129.3	73.2	58.1	114.2	137.3	107.2	30.1	24.1	32.1
30	20.0		89.2	126.3	68.1	85.2	137.3	165.4	72.2	29.1	25.1	33.1
31	19.0		87.2		58.1		85.2	107.2		28.1		24.1
Average	21.8	53.7	78.1	159.8	82.7	70.6	154.9	143.2	122.4	45.6	32.9	31.7
Maximum	28.1	215.5	162.4	581.3	146.3	225.5	1,247.9	592.8	391.8	71.2	153.3	165.4
Minimum	19.0	18.0	58.1	74.2	48.1	47.1	39.1	61.1	27.1	28.1	20.0	20.0

Average annual discharge = 83 (m^3/sec)

Annual inflow volume = 2,624 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1963

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.0	21.0	32.1	83.2	60.1	241.5	216.5	879.2	402.9	34.1	14.0	23.0
2	21.0	20.0	31.1	77.2	163.4	113.2	194.4	266.6	136.3	29.1	15.0	21.0
3	22.0	20.0	34.1	187.4	134.3	100.2	140.3	130.3	87.2	25.1	18.0	22.0
4	24.1	20.0	67.1	188.4	114.2	106.2	113.2	136.3	105.2	23.0	16.0	21.0
5	25.1	19.0	202.4	51.1	181.4	107.2	74.2	342.7	122.3	21.0	15.0	20.0
6	26.1	19.0	247.5	70.2	205.4	111.2	70.2	227.5	151.3	23.0	13.0	19.0
7	25.1	19.0	124.3	96.2	129.3	100.2	85.2	194.4	91.2	27.1	15.0	19.0
8	25.1	19.0	137.3	103.2	126.3	97.2	112.2	311.7	56.1	27.1	16.0	16.0
9	25.1	19.0	141.3	108.2	208.5	88.2	75.2	267.6	134.3	27.1	13.0	17.0
10	25.1	19.0	240.5	84.2	215.5	63.1	84.2	133.3	127.3	26.1	11.0	17.0
11	24.1	19.0	117.3	91.2	145.3	93.2	170.4	276.6	71.2	25.1	10.0	17.0
12	23.0	18.0	90.2	99.2	136.3	94.2	261.6	314.7	45.1	24.1	10.0	17.0
13	27.1	19.0	76.2	106.2	165.4	91.2	182.4	211.5	33.1	22.0	10.0	158.3
14	28.1	19.0	65.1	109.2	317.7	90.2	210.5	130.3	53.1	21.0	10.0	111.2
15	27.1	37.1	75.2	106.2	185.4	91.2	103.2	128.3	56.1	21.0	17.0	32.1
16	26.1	147.3	182.4	104.2	201.4	99.2	57.1	116.3	45.1	22.0	31.1	29.1
17	23.0	101.2	198.4	161.3	188.4	100.2	58.1	274.6	76.2	18.0	32.1	29.1
18	22.0	67.1	137.3	130.3	150.3	108.2	379.8	448.0	62.1	17.0	34.1	27.1
19	23.0	53.1	97.2	116.3	120.3	231.5	202.4	196.4	46.1	16.0	30.1	28.1
20	21.0	39.1	74.2	110.2	152.3	127.3	188.4	391.8	85.2	15.0	29.1	26.1
21	21.0	31.1	66.1	96.2	122.3	109.2	493.1	561.2	70.2	15.0	27.1	27.1
22	21.0	36.1	92.2	117.3	107.2	108.2	224.5	479.0	50.1	16.0	25.1	25.1
23	21.0	39.1	233.5	134.3	100.2	114.2	128.3	317.7	39.1	14.0	24.1	24.1
24	21.0	35.1	357.8	186.4	93.2	110.2	70.2	300.7	38.1	12.0	22.0	24.1
25	21.0	34.1	114.2	120.3	97.2	105.2	59.1	200.4	39.1	11.0	22.0	25.1
26	21.0	33.1	91.2	106.2	100.2	112.2	64.1	242.5	59.1	11.0	21.0	25.1
27	21.0	33.1	94.2	230.5	98.2	100.2	60.1	209.5	85.2	12.0	22.0	22.0
28	22.0	32.1	97.2	468.0	97.2	225.5	205.4	159.3	82.2	12.0	28.1	21.0
29	22.0		97.2	295.6	99.2	228.5	289.6	129.3	62.1	13.0	25.1	21.0
30	22.0		99.2	224.5	97.2	192.4	1,304.8	79.2	50.1	12.0	27.1	22.0
31	20.0		99.2		101.2		706.5	245.5		13.0		27.1
Average	23.2	35.3	123.0	138.8	142.4	122.0	212.4	267.8	85.4	19.5	20.1	30.1
Maximum	28.1	147.3	357.8	468.0	317.7	241.5	1,304.8	879.2	402.9	34.1	34.1	158.3
Minimum	20.0	18.0	31.1	51.1	60.1	63.1	57.1	79.2	33.1	11.0	10.0	16.0

Average annual discharge = 102 (m^3/sec)

Annual inflow volume = 3,227 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1964

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.1	78.2	74.2	89.2	104.2	57.1	81.2	160.3	345.7	63.1	29.1	20.0
2	23.0	75.2	73.2	94.2	118.3	59.1	141.3	155.3	219.5	60.1	28.1	20.0
3	23.0	72.2	93.2	342.7	119.3	59.1	280.6	141.3	169.4	60.1	27.1	20.0
4	23.0	68.1	88.2	183.4	116.3	60.1	154.3	132.3	141.3	59.1	26.1	20.0
5	25.1	64.1	78.2	137.3	101.2	59.1	159.3	141.3	140.3	58.1	25.1	20.0
6	79.2	65.1	75.2	124.3	102.2	64.1	124.3	166.4	96.2	57.1	23.0	20.0
7	419.9	68.1	72.2	121.3	95.2	61.1	177.4	171.4	73.2	55.1	22.0	20.0
8	1,514.3	67.1	73.2	117.3	99.2	55.1	178.4	174.4	76.2	53.1	22.0	20.0
9	604.3	68.1	75.2	112.2	97.2	49.1	94.2	228.5	70.2	51.1	22.0	20.0
10	146.3	70.2	80.2	112.2	102.2	48.1	97.2	646.4	267.6	50.1	22.0	70.2
11	158.3	71.2	85.2	126.3	101.2	47.1	106.2	171.4	132.3	49.1	22.0	118.3
12	147.3	70.2	83.2	147.3	81.2	55.1	106.2	224.5	151.3	49.1	22.0	68.1
13	100.2	69.1	89.2	149.3	88.2	55.1	263.6	134.3	163.4	47.1	21.0	37.1
14	83.2	72.2	100.2	142.3	160.3	143.3	264.6	193.4	163.4	46.1	20.0	36.1
15	69.1	70.2	94.2	144.3	87.2	130.3	1,545.3	1,309.8	145.3	44.1	19.0	36.1
16	61.1	70.2	99.2	270.6	85.2	117.3	547.2	782.7	153.3	43.1	19.0	35.1
17	57.1	80.2	102.2	183.4	76.2	104.2	508.1	646.4	142.3	40.1	19.0	34.1
18	55.1	200.4	141.3	121.3	75.2	81.2	340.7	584.3	107.2	38.1	19.0	34.1
19	53.1	132.3	253.5	96.2	75.2	78.2	186.4	396.9	110.2	37.1	19.0	34.1
20	50.1	121.3	167.4	92.2	72.2	78.2	147.3	493.1	108.2	35.1	19.0	34.1
21	80.2	107.2	142.3	90.2	113.2	77.2	115.2	779.7	101.2	35.1	19.0	34.1
22	170.4	97.2	128.3	92.2	110.2	82.2	90.2	422.9	94.2	34.1	19.0	34.1
23	126.3	97.2	118.3	94.2	87.2	87.2	81.2	297.6	87.2	33.1	19.0	34.1
24	106.2	91.2	126.3	96.2	65.1	88.2	95.2	788.7	82.2	33.1	19.0	35.1
25	99.2	87.2	145.3	118.3	54.1	83.2	1,763.8	493.1	78.2	32.1	19.0	32.1
26	95.2	83.2	124.3	203.4	54.1	78.2	723.6	320.7	96.2	32.1	19.0	29.1
27	94.2	87.2	114.2	166.4	52.1	87.2	491.1	255.6	77.2	31.1	19.0	26.1
28	91.2	77.2	109.2	155.3	50.1	85.2	396.9	215.5	72.2	31.1	19.0	24.1
29	84.2	75.2	117.3	128.3	48.1	87.2	508.1	187.4	67.1	31.1	19.0	21.0
30	82.2		106.2	111.2	48.1	87.2	323.7	196.4	64.1	30.1	20.0	20.0
31	77.2		92.2		53.1		192.4	204.4		30.1		20.0
Average	155.6	84.7	107.2	138.8	86.9	76.8	331.8	361.8	126.5	43.5	21.2	33.1
Maximum	1,514.3	200.4	253.5	342.7	160.3	143.3	1,763.8	1,309.8	345.7	63.1	29.1	118.3
Minimum	23.0	64.1	72.2	89.2	48.1	47.1	81.2	132.3	64.1	30.1	19.0	20.0

Average annual discharge = 131 (m^3/sec)

Annual inflow volume = 4,154 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1965

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.0	59.1	118.3	317.7	227.5	161.3	115.2	200.4	85.2	39.1	19.0	17.0
2	20.0	62.1	114.2	182.4	205.4	166.4	175.4	132.3	83.2	38.1	19.0	17.0
3	20.0	141.3	116.3	155.3	189.4	168.4	153.3	122.3	91.2	35.1	19.0	17.0
4	42.1	317.7	115.2	244.5	189.4	168.4	173.4	139.3	81.2	38.1	19.0	17.0
5	27.1	157.3	112.2	201.4	185.4	164.4	132.3	142.3	69.1	34.1	27.1	17.0
6	25.1	68.1	119.3	303.7	191.4	190.4	119.3	173.4	61.1	28.1	37.1	17.0
7	24.1	87.2	116.3	430.9	193.4	176.4	113.2	155.3	59.1	26.1	24.1	16.0
8	24.1	81.2	144.3	340.7	205.4	142.3	117.3	124.3	64.1	26.1	21.0	16.0
9	25.1	71.2	203.4	297.6	200.4	139.3	171.4	164.4	65.1	28.1	20.0	16.0
10	22.0	65.1	126.3	250.5	166.4	140.3	150.3	161.3	61.1	29.1	19.0	16.0
11	21.0	68.1	112.2	234.5	164.4	134.3	120.3	117.3	62.1	27.1	19.0	16.0
12	21.0	70.2	106.2	216.5	151.3	132.3	116.3	106.2	59.1	27.1	19.0	15.0
13	21.0	115.2	112.2	234.5	144.3	142.3	114.2	93.2	56.1	36.1	19.0	15.0
14	20.0	106.2	122.3	209.5	149.3	148.3	108.2	103.2	57.1	52.1	41.1	15.0
15	20.0	87.2	128.3	188.4	163.4	147.3	203.4	95.2	52.1	24.1	36.1	15.0
16	20.0	130.3	131.3	198.4	163.4	136.3	405.9	92.2	50.1	22.0	25.1	15.0
17	20.0	830.8	123.3	196.4	164.4	123.3	218.5	121.3	49.1	22.0	20.0	14.0
18	20.0	402.9	132.3	331.7	168.4	108.2	362.8	101.2	50.1	22.0	19.0	14.0
19	522.1	246.5	251.5	502.1	171.4	109.2	226.5	104.2	69.1	21.0	18.0	14.0
20	160.3	198.4	201.4	303.7	203.4	143.3	323.7	130.3	62.1	20.0	19.0	14.0
21	79.2	166.4	126.3	217.5	253.5	156.3	156.3	102.2	63.1	19.0	19.0	14.0
22	63.1	149.3	113.2	204.4	402.9	157.3	130.3	405.9	91.2	19.0	19.0	13.0
23	59.1	139.3	105.2	251.5	354.8	158.3	320.7	161.3	57.1	18.0	19.0	13.0
24	53.1	132.3	97.2	944.0	250.5	146.3	430.9	365.8	48.1	19.0	19.0	14.0
25	47.1	129.3	101.2	468.0	178.4	146.3	578.3	173.4	52.1	19.0	19.0	15.0
26	45.1	130.3	121.3	337.7	161.3	140.3	765.7	136.3	51.1	19.0	18.0	15.0
27	38.1	126.3	123.3	297.6	169.4	135.3	297.6	110.2	47.1	19.0	18.0	14.0
28	44.1	124.3	104.2	283.6	171.4	143.3	174.4	179.4	44.1	19.0	18.0	13.0
29	44.1		101.2	245.5	163.4	140.3	143.3	146.3	46.1	19.0	17.0	13.0
30	71.2		100.2	229.5	166.4	125.3	151.3	123.3	41.1	19.0	17.0	13.0
31	64.1		199.4		158.3		176.4	96.2		19.0		13.0
Average	55.0	159.4	129.0	294.0	194.5	146.4	224.1	147.7	61.0	25.9	21.4	15.0
Maximum	522.1	830.8	251.5	944.0	402.9	190.4	765.7	405.9	91.2	52.1	41.1	17.0
Minimum	20.0	59.1	97.2	155.3	144.3	108.2	108.2	92.2	41.1	18.0	17.0	13.0

Average annual discharge = 122 (m^3/sec)

Annual inflow volume = 3,860 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1966

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13.0	12.0	88.2	161.3	148.3	99.2	155.3	1,018.2	132.3	125.3	40.1	28.1
2	13.0	12.0	79.2	145.3	127.3	83.2	101.2	516.1	93.2	122.3	41.1	27.1
3	13.0	12.0	77.2	151.3	117.3	77.2	115.2	408.9	493.1	126.3	41.1	27.1
4	13.0	12.0	136.3	157.3	130.3	78.2	247.5	362.8	176.4	207.4	42.1	27.1
5	13.0	12.0	164.4	138.3	140.3	91.2	144.3	374.8	155.3	157.3	40.1	27.1
6	13.0	12.0	115.2	126.3	139.3	80.2	102.2	508.1	136.3	166.4	38.1	27.1
7	13.0	12.0	96.2	210.5	149.3	78.2	72.2	976.1	185.4	122.3	39.1	27.1
8	12.0	52.1	99.2	139.3	156.3	96.2	79.2	451.0	2,160.7	116.3	59.1	26.1
9	12.0	70.2	98.2	120.3	156.3	107.2	73.2	325.7	2,802.1	110.2	48.1	26.1
10	12.0	62.1	97.2	112.2	150.3	98.2	69.1	311.7	430.9	291.6	35.1	26.1
11	12.0	56.1	113.2	108.2	311.7	70.2	57.1	303.7	325.7	203.4	34.1	26.1
12	12.0	320.7	118.3	105.2	215.5	64.1	193.4	215.5	256.6	145.3	34.1	26.1
13	12.0	376.8	119.3	125.3	181.4	78.2	232.5	229.5	246.5	127.3	34.1	26.1
14	12.0	187.4	119.3	212.5	144.3	79.2	181.4	203.4	227.5	119.3	34.1	25.1
15	12.0	98.2	122.3	167.4	119.3	79.2	91.2	291.6	216.5	117.3	33.1	25.1
16	12.0	67.1	123.3	161.3	102.2	115.2	121.3	191.4	204.4	114.2	33.1	25.1
17	12.0	49.1	118.3	174.4	105.2	115.2	89.2	176.4	223.5	112.2	33.1	25.1
18	12.0	40.1	264.6	138.3	106.2	140.3	87.2	183.4	206.4	109.2	32.1	25.1
19	12.0	37.1	158.3	116.3	109.2	239.5	81.2	283.6	237.5	106.2	31.1	25.1
20	12.0	35.1	140.3	113.2	113.2	187.4	186.4	365.8	198.4	255.6	31.1	24.1
21	12.0	207.4	112.2	119.3	110.2	142.3	87.2	181.4	189.4	99.2	31.1	24.1
22	12.0	142.3	161.3	145.3	110.2	176.4	262.6	121.3	174.4	75.2	30.1	24.1
23	12.0	63.1	291.6	118.3	114.2	276.6	399.9	110.2	186.4	75.2	29.1	24.1
24	12.0	56.1	229.5	120.3	115.2	402.9	241.5	114.2	161.3	76.2	29.1	24.1
25	12.0	54.1	184.4	106.2	114.2	283.6	858.9	113.2	147.3	79.2	29.1	43.1
26	12.0	271.6	176.4	106.2	130.3	131.3	981.1	90.2	143.3	79.2	29.1	44.1
27	12.0	178.4	430.9	129.3	139.3	104.2	245.5	98.2	141.3	71.2	29.1	38.1
28	12.0	131.3	217.5	190.4	120.3	137.3	294.6	104.2	136.3	59.1	29.1	36.1
29	12.0		168.4	198.4	143.3	166.4	213.5	77.2	130.3	57.1	28.1	33.1
30	12.0		169.4	185.4	202.4	262.6	379.8	85.2	124.3	50.1	28.1	35.1
31	12.0		159.3		147.3		978.1	102.2		41.1		45.1
Average	12.3	94.3	153.2	143.4	141.0	138.0	239.5	286.9	354.8	119.9	34.8	28.8
Maximum	13.0	376.8	430.9	212.5	311.7	402.9	981.1	1,018.2	2,802.1	291.6	59.1	45.1
Minimum	12.0	12.0	77.2	105.2	102.2	64.1	57.1	77.2	93.2	41.1	28.1	24.1

Average annual discharge = 146 (m^3/sec)

Annual inflow volume = 4,597 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1967

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	42.1	17.0	74.2	306.7	289.6	108.2	129.3	195.4	96.2	52.1	36.1	23.0
2	35.1	16.0	75.2	757.6	261.6	119.3	117.3	185.4	132.3	51.1	35.1	23.0
3	33.1	16.0	74.2	289.6	156.3	117.3	82.2	825.8	121.3	50.1	34.1	567.2
4	32.1	16.0	74.2	186.4	149.3	122.3	126.3	311.7	116.3	89.2	34.1	92.2
5	31.1	16.0	75.2	151.3	127.3	108.2	99.2	485.1	100.2	61.1	33.1	55.1
6	31.1	16.0	74.2	151.3	116.3	100.2	96.2	590.3	93.2	53.1	32.1	46.1
7	27.1	16.0	74.2	138.3	100.2	117.3	104.2	241.5	271.6	50.1	31.1	40.1
8	27.1	17.0	66.1	134.3	106.2	124.3	120.3	334.7	88.2	48.1	31.1	37.1
9	27.1	16.0	66.1	113.2	121.3	113.2	132.3	222.5	78.2	46.1	31.1	35.1
10	26.1	16.0	68.1	114.2	127.3	95.2	142.3	179.4	91.2	48.1	30.1	33.1
11	25.1	16.0	66.1	106.2	126.3	102.2	132.3	168.4	201.4	46.1	30.1	34.1
12	24.1	17.0	142.3	100.2	110.2	104.2	104.2	303.7	195.4	51.1	29.1	38.1
13	23.0	18.0	445.0	99.2	97.2	115.2	230.5	158.3	362.8	46.1	28.1	39.1
14	22.0	17.0	207.4	115.2	91.2	110.2	90.2	964.1	331.7	43.1	27.1	37.1
15	21.0	17.0	156.3	122.3	90.2	109.2	85.2	180.4	138.3	42.1	27.1	37.1
16	20.0	17.0	536.2	128.3	96.2	173.4	105.2	173.4	154.3	40.1	27.1	36.1
17	20.0	30.1	291.6	135.3	99.2	161.3	80.2	139.3	120.3	39.1	28.1	36.1
18	19.0	65.1	231.5	148.3	108.2	84.2	84.2	165.4	96.2	38.1	27.1	35.1
19	19.0	166.4	205.4	143.3	109.2	71.2	85.2	193.4	120.3	43.1	27.1	35.1
20	18.0	601.3	195.4	147.3	121.3	64.1	1,026.2	297.6	87.2	42.1	27.1	34.1
21	18.0	224.5	187.4	142.3	130.3	63.1	219.5	160.3	77.2	38.1	26.1	33.1
22	18.0	135.3	186.4	141.3	151.3	64.1	183.4	140.3	72.2	37.1	26.1	31.1
23	18.0	90.2	185.4	144.3	157.3	67.1	964.1	130.3	69.1	36.1	28.1	31.1
24	18.0	79.2	181.4	143.3	160.3	68.1	328.7	179.4	68.1	41.1	28.1	92.2
25	18.0	70.2	1,120.4	147.3	147.3	81.2	291.6	161.3	87.2	101.2	28.1	104.2
26	17.0	70.2	745.6	150.3	133.3	86.2	233.5	150.3	96.2	84.2	27.1	672.5
27	17.0	68.1	229.5	187.4	106.2	76.2	539.2	129.3	79.2	53.1	26.1	527.1
28	17.0	71.2	188.4	570.2	93.2	72.2	207.4	150.3	64.1	44.1	27.1	132.3
29	17.0		176.4	351.8	88.2	78.2	186.4	119.3	58.1	40.1	26.1	106.2
30	17.0		160.3	177.4	89.2	240.5	513.1	119.3	55.1	38.1	24.1	91.2
31	17.0		149.3		98.2		177.4	121.3		37.1		83.2
Average	23.1	69.1	216.4	191.5	127.7	103.9	226.4	254.1	124.1	49.4	29.1	103.8
Maximum	42.1	601.3	1,120.4	757.6	289.6	240.5	1,026.2	964.1	362.8	101.2	36.1	672.5
Minimum	17.0	16.0	66.1	99.2	88.2	63.1	80.2	119.3	55.1	36.1	24.1	23.0

Average annual discharge = 127 (m^3/sec)

Annual inflow volume = 4,011 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1968

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	78.2	125.3	143.3	104.2	135.3	80.2	79.2	187.4	104.2	47.1	107.2	25.1
2	74.2	112.2	139.3	99.2	140.3	81.2	83.2	189.4	96.2	44.1	134.3	24.1
3	71.2	106.2	138.3	95.2	114.2	81.2	80.2	144.3	90.2	43.1	64.1	23.0
4	67.1	102.2	136.3	95.2	99.2	114.2	97.2	320.7	88.2	84.2	55.1	23.0
5	61.1	96.2	138.3	104.2	96.2	99.2	91.2	266.6	83.2	72.2	53.1	23.0
6	69.1	155.3	136.3	130.3	89.2	81.2	103.2	663.4	80.2	60.1	50.1	23.0
7	67.1	130.3	135.3	130.3	83.2	81.2	85.2	185.4	78.2	218.5	46.1	23.0
8	58.1	110.2	136.3	125.3	71.2	95.2	96.2	200.4	74.2	84.2	43.1	22.0
9	54.1	101.2	136.3	123.3	61.1	96.2	213.5	273.6	81.2	57.1	41.1	22.0
10	59.1	99.2	133.3	117.3	57.1	108.2	174.4	255.6	73.2	67.1	39.1	23.0
11	66.1	98.2	137.3	109.2	61.1	104.2	135.3	858.9	68.1	56.1	38.1	31.1
12	64.1	98.2	136.3	108.2	67.1	183.4	223.5	351.8	80.2	45.1	44.1	83.2
13	67.1	97.2	132.3	106.2	77.2	102.2	148.3	278.6	70.2	42.1	42.1	40.1
14	62.1	106.2	134.3	218.5	85.2	96.2	242.5	410.9	67.1	82.2	37.1	30.1
15	58.1	100.2	126.3	376.8	74.2	97.2	126.3	314.7	64.1	79.2	37.1	28.1
16	57.1	96.2	124.3	185.4	72.2	97.2	126.3	233.5	68.1	59.1	35.1	26.1
17	57.1	97.2	128.3	155.3	69.1	98.2	101.2	235.5	65.1	51.1	34.1	25.1
18	55.1	98.2	279.6	142.3	71.2	95.2	95.2	393.9	63.1	51.1	33.1	24.1
19	54.1	106.2	419.9	140.3	75.2	98.2	132.3	525.1	62.1	44.1	33.1	23.0
20	365.8	561.2	280.6	139.3	90.2	98.2	133.3	294.6	61.1	41.1	31.1	23.0
21	311.7	177.4	225.5	141.3	119.3	95.2	204.4	204.4	56.1	40.1	31.1	22.0
22	177.4	164.4	176.4	138.3	189.4	93.2	151.3	342.7	54.1	38.1	30.1	23.0
23	126.3	153.3	161.3	168.4	169.4	92.2	197.4	222.5	52.1	37.1	30.1	23.0
24	123.3	146.3	148.3	147.3	100.2	92.2	141.3	185.4	50.1	37.1	28.1	23.0
25	120.3	143.3	138.3	137.3	78.2	136.3	99.2	191.4	50.1	36.1	27.1	25.1
26	123.3	149.3	230.5	132.3	76.2	163.4	83.2	151.3	50.1	35.1	26.1	25.1
27	201.4	303.7	157.3	136.3	81.2	113.2	92.2	130.3	49.1	34.1	26.1	24.1
28	342.7	224.5	130.3	135.3	78.2	127.3	191.4	119.3	54.1	33.1	26.1	23.0
29	219.5	165.4	112.2	135.3	76.2	108.2	1,191.6	112.2	52.1	32.1	26.1	22.0
30	139.3		104.2	136.3	77.2	89.2	221.5	110.2	49.1	34.1	26.1	22.0
31	133.3		106.2		81.2		168.4	109.2		35.1		21.0
Average	115.6	145.7	160.1	140.5	90.8	103.3	171.3	273.0	67.8	55.5	42.5	26.4
Maximum	365.8	561.2	419.9	376.8	189.4	183.4	1,191.6	858.9	104.2	218.5	134.3	83.2
Minimum	54.1	96.2	104.2	95.2	57.1	80.2	79.2	109.2	49.1	32.1	26.1	21.0

Average annual discharge = 116 (m^3/sec)

Annual inflow volume = 3,674 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1969

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.0	255.6	88.2	127.3	157.3	168.4	105.2	101.2	69.1	72.2	31.1	21.0
2	21.0	87.2	89.2	127.3	153.3	150.3	87.2	95.2	64.1	145.3	33.1	21.0
3	21.0	60.1	95.2	121.3	147.3	136.3	88.2	135.3	62.1	66.1	32.1	21.0
4	21.0	52.1	96.2	112.2	140.3	143.3	93.2	243.5	69.1	45.1	34.1	20.0
5	21.0	53.1	99.2	104.2	139.3	119.3	115.2	575.2	58.1	41.1	33.1	20.0
6	21.0	44.1	106.2	96.2	134.3	108.2	95.2	1,579.4	120.3	38.1	33.1	20.0
7	21.0	42.1	107.2	98.2	133.3	98.2	96.2	357.8	88.2	35.1	31.1	20.0
8	21.0	40.1	108.2	111.2	135.3	94.2	129.3	232.5	67.1	33.1	30.1	20.0
9	20.0	41.1	108.2	118.3	143.3	88.2	165.4	314.7	108.2	33.1	30.1	19.0
10	20.0	40.1	105.2	119.3	173.4	85.2	145.3	419.9	64.1	32.1	29.1	19.0
11	20.0	40.1	107.2	117.3	194.4	86.2	113.2	248.5	57.1	130.3	29.1	19.0
12	21.0	38.1	112.2	114.2	300.7	85.2	92.2	239.5	57.1	91.2	29.1	19.0
13	28.1	41.1	117.3	106.2	575.2	91.2	108.2	196.4	58.1	32.1	29.1	19.0
14	28.1	67.1	119.3	111.2	425.9	88.2	264.6	179.4	71.2	47.1	28.1	19.0
15	24.1	50.1	121.3	114.2	228.5	87.2	164.4	231.5	92.2	106.2	26.1	18.0
16	23.0	43.1	117.3	143.3	168.4	88.2	143.3	244.5	76.2	72.2	25.1	18.0
17	22.0	101.2	114.2	113.2	141.3	91.2	106.2	374.8	67.1	47.1	24.1	18.0
18	21.0	88.2	141.3	97.2	135.3	100.2	101.2	320.7	65.1	44.1	24.1	18.0
19	21.0	65.1	448.0	84.2	132.3	113.2	96.2	236.5	57.1	42.1	23.0	18.0
20	21.0	55.1	306.7	342.7	119.3	123.3	172.4	212.5	53.1	40.1	23.0	17.0
21	21.0	51.1	158.3	216.5	114.2	115.2	283.6	176.4	52.1	37.1	23.0	17.0
22	21.0	48.1	148.3	138.3	123.3	106.2	186.4	205.4	47.1	35.1	23.0	17.0
23	21.0	47.1	294.6	113.2	132.3	117.3	136.3	147.3	50.1	35.1	23.0	17.0
24	21.0	48.1	171.4	99.2	130.3	102.2	1,123.4	124.3	52.1	33.1	23.0	16.0
25	20.0	60.1	282.6	85.2	113.2	93.2	283.6	136.3	44.1	32.1	22.0	16.0
26	63.1	64.1	542.2	78.2	112.2	90.2	262.6	140.3	38.1	33.1	22.0	16.0
27	89.2	252.5	230.5	72.2	105.2	86.2	244.5	97.2	38.1	32.1	21.0	15.0
28	51.1	102.2	167.4	104.2	101.2	131.3	396.9	89.2	38.1	53.1	21.0	15.0
29	40.1		152.3	522.1	106.2	94.2	213.5	82.2	37.1	63.1	21.0	15.0
30	33.1		140.3	218.5	112.2	125.3	144.3	76.2	37.1	46.1	21.0	15.0
31	31.1		138.3		114.2		112.2	74.2		32.1		16.0
Average	27.4	70.7	165.6	137.6	165.9	106.9	189.3	254.5	62.0	52.4	26.6	18.1
Maximum	89.2	255.6	542.2	522.1	575.2	168.4	1,123.4	1,579.4	120.3	145.3	34.1	21.0
Minimum	20.0	38.1	88.2	72.2	101.2	85.2	87.2	74.2	37.1	32.1	21.0	15.0

Average annual discharge = 107 (m^3/sec)

Annual inflow volume = 3,373 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1970

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.0	23.0	82.2	52.1	61.1	40.1	159.3	66.1	1,341.9	66.1	31.1	18.0
2	16.0	22.0	48.1	51.1	64.1	42.1	368.8	85.2	268.6	64.1	31.1	18.0
3	16.0	21.0	40.1	53.1	53.1	43.1	208.5	60.1	163.4	60.1	29.1	18.0
4	16.0	20.0	38.1	59.1	51.1	182.4	226.5	106.2	759.6	56.1	29.1	18.0
5	16.0	20.0	37.1	68.1	54.1	110.2	122.3	190.4	254.6	54.1	28.1	18.0
6	16.0	20.0	34.1	78.2	60.1	58.1	122.3	78.2	215.5	75.2	28.1	18.0
7	16.0	19.0	31.1	79.2	77.2	44.1	111.2	65.1	325.7	67.1	28.1	18.0
8	15.0	19.0	30.1	72.2	51.1	35.1	110.2	69.1	547.2	55.1	27.1	18.0
9	15.0	19.0	31.1	75.2	43.1	31.1	107.2	122.3	266.6	54.1	26.1	18.0
10	15.0	19.0	32.1	81.2	44.1	31.1	270.6	442.0	226.5	54.1	25.1	17.0
11	16.0	19.0	50.1	88.2	46.1	32.1	106.2	118.3	410.9	46.1	24.1	17.0
12	17.0	18.0	44.1	83.2	50.1	63.1	73.2	120.3	314.7	43.1	24.1	17.0
13	17.0	18.0	86.2	75.2	56.1	291.6	113.2	612.3	258.6	42.1	24.1	17.0
14	17.0	18.0	140.3	74.2	59.1	93.2	87.2	257.6	257.6	41.1	24.1	17.0
15	17.0	19.0	176.4	72.2	47.1	171.4	60.1	256.6	174.4	40.1	22.0	17.0
16	17.0	19.0	195.4	108.2	51.1	93.2	85.2	202.4	169.4	38.1	22.0	17.0
17	16.0	19.0	110.2	71.2	56.1	52.1	108.2	233.5	166.4	38.1	22.0	17.0
18	17.0	18.0	96.2	60.1	60.1	47.1	116.3	527.1	172.4	37.1	21.0	17.0
19	16.0	18.0	83.2	64.1	54.1	40.1	62.1	235.5	249.5	36.1	20.0	17.0
20	16.0	19.0	68.1	59.1	56.1	37.1	80.2	192.4	260.6	36.1	20.0	17.0
21	16.0	21.0	70.2	60.1	60.1	37.1	73.2	919.0	164.4	36.1	19.0	18.0
22	16.0	23.0	72.2	79.2	54.1	40.1	74.2	258.6	155.3	124.3	19.0	17.0
23	16.0	26.1	74.2	83.2	100.2	51.1	53.1	320.7	119.3	113.2	19.0	17.0
24	16.0	24.1	76.2	88.2	62.1	40.1	50.1	311.7	83.2	75.2	19.0	17.0
25	188.4	25.1	82.2	94.2	48.1	40.1	42.1	413.9	64.1	69.1	19.0	17.0
26	92.2	35.1	77.2	100.2	42.1	59.1	39.1	709.5	69.1	60.1	19.0	17.0
27	37.1	29.1	121.3	78.2	32.1	56.1	142.3	325.7	68.1	49.1	19.0	17.0
28	28.1	342.7	124.3	78.2	31.1	177.4	114.2	240.5	63.1	42.1	19.0	17.0
29	24.1		91.2	62.1	37.1	147.3	73.2	413.9	63.1	35.1	19.0	16.0
30	24.1		68.1	55.1	36.1	97.2	92.2	252.5	65.1	34.1	19.0	16.0
31	24.1		58.1		45.1		79.2	1,046.3		32.1		16.0
Average	26.0	32.6	76.4	73.5	53.0	76.1	113.9	298.5	257.3	54.0	23.2	17.3
Maximum	188.4	342.7	195.4	108.2	100.2	291.6	368.8	1,046.3	1,341.9	124.3	31.1	18.0
Minimum	15.0	18.0	30.1	51.1	31.1	31.1	39.1	60.1	63.1	32.1	19.0	16.0

Average annual discharge = 92 (m^3/sec)

Annual inflow volume = 2,906 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1971

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.0	13.0	37.1	44.1	60.1	210.5	96.2	791.7	263.6	38.1	34.1	22.0
2	16.0	13.0	31.1	48.1	61.1	143.3	601.3	1,176.5	202.4	37.1	61.1	22.0
3	15.0	13.0	27.1	49.1	59.1	117.3	256.6	291.6	223.5	37.1	48.1	22.0
4	16.0	13.0	34.1	59.1	61.1	102.2	205.4	208.5	177.4	35.1	37.1	21.0
5	16.0	13.0	36.1	83.2	61.1	91.2	249.5	206.4	148.3	35.1	33.1	22.0
6	16.0	13.0	41.1	67.1	51.1	83.2	160.3	174.4	102.2	34.1	31.1	22.0
7	16.0	13.0	40.1	60.1	51.1	89.2	116.3	765.7	103.2	33.1	30.1	22.0
8	16.0	13.0	40.1	57.1	52.1	94.2	132.3	445.0	83.2	32.1	30.1	21.0
9	15.0	13.0	39.1	54.1	43.1	119.3	113.2	462.0	80.2	32.1	28.1	21.0
10	15.0	14.0	40.1	53.1	48.1	573.2	86.2	272.6	74.2	32.1	28.1	21.0
11	15.0	15.0	44.1	47.1	43.1	233.5	84.2	213.5	81.2	31.1	27.1	21.0
12	14.0	16.0	48.1	38.1	40.1	149.3	104.2	181.4	77.2	31.1	26.1	21.0
13	14.0	14.0	51.1	34.1	37.1	107.2	632.4	153.3	73.2	31.1	25.1	21.0
14	14.0	13.0	50.1	44.1	49.1	323.7	216.5	145.3	64.1	31.1	25.1	21.0
15	13.0	13.0	50.1	36.1	40.1	164.4	125.3	126.3	59.1	30.1	23.0	20.0
16	13.0	13.0	49.1	44.1	48.1	157.3	195.4	111.2	59.1	31.1	23.0	21.0
17	13.0	13.0	49.1	55.1	40.1	94.2	286.6	125.3	58.1	31.1	23.0	21.0
18	13.0	13.0	51.1	47.1	43.1	93.2	159.3	100.2	52.1	30.1	23.0	20.0
19	13.0	15.0	52.1	42.1	47.1	81.2	140.3	96.2	52.1	30.1	23.0	20.0
20	13.0	15.0	50.1	40.1	62.1	79.2	122.3	146.3	50.1	30.1	23.0	20.0
21	13.0	14.0	48.1	256.6	122.3	157.3	77.2	128.3	48.1	29.1	23.0	20.0
22	13.0	14.0	42.1	99.2	123.3	491.1	99.2	104.2	47.1	29.1	23.0	21.0
23	13.0	13.0	40.1	87.2	85.2	479.0	74.2	93.2	46.1	29.1	23.0	21.0
24	13.0	13.0	38.1	72.2	87.2	256.6	69.1	93.2	44.1	28.1	22.0	20.0
25	14.0	13.0	40.1	69.1	99.2	251.5	97.2	170.4	42.1	27.1	23.0	20.0
26	14.0	16.0	41.1	69.1	92.2	221.5	280.6	961.1	41.1	26.1	23.0	20.0
27	15.0	419.9	43.1	72.2	108.2	170.4	134.3	274.6	41.1	26.1	23.0	20.0
28	15.0	63.1	44.1	85.2	130.3	239.5	97.2	184.4	41.1	25.1	22.0	20.0
29	14.0		41.1	112.2	104.2	129.3	892.9	148.3	40.1	25.1	22.0	20.0
30	14.0		37.1	75.2	87.2	97.2	297.6	430.9	39.1	25.1	22.0	20.0
31	13.0		39.1		124.3		181.4	223.5		25.1		20.0
Average	14.3	29.9	42.4	66.7	69.7	186.7	206.0	290.5	83.8	30.6	27.6	20.8
Maximum	16.0	419.9	52.1	256.6	130.3	573.2	892.9	1,176.5	263.6	38.1	61.1	22.0
Minimum	13.0	13.0	27.1	34.1	37.1	79.2	69.1	93.2	39.1	25.1	22.0	20.0

Average annual discharge = 90 (m^3/sec)

Annual inflow volume = 2,824 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1972

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.0	474.0	52.1	98.2	75.2	103.2	97.2	72.2	150.3	59.1	48.1	28.4
2	20.0	202.4	59.1	94.2	64.1	98.2	67.1	67.1	111.2	53.1	45.1	27.1
3	19.0	77.2	67.1	86.2	59.1	82.2	240.5	60.1	96.2	51.1	43.1	25.1
4	20.0	53.1	72.2	82.2	58.1	75.2	142.3	49.1	114.2	48.1	42.1	24.1
5	19.0	43.1	97.2	164.4	60.1	65.1	163.4	261.6	84.2	46.1	41.1	23.0
6	19.0	40.1	69.1	108.2	68.1	55.1	150.3	1,911.1	84.2	48.1	40.1	23.0
7	19.0	36.1	60.1	89.2	84.2	47.1	158.3	40.1	123.3	51.1	39.1	22.0
8	19.0	31.1	311.7	78.2	76.2	48.1	84.2	194.4	149.3	55.1	39.1	22.0
9	19.0	27.1	223.5	95.2	86.2	42.1	1,398.0	270.6	300.7	44.1	39.1	23.0
10	19.0	25.1	118.3	75.2	85.2	39.1	413.9	118.3	488.1	44.1	39.1	128.3
11	19.0	25.1	95.2	65.1	90.2	43.1	559.2	97.2	122.3	43.1	38.1	87.2
12	19.0	323.7	89.2	74.2	92.2	53.1	351.8	96.2	91.2	42.1	37.1	37.1
13	19.0	168.4	279.6	79.2	99.2	53.1	195.4	112.2	78.2	38.1	36.1	31.1
14	19.0	77.2	135.3	85.2	105.2	60.1	117.3	164.4	82.2	37.1	34.1	30.1
15	19.0	58.1	111.2	86.2	97.2	64.1	110.2	104.2	67.1	35.1	33.1	32.1
16	19.0	53.1	103.2	146.3	93.2	65.1	87.2	115.2	122.3	36.1	32.1	29.1
17	19.0	51.1	111.2	240.5	94.2	70.2	135.3	207.4	175.4	36.1	31.1	31.1
18	19.0	49.1	101.2	186.4	106.2	71.2	95.2	115.2	74.2	64.1	30.1	42.1
19	19.0	50.1	109.2	156.3	103.2	62.1	114.2	283.6	247.5	160.3	29.1	37.1
20	19.0	57.1	222.5	125.3	110.2	48.1	94.2	268.6	177.4	75.2	29.1	54.1
21	22.0	63.1	166.4	95.2	109.2	48.1	74.2	152.3	108.2	55.1	27.1	38.1
22	137.3	60.1	122.3	82.2	98.2	59.1	64.1	98.2	78.2	228.5	29.1	32.1
23	45.1	57.1	119.3	76.2	213.5	67.1	57.1	87.2	70.2	111.2	32.1	30.1
24	25.1	63.1	127.3	80.2	283.6	62.1	80.2	96.2	69.1	82.2	34.1	32.1
25	22.0	61.1	142.3	81.2	114.2	71.2	71.2	120.3	64.1	65.1	35.1	37.1
26	21.0	60.1	164.4	78.2	85.2	109.2	82.2	80.2	60.1	54.1	38.1	44.1
27	20.0	57.1	265.6	79.2	76.2	75.2	60.1	74.2	59.1	47.1	37.1	98.2
28	20.0	61.1	189.4	140.3	78.2	218.5	56.1	110.2	57.1	41.1	32.1	100.2
29	20.0	51.1	179.4	150.3	79.2	105.2	63.1	265.6	57.1	38.1	31.1	75.2
30	20.0		185.4	101.2	82.2	96.2	144.3	201.4	67.1	37.1	30.1	57.1
31	107.2		120.3		102.2		97.2	186.4		35.1		48.1
Average	27.2	84.7	137.7	106.0	97.7	71.9	181.5	196.2	121.0	60.1	35.7	43.5
Maximum	137.3	474.0	311.7	240.5	283.6	218.5	1,398.0	1,911.1	488.1	228.5	48.1	128.3
Minimum	19.0	25.1	52.1	65.1	58.1	39.1	56.1	40.1	57.1	35.1	27.1	22.0

Average annual discharge = 97 (m^3/sec)

Annual inflow volume = 3,072 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1973

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	46.1	63.1	161.3	247.5	152.3	74.2	94.2	85.2	465.0	128.3	33.1	21.0
2	42.1	60.1	200.4	187.4	156.3	65.1	135.3	112.2	269.6	82.2	32.1	20.0
3	39.1	61.1	151.3	205.4	131.3	67.1	142.3	376.8	226.5	67.1	31.1	20.0
4	37.1	58.1	130.3	203.4	123.3	73.2	94.2	245.5	165.4	65.1	30.1	20.0
5	34.1	58.1	116.3	175.4	126.3	83.2	371.8	164.4	142.3	59.1	30.1	20.0
6	53.1	60.1	108.2	192.4	125.3	94.2	135.3	462.0	122.3	54.1	29.1	20.0
7	58.1	60.1	105.2	152.3	111.2	98.2	92.2	281.6	143.3	50.1	29.1	20.0
8	48.1	60.1	242.5	136.3	135.3	103.2	127.3	782.7	109.2	48.1	29.1	20.0
9	40.1	60.1	459.0	129.3	124.3	103.2	102.2	3,488.6	94.2	47.1	29.1	19.0
10	37.1	65.1	1,656.6	128.3	109.2	108.2	57.1	853.8	86.2	46.1	29.1	19.0
11	34.1	79.2	629.4	169.4	73.2	96.2	59.1	457.0	97.2	47.1	28.1	19.0
12	63.1	80.2	374.8	203.4	47.1	139.3	325.7	425.9	152.3	48.1	28.1	20.0
13	116.3	83.2	275.6	157.3	44.1	158.3	927.0	618.3	102.2	47.1	27.1	20.0
14	60.1	85.2	255.6	145.3	43.1	134.3	109.2	575.2	116.3	47.1	27.1	20.0
15	51.1	84.2	229.5	147.3	63.1	98.2	354.8	459.0	121.3	46.1	27.1	19.0
16	48.1	79.2	228.5	96.2	70.2	102.2	195.4	371.8	98.2	62.1	26.1	31.1
17	48.1	79.2	220.5	87.2	196.4	111.2	69.1	306.7	113.2	67.1	26.1	78.2
18	52.1	73.2	190.4	107.2	113.2	118.3	77.2	286.6	200.4	57.1	25.1	38.1
19	388.8	68.1	149.3	133.3	81.2	111.2	235.5	379.8	130.3	53.1	25.1	30.1
20	944.0	68.1	178.4	154.3	63.1	132.3	234.5	289.6	379.8	52.1	25.1	24.1
21	249.5	69.1	166.4	166.4	63.1	166.4	246.5	533.2	158.3	51.1	24.1	22.0
22	135.3	65.1	138.3	126.3	68.1	131.3	89.2	391.8	110.2	50.1	24.1	21.0
23	199.4	67.1	155.3	159.3	75.2	97.2	61.1	276.6	72.2	48.1	23.0	21.0
24	92.2	275.6	195.4	162.4	79.2	135.3	223.5	235.5	99.2	47.1	23.0	21.0
25	80.2	933.0	232.5	159.3	84.2	187.4	168.4	144.3	271.6	45.1	23.0	21.0
26	77.2	754.6	231.5	172.4	84.2	289.6	320.7	166.4	109.2	43.1	22.0	21.0
27	76.2	282.6	235.5	173.4	98.2	129.3	451.0	505.1	80.2	42.1	22.0	21.0
28	72.2	199.4	223.5	137.3	102.2	94.2	185.4	114.2	74.2	39.1	22.0	21.0
29	65.1		201.4	146.3	87.2	100.2	125.3	93.2	67.1	37.1	21.0	21.0
30	66.1		204.4	147.3	89.2	85.2	143.3	80.2	93.2	35.1	21.0	21.0
31	67.1		232.5		83.2		130.3	615.3		34.1		21.0
Average	110.4	144.0	267.1	157.0	96.9	116.3	196.3	457.4	149.0	53.1	26.4	23.6
Maximum	944.0	933.0	1,656.6	247.5	196.4	289.6	927.0	3,488.6	465.0	128.3	33.1	78.2
Minimum	34.1	58.1	105.2	87.2	43.1	65.1	57.1	80.2	67.1	34.1	21.0	19.0

Average annual discharge = 150 (m^3/sec)

Annual inflow volume = 4,738 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1974

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.0	25.1	66.1	95.2	62.1	48.1	79.2	109.2	81.2	67.1	16.0	13.0
2	21.0	42.1	80.2	84.2	62.1	42.1	79.2	132.3	76.2	42.1	16.0	13.0
3	20.0	345.7	91.2	92.2	59.1	56.1	126.3	422.9	51.1	36.1	16.0	20.0
4	19.0	104.2	95.2	94.2	63.1	48.1	128.3	303.7	57.1	34.1	16.0	21.0
5	19.0	74.2	93.2	77.2	61.1	51.1	84.2	216.5	42.1	34.1	16.0	19.0
6	18.0	67.1	76.2	74.2	60.1	151.3	75.2	167.4	45.1	33.1	16.0	16.0
7	17.0	60.1	75.2	71.2	59.1	67.1	72.2	118.3	44.1	32.1	16.0	16.0
8	17.0	52.1	86.2	68.1	64.1	46.1	74.2	86.2	76.2	30.1	15.0	15.0
9	16.0	49.1	95.2	122.3	68.1	57.1	91.2	74.2	47.1	27.1	16.0	15.0
10	16.0	44.1	84.2	81.2	62.1	48.1	297.6	65.1	46.1	27.1	15.0	15.0
11	16.0	43.1	82.2	71.2	59.1	60.1	165.4	85.2	44.1	26.1	15.0	14.0
12	16.0	42.1	74.2	71.2	42.1	48.1	117.3	138.3	39.1	25.1	15.0	14.0
13	17.0	41.1	66.1	75.2	38.1	34.1	157.3	141.3	38.1	25.1	15.0	14.0
14	27.1	40.1	63.1	80.2	36.1	37.1	108.2	202.4	34.1	24.1	15.0	14.0
15	25.1	46.1	61.1	84.2	38.1	39.1	245.5	177.4	34.1	24.1	15.0	18.0
16	24.1	54.1	65.1	78.2	53.1	39.1	172.4	98.2	38.1	23.0	15.0	34.1
17	22.0	62.1	67.1	70.2	67.1	39.1	200.4	71.2	33.1	23.0	14.0	27.1
18	21.0	66.1	58.1	74.2	52.1	39.1	118.3	63.1	33.1	23.0	14.0	17.0
19	20.0	55.1	67.1	78.2	51.1	58.1	124.3	59.1	33.1	22.0	14.0	19.0
20	238.5	55.1	97.2	72.2	56.1	146.3	351.8	71.2	34.1	22.0	14.0	18.0
21	125.3	55.1	103.2	78.2	53.1	131.3	125.3	63.1	38.1	21.0	14.0	17.0
22	57.1	119.3	118.3	70.2	47.1	68.1	248.5	69.1	33.1	20.0	14.0	16.0
23	45.1	181.4	155.3	56.1	33.1	297.6	134.3	58.1	32.1	20.0	14.0	16.0
24	43.1	80.2	311.7	63.1	30.1	976.1	328.7	56.1	31.1	19.0	14.0	15.0
25	42.1	63.1	255.6	72.2	28.1	362.8	243.5	80.2	46.1	18.0	13.0	15.0
26	31.1	67.1	141.3	77.2	36.1	197.4	308.7	54.1	61.1	17.0	13.0	15.0
27	27.1	65.1	105.2	72.2	71.2	123.3	153.3	60.1	35.1	17.0	13.0	15.0
28	26.1	64.1	113.2	66.1	65.1	99.2	101.2	51.1	50.1	17.0	13.0	15.0
29	26.1		96.2	63.1	58.1	91.2	98.2	47.1	41.1	16.0	13.0	15.0
30	25.1		105.2	60.1	53.1	81.2	92.2	56.1	67.1	16.0	13.0	15.0
31	25.1		98.2		52.1		192.4	56.1		16.0		15.0
Average	35.0	73.7	101.5	76.4	53.0	119.5	157.9	111.4	45.4	25.7	14.6	16.8
Maximum	238.5	345.7	311.7	122.3	71.2	976.1	351.8	422.9	81.2	67.1	16.0	34.1
Minimum	16.0	25.1	58.1	56.1	28.1	34.1	72.2	47.1	31.1	16.0	13.0	13.0

Average annual discharge = 69 (m^3/sec)

Annual inflow volume = 2,185 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1975

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.0	60.1	108.2	145.3	95.2	97.2	87.2	108.2	337.7	97.2	36.1	24.1
2	15.0	35.1	85.2	152.3	91.2	92.2	95.2	371.8	474.0	96.2	35.1	23.0
3	14.0	27.1	80.2	182.4	95.2	99.2	76.2	267.6	320.7	70.2	35.1	22.0
4	14.0	25.1	184.4	168.4	136.3	90.2	93.2	277.6	237.5	72.2	35.1	22.0
5	14.0	23.0	155.3	149.3	136.3	88.2	98.2	587.3	303.7	70.2	35.1	21.0
6	14.0	27.1	98.2	139.3	100.2	86.2	83.2	300.7	194.4	70.2	34.1	21.0
7	14.0	25.1	84.2	134.3	91.2	89.2	94.2	267.6	357.8	67.1	33.1	21.0
8	14.0	53.1	79.2	129.3	90.2	112.2	97.2	208.5	190.4	65.1	33.1	21.0
9	14.0	74.2	76.2	108.2	68.1	106.2	90.2	185.4	206.4	63.1	34.1	21.0
10	13.0	51.1	121.3	95.2	100.2	94.2	90.2	138.3	213.5	60.1	33.1	20.0
11	14.0	40.1	294.6	97.2	95.2	78.2	85.2	164.4	799.7	58.1	30.1	20.0
12	14.0	39.1	130.3	95.2	98.2	79.2	143.3	898.9	342.7	57.1	27.1	20.0
13	14.0	365.8	104.2	94.2	106.2	81.2	114.2	300.7	273.6	56.1	29.1	20.0
14	14.0	153.3	106.2	82.2	107.2	95.2	172.4	188.4	246.5	55.1	27.1	20.0
15	14.0	87.2	109.2	73.2	99.2	95.2	697.5	163.4	297.6	53.1	26.1	20.0
16	13.0	68.1	102.2	74.2	139.3	95.2	1,410.1	221.5	144.3	51.1	27.1	19.0
17	13.0	63.1	103.2	94.2	300.7	103.2	371.8	234.5	311.7	50.1	27.1	19.0
18	13.0	61.1	103.2	101.2	157.3	97.2	181.4	737.6	226.5	49.1	27.1	19.0
19	13.0	59.1	104.2	108.2	106.2	104.2	252.5	881.9	252.5	48.1	28.1	19.0
20	12.0	60.1	102.2	96.2	104.2	134.3	198.4	2,013.4	241.5	48.1	28.1	19.0
21	12.0	57.1	97.2	95.2	104.2	106.2	396.9	536.2	242.5	45.1	28.1	19.0
22	15.0	53.1	144.3	115.2	90.2	87.2	182.4	788.7	247.5	43.1	29.1	19.0
23	20.0	57.1	493.1	211.5	84.2	89.2	153.3	853.8	137.3	43.1	28.1	19.0
24	16.0	55.1	234.5	129.3	90.2	84.2	201.4	388.8	114.2	42.1	28.1	19.0
25	16.0	62.1	163.4	146.3	91.2	73.2	177.4	283.6	96.2	40.1	28.1	19.0
26	16.0	70.2	144.3	294.6	96.2	76.2	158.3	198.4	89.2	39.1	27.1	19.0
27	16.0	72.2	138.3	308.7	92.2	82.2	143.3	173.4	70.2	40.1	27.1	19.0
28	16.0	124.3	137.3	145.3	98.2	175.4	179.4	2,027.4	71.2	40.1	27.1	19.0
29	16.0		138.3	108.2	118.3	163.4	258.6	621.3	79.2	38.1	27.1	19.0
30	29.1		139.3	98.2	114.2	84.2	134.3	442.0	79.2	38.1	26.1	19.0
31	83.2		139.3		92.2		114.2	374.8		37.1		19.0
Average	17.1	69.6	138.8	132.4	109.3	98.0	213.9	490.5	240.0	55.0	29.9	20.0
Maximum	83.2	365.8	493.1	308.7	300.7	175.4	1,410.1	2,027.4	799.7	97.2	36.1	24.1
Minimum	12.0	23.0	76.2	73.2	68.1	73.2	76.2	108.2	70.2	37.1	26.1	19.0

Average annual discharge = 135 (m^3/sec)

Annual inflow volume = 4,263 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1976

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.0	94.2	175.4	140.3	147.3	141.3	103.2	3,715.0	256.6	181.4	39.1	26.1
2	17.0	79.2	197.4	138.3	149.3	141.3	132.3	3,885.4	419.9	95.2	38.1	27.1
3	17.0	59.1	191.4	136.3	149.3	141.3	150.3	873.9	598.3	80.2	37.1	34.1
4	17.0	53.1	196.4	114.2	147.3	135.3	119.3	740.6	479.0	73.2	36.1	31.1
5	17.0	48.1	194.4	254.6	134.3	137.3	91.2	993.2	323.7	71.2	35.1	29.1
6	17.0	45.1	164.4	211.5	129.3	140.3	106.2	993.2	235.5	64.1	35.1	29.1
7	16.0	43.1	149.3	157.3	138.3	118.3	111.2	2,209.8	209.5	91.2	35.1	28.1
8	16.0	43.1	138.3	161.3	144.3	123.3	125.3	805.7	256.6	81.2	34.1	27.1
9	16.0	43.1	245.5	195.4	134.3	123.3	195.4	550.2	174.4	67.1	34.1	27.1
10	16.0	43.1	163.4	256.6	152.3	159.3	556.2	422.9	159.3	61.1	33.1	26.1
11	16.0	44.1	126.3	231.5	164.4	134.3	263.6	328.7	153.3	57.1	33.1	26.1
12	16.0	60.1	113.2	183.4	157.3	165.4	252.5	379.8	150.3	55.1	33.1	25.1
13	25.1	101.2	136.3	165.4	175.4	243.5	300.7	252.5	165.4	54.1	32.1	25.1
14	185.4	147.3	130.3	163.4	160.3	194.4	365.8	493.1	138.3	52.1	31.1	24.1
15	44.1	1,043.3	151.3	166.4	143.3	268.6	413.9	294.6	126.3	51.1	31.1	24.1
16	29.1	334.7	522.1	168.4	151.3	207.4	953.1	359.8	119.3	51.1	30.1	24.1
17	26.1	232.5	527.1	199.4	235.5	256.6	317.7	263.6	118.3	49.1	29.1	23.0
18	24.1	436.9	342.7	192.4	185.4	208.5	1,449.1	289.6	143.3	47.1	30.1	23.0
19	22.0	393.9	281.6	190.4	197.4	173.4	493.1	334.7	102.2	46.1	30.1	23.0
20	21.0	263.6	362.8	222.5	158.3	115.2	522.1	345.7	95.2	43.1	29.1	23.0
21	20.0	206.4	294.6	239.5	138.3	134.3	479.0	243.5	91.2	42.1	29.1	23.0
22	20.0	170.4	241.5	237.5	132.3	142.3	337.7	197.4	87.2	40.1	28.1	22.0
23	20.0	150.3	207.4	223.5	127.3	128.3	374.8	173.4	83.2	38.1	28.1	22.0
24	21.0	134.3	181.4	273.6	182.4	98.2	491.1	181.4	81.2	37.1	28.1	22.0
25	23.0	342.7	172.4	259.6	174.4	94.2	311.7	212.5	78.2	76.2	29.1	22.0
26	31.1	331.7	175.4	221.5	141.3	95.2	740.6	168.4	75.2	52.1	28.1	23.0
27	536.2	221.5	225.5	212.5	121.3	95.2	425.9	294.6	74.2	45.1	27.1	24.1
28	187.4	189.4	239.5	226.5	124.3	101.2	235.5	187.4	73.2	44.1	28.1	23.0
29	78.2	175.4	186.4	203.4	125.3	104.2	221.5	174.4	72.2	44.1	27.1	22.0
30	61.1		160.3	166.4	129.3	107.2	215.5	168.4	181.4	42.1	26.1	22.0
31	55.1		160.3		143.3		179.4	109.2		41.1		22.0
Average	52.6	190.7	217.9	197.1	151.4	147.6	356.0	665.9	177.4	60.5	31.5	24.9
Maximum	536.2	1,043.3	527.1	273.6	235.5	268.6	1,449.1	3,885.4	598.3	181.4	39.1	34.1
Minimum	16.0	43.1	113.2	114.2	121.3	94.2	91.2	109.2	72.2	37.1	26.1	22.0

Average annual discharge = 190 (m^3/sec)

Annual inflow volume = 6,008 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1977

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.1	74.2	50.1	62.1	92.2	95.2	125.3	104.2	152.3	75.2	46.1	64.1
2	24.1	78.2	48.1	60.1	95.2	95.2	283.6	331.7	149.3	78.2	42.1	41.1
3	23.0	73.2	48.1	59.1	362.8	92.2	374.8	263.6	229.5	87.2	266.6	38.1
4	22.0	65.1	50.1	62.1	214.5	94.2	203.4	1,523.3	114.2	67.1	102.2	37.1
5	22.0	63.1	50.1	84.2	129.3	89.2	199.4	638.4	202.4	67.1	58.1	37.1
6	22.0	57.1	59.1	164.4	102.2	72.2	1,349.9	374.8	303.7	79.2	49.1	36.1
7	21.0	53.1	64.1	114.2	87.2	67.1	209.5	282.6	106.2	63.1	44.1	35.1
8	21.0	50.1	74.2	79.2	79.2	62.1	233.5	294.6	291.6	60.1	42.1	35.1
9	22.0	52.1	73.2	71.2	159.3	63.1	165.4	217.5	95.2	57.1	42.1	33.1
10	35.1	60.1	73.2	100.2	172.4	68.1	145.3	205.4	157.3	93.2	42.1	34.1
11	118.3	62.1	67.1	80.2	160.3	62.1	595.3	217.5	143.3	55.1	40.1	36.1
12	29.1	60.1	61.1	98.2	98.2	72.2	254.6	280.6	106.2	52.1	41.1	60.1
13	22.0	59.1	62.1	86.2	115.2	89.2	357.8	199.4	144.3	50.1	41.1	39.1
14	20.0	60.1	85.2	90.2	117.3	126.3	723.6	209.5	111.2	49.1	42.1	38.1
15	20.0	59.1	62.1	83.2	104.2	85.2	1,338.9	152.3	102.2	49.1	40.1	36.1
16	21.0	58.1	71.2	71.2	86.2	67.1	1,120.4	396.9	90.2	125.3	40.1	35.1
17	21.0	58.1	57.1	80.2	81.2	71.2	601.3	185.4	109.2	71.2	38.1	34.1
18	22.0	60.1	52.1	97.2	84.2	75.2	300.7	224.5	325.7	53.1	38.1	33.1
19	24.1	62.1	49.1	283.6	89.2	67.1	286.6	311.7	198.4	49.1	37.1	35.1
20	25.1	61.1	44.1	211.5	99.2	72.2	294.6	255.6	113.2	48.1	38.1	36.1
21	24.1	56.1	44.1	118.3	92.2	79.2	351.8	200.4	110.2	49.1	38.1	37.1
22	24.1	37.1	53.1	98.2	92.2	86.2	485.1	214.5	112.2	48.1	36.1	37.1
23	27.1	48.1	61.1	99.2	89.2	101.2	368.8	223.5	111.2	48.1	39.1	35.1
24	256.6	47.1	65.1	101.2	81.2	263.6	542.2	224.5	102.2	43.1	38.1	37.1
25	493.1	44.1	70.2	91.2	148.3	131.3	505.1	187.4	92.2	581.3	37.1	320.7
26	239.5	44.1	67.1	88.2	99.2	451.0	368.8	138.3	83.2	179.4	40.1	433.9
27	164.4	53.1	71.2	83.2	103.2	171.4	291.6	106.2	82.2	88.2	40.1	166.4
28	105.2	55.1	63.1	114.2	110.2	156.3	204.4	148.3	80.2	69.1	35.1	84.2
29	80.2		63.1	106.2	111.2	379.8	129.3	121.3	86.2	57.1	32.1	54.1
30	71.2		65.1	107.2	142.3	158.3	177.4	291.6	139.3	54.1	79.2	34.1
31	75.2		65.1		107.2		105.2	192.4		49.1		31.1
Average	68.4	57.6	61.0	101.5	119.5	118.8	409.5	281.2	141.5	83.8	51.5	65.9
Maximum	493.1	78.2	85.2	283.6	362.8	451.0	1,349.9	1,523.3	325.7	581.3	266.6	433.9
Minimum	20.0	37.1	44.1	59.1	79.2	62.1	105.2	104.2	80.2	43.1	32.1	31.1

Average annual discharge = 131 (m^3/sec)

Annual inflow volume = 4,128 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1978

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	58.1	101.2	220.5	168.4	170.4	110.2	178.4	416.9	166.4	119.3	47.1	48.1
2	57.1	92.2	177.4	167.4	170.4	123.3	170.4	402.9	154.3	108.2	45.1	48.1
3	56.1	84.2	151.3	168.4	177.4	140.3	410.9	1,242.7	162.4	102.2	43.1	47.1
4	54.1	78.2	192.4	171.4	187.4	135.3	224.5	289.6	150.3	93.2	72.2	46.1
5	51.1	73.2	306.7	165.4	183.4	152.3	382.8	251.5	130.3	87.2	63.1	45.1
6	51.1	92.2	235.5	163.4	185.4	147.3	1,560.4	227.5	136.3	81.2	199.4	49.1
7	50.1	112.2	178.4	173.4	186.4	142.3	850.8	162.4	140.3	76.2	188.4	46.1
8	49.1	82.2	157.3	187.4	161.3	142.3	371.8	212.5	130.3	75.2	122.3	47.1
9	45.1	67.1	148.3	196.4	170.4	139.3	251.5	1,647.6	135.3	74.2	132.3	49.1
10	43.1	73.2	227.5	208.5	169.4	117.3	291.6	950.1	157.3	73.2	88.2	51.1
11	40.1	72.2	294.6	207.4	168.4	113.2	188.4	816.8	152.3	72.2	78.2	52.1
12	40.1	77.2	225.5	226.5	151.3	98.2	169.4	635.4	161.3	72.2	70.2	53.1
13	50.1	87.2	183.4	228.5	140.3	142.3	345.7	779.7	131.3	71.2	134.3	54.1
14	108.2	91.2	177.4	245.5	136.3	155.3	325.7	454.0	233.5	69.1	147.3	54.1
15	63.1	110.2	169.4	247.5	140.3	112.2	235.5	351.8	191.4	67.1	78.2	51.1
16	51.1	109.2	813.8	238.5	158.3	109.2	247.5	575.2	161.3	61.1	56.1	47.1
17	49.1	108.2	3,290.1	279.6	161.3	102.2	314.7	382.8	161.3	56.1	52.1	42.1
18	47.1	110.2	706.5	459.0	166.4	101.2	282.6	371.8	134.3	53.1	50.1	38.1
19	47.1	100.2	465.0	229.5	144.3	100.2	399.9	723.6	144.3	50.1	44.1	34.1
20	47.1	96.2	365.8	183.4	151.3	98.2	306.7	436.9	126.3	50.1	45.1	31.1
21	49.1	92.2	317.7	168.4	135.3	136.3	822.8	385.8	117.3	52.1	45.1	27.1
22	48.1	93.2	279.6	159.3	139.3	153.3	536.2	516.1	131.3	52.1	57.1	24.1
23	56.1	97.2	255.6	187.4	140.3	140.3	601.3	259.6	227.5	53.1	55.1	20.0
24	55.1	95.2	245.5	185.4	167.4	135.3	561.2	241.5	169.4	52.1	48.1	16.0
25	52.1	111.2	230.5	171.4	270.6	125.3	553.2	214.5	116.3	54.1	47.1	12.0
26	52.1	121.3	214.5	169.4	200.4	121.3	519.1	200.4	100.2	52.1	47.1	11.0
27	55.1	108.2	209.5	165.4	184.4	183.4	550.2	192.4	247.5	51.1	48.1	11.0
28	250.5	115.2	229.5	171.4	145.3	149.3	430.9	244.5	202.4	53.1	48.1	11.0
29	263.6		210.5	175.4	144.3	249.5	368.8	197.4	149.3	55.1	47.1	11.0
30	139.3		196.4	170.4	149.3	1,120.4	1,069.3	179.4	132.3	53.1	48.1	11.0
31	114.2		178.4		121.3		510.1	189.4		50.1		11.0
Average	70.8	94.7	363.0	201.3	163.8	166.6	452.7	456.5	155.1	67.4	74.9	35.5
Maximum	263.6	121.3	3,290.1	459.0	270.6	1,120.4	1,560.4	1,647.6	247.5	119.3	199.4	54.1
Minimum	40.1	67.1	148.3	159.3	121.3	98.2	169.4	162.4	100.2	50.1	43.1	11.0

Average annual discharge = 193 (m^3/sec)

Annual inflow volume = 6,090 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1979

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	9.0	34.1	64.1	175.4	95.2	59.1	102.2	61.1	100.2	94.2	55.1	47.1
2	9.0	42.1	103.2	149.3	107.2	181.4	90.2	652.4	100.2	85.2	46.1	44.1
3	9.0	35.1	230.5	190.4	102.2	80.2	102.2	73.2	101.2	80.2	46.1	44.1
4	9.0	38.1	442.0	286.6	96.2	67.1	103.2	793.7	117.3	70.2	45.1	46.1
5	9.0	38.1	796.7	213.5	85.2	65.1	118.3	205.4	122.3	66.1	45.1	46.1
6	9.0	35.1	709.5	178.4	79.2	73.2	77.2	160.3	142.3	71.2	41.1	45.1
7	9.0	34.1	454.0	187.4	70.2	71.2	77.2	153.3	130.3	66.1	40.1	44.1
8	9.0	33.1	413.9	199.4	71.2	106.2	67.1	345.7	191.4	65.1	52.1	42.1
9	9.0	34.1	314.7	191.4	98.2	126.3	111.2	311.7	81.2	64.1	94.2	42.1
10	9.0	35.1	283.6	179.4	132.3	106.2	108.2	323.7	79.2	63.1	63.1	42.1
11	9.0	34.1	214.5	174.4	104.2	101.2	76.2	314.7	212.5	63.1	53.1	42.1
12	10.0	31.1	190.4	173.4	69.1	98.2	158.3	294.6	170.4	63.1	46.1	42.1
13	12.0	29.1	191.4	165.4	78.2	365.8	662.4	272.6	82.2	79.2	43.1	42.1
14	32.1	28.1	178.4	144.3	78.2	151.3	226.5	232.5	154.3	83.2	41.1	41.1
15	61.1	25.1	165.4	141.3	89.2	85.2	91.2	283.6	126.3	75.2	42.1	41.1
16	38.1	24.1	152.3	123.3	105.2	60.1	89.2	250.5	119.3	63.1	46.1	43.1
17	26.1	28.1	878.9	124.3	77.2	60.1	78.2	143.3	92.2	60.1	51.1	41.1
18	22.0	23.0	240.5	118.3	60.1	58.1	61.1	117.3	191.4	57.1	47.1	41.1
19	23.0	269.6	198.4	110.2	58.1	87.2	56.1	172.4	238.5	53.1	47.1	41.1
20	24.1	465.0	194.4	123.3	63.1	91.2	170.4	154.3	189.4	52.1	45.1	41.1
21	29.1	96.2	205.4	101.2	90.2	105.2	114.2	92.2	204.4	53.1	43.1	40.1
22	29.1	66.1	209.5	93.2	110.2	127.3	289.6	85.2	120.3	56.1	41.1	39.1
23	27.1	57.1	207.4	88.2	90.2	124.3	97.2	193.4	125.3	55.1	41.1	39.1
24	26.1	57.1	203.4	95.2	77.2	127.3	175.4	264.6	116.3	50.1	49.1	35.1
25	26.1	80.2	205.4	98.2	106.2	127.3	72.2	186.4	222.5	49.1	134.3	32.1
26	27.1	80.2	191.4	97.2	192.4	112.2	49.1	132.3	160.3	48.1	70.2	65.1
27	26.1	79.2	198.4	98.2	157.3	106.2	46.1	106.2	127.3	48.1	58.1	63.1
28	25.1	71.2	211.5	106.2	98.2	100.2	70.2	96.2	116.3	48.1	53.1	42.1
29	28.1		189.4	103.2	74.2	94.2	49.1	122.3	93.2	48.1	48.1	39.1
30	107.2		226.5	101.2	58.1	94.2	46.1	107.2	99.2	46.1	49.1	46.1
31	36.1		241.5		49.1		94.2	98.2		47.1		64.1
Average	23.7	68.0	280.9	144.4	91.1	107.1	120.3	219.4	137.6	62.1	52.6	44.0
Maximum	107.2	465.0	878.9	286.6	192.4	365.8	662.4	793.7	238.5	94.2	134.3	65.1
Minimum	9.0	23.0	64.1	88.2	49.1	58.1	46.1	61.1	79.2	46.1	40.1	32.1

Average annual discharge = 113 (m^3/sec)

Annual inflow volume = 3,563 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1980

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	110.2	49.1	97.2	121.3	109.2	122.3	68.1	143.3	221.5	40.1	45.1	44.1
2	103.2	47.1	86.2	125.3	109.2	119.3	76.2	194.4	47.1	40.1	44.1	42.1
3	65.1	155.3	75.2	138.3	108.2	114.2	98.2	970.1	27.1	40.1	42.1	40.1
4	54.1	113.2	67.1	101.2	106.2	97.2	196.4	365.8	31.1	37.1	40.1	38.1
5	53.1	94.2	561.2	108.2	102.2	86.2	182.4	282.6	57.1	35.1	38.1	37.1
6	56.1	79.2	638.4	119.3	105.2	79.2	143.3	162.4	80.2	37.1	38.1	34.1
7	57.1	73.2	211.5	123.3	111.2	74.2	82.2	178.4	81.2	35.1	36.1	33.1
8	55.1	67.1	203.4	108.2	111.2	74.2	65.1	150.3	74.2	147.3	35.1	33.1
9	53.1	62.1	147.3	114.2	110.2	84.2	82.2	530.1	85.2	84.2	34.1	33.1
10	52.1	57.1	113.2	121.3	104.2	86.2	59.1	65.1	259.6	47.1	34.1	32.1
11	51.1	54.1	103.2	116.3	91.2	102.2	359.8	35.1	89.2	55.1	33.1	31.1
12	50.1	50.1	128.3	95.2	91.2	108.2	131.3	40.1	111.2	44.1	33.1	32.1
13	49.1	54.1	94.2	85.2	89.2	222.5	105.2	58.1	184.4	39.1	32.1	32.1
14	48.1	62.1	82.2	91.2	101.2	209.5	177.4	80.2	119.3	37.1	32.1	31.1
15	46.1	199.4	169.4	85.2	107.2	126.3	185.4	92.2	84.2	35.1	31.1	31.1
16	50.1	151.3	155.3	87.2	106.2	104.2	87.2	76.2	67.1	37.1	31.1	31.1
17	50.1	104.2	122.3	109.2	96.2	91.2	94.2	155.3	58.1	35.1	30.1	29.1
18	46.1	93.2	233.5	122.3	86.2	96.2	74.2	94.2	48.1	40.1	29.1	29.1
19	50.1	84.2	145.3	121.3	90.2	98.2	84.2	72.2	49.1	48.1	29.1	29.1
20	51.1	112.2	118.3	127.3	100.2	104.2	141.3	67.1	56.1	41.1	28.1	28.1
21	52.1	99.2	114.2	128.3	85.2	173.4	110.2	59.1	49.1	40.1	28.1	28.1
22	49.1	108.2	280.6	112.2	77.2	120.3	71.2	52.1	40.1	36.1	28.1	28.1
23	48.1	122.3	168.4	96.2	71.2	108.2	97.2	47.1	37.1	33.1	27.1	29.1
24	48.1	102.2	162.4	97.2	71.2	956.1	70.2	84.2	34.1	31.1	27.1	35.1
25	48.1	85.2	154.3	108.2	76.2	238.5	73.2	83.2	67.1	31.1	26.1	32.1
26	60.1	75.2	180.4	109.2	79.2	247.5	180.4	83.2	44.1	34.1	29.1	41.1
27	79.2	146.3	124.3	104.2	88.2	118.3	270.6	84.2	38.1	33.1	294.6	52.1
28	85.2	231.5	131.3	110.2	110.2	89.2	224.5	69.1	38.1	33.1	92.2	36.1
29	78.2	118.3	126.3	109.2	113.2	70.2	218.5	65.1	35.1	34.1	56.1	31.1
30	67.1		118.3	105.2	101.2	97.2	183.4	70.2	37.1	41.1	46.1	29.1
31	61.1		117.3		114.2		126.3	145.3		53.1		28.1
Average	59.0	98.3	168.7	110.0	97.5	147.3	132.9	150.2	75.0	43.7	45.0	33.6
Maximum	110.2	231.5	638.4	138.3	114.2	956.1	359.8	970.1	259.6	147.3	294.6	52.1
Minimum	46.1	47.1	67.1	85.2	71.2	70.2	59.1	35.1	27.1	31.1	26.1	28.1

Average annual discharge = 97 (m^3/sec)

Annual inflow volume = 3,061 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1981

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.1	91.2	250.5	306.7	124.3	165.4	143.3	275.6	60.1	57.1	27.1	21.0
2	29.1	78.2	166.4	269.6	143.3	122.3	174.4	238.5	59.1	80.2	26.1	21.0
3	31.1	78.2	130.3	354.8	172.4	92.2	85.2	218.5	67.1	55.1	27.1	22.0
4	67.1	117.3	120.3	317.7	152.3	80.2	101.2	228.5	64.1	48.1	27.1	22.0
5	119.3	410.9	119.3	234.5	238.5	70.2	213.5	471.0	62.1	45.1	27.1	22.0
6	82.2	215.5	573.2	187.4	168.4	71.2	163.4	408.9	56.1	40.1	27.1	21.0
7	52.1	160.3	505.1	192.4	126.3	85.2	77.2	465.0	50.1	39.1	27.1	21.0
8	35.1	141.3	291.6	162.4	117.3	113.2	117.3	362.8	49.1	38.1	27.1	21.0
9	38.1	134.3	230.5	180.4	122.3	131.3	388.8	519.1	49.1	37.1	27.1	20.0
10	37.1	130.3	325.7	183.4	102.2	104.2	209.5	303.7	47.1	36.1	26.1	20.0
11	35.1	122.3	249.5	178.4	92.2	89.2	148.3	265.6	46.1	35.1	26.1	20.0
12	34.1	136.3	192.4	204.4	108.2	68.1	131.3	204.4	47.1	34.1	29.1	19.0
13	33.1	165.4	186.4	214.5	114.2	56.1	362.8	223.5	47.1	33.1	31.1	18.0
14	33.1	680.5	267.6	205.4	135.3	53.1	902.0	182.4	49.1	32.1	29.1	19.0
15	33.1	317.7	254.6	228.5	129.3	53.1	143.3	263.6	45.1	31.1	28.1	19.0
16	33.1	223.5	213.5	436.9	107.2	56.1	235.5	188.4	42.1	35.1	27.1	20.0
17	33.1	180.4	195.4	261.6	110.2	49.1	82.2	135.3	43.1	37.1	27.1	21.0
18	32.1	164.4	204.4	194.4	127.3	57.1	391.8	123.3	59.1	35.1	27.1	21.0
19	32.1	179.4	208.5	169.4	140.3	67.1	218.5	109.2	59.1	34.1	27.1	20.0
20	31.1	152.3	479.0	190.4	127.3	62.1	108.2	104.2	50.1	32.1	25.1	20.0
21	31.1	145.3	723.6	362.8	123.3	69.1	71.2	95.2	48.1	31.1	25.1	20.0
22	31.1	138.3	405.9	239.5	92.2	60.1	170.4	114.2	46.1	30.1	24.1	20.0
23	63.1	119.3	300.7	156.3	85.2	58.1	205.4	101.2	46.1	29.1	24.1	20.0
24	265.6	140.3	264.6	158.3	125.3	57.1	933.0	79.2	44.1	29.1	23.0	20.0
25	268.6	222.5	257.6	174.4	138.3	78.2	788.7	68.1	44.1	29.1	22.0	20.0
26	124.3	134.3	223.5	189.4	126.3	55.1	334.7	67.1	43.1	28.1	22.0	19.0
27	85.2	114.2	208.5	158.3	101.2	70.2	245.5	118.3	51.1	27.1	22.0	19.0
28	150.3	178.4	216.5	140.3	101.2	70.2	607.3	71.2	44.1	25.1	21.0	20.0
29	127.3		280.6	124.3	94.2	81.2	454.0	139.3	57.1	29.1	21.0	20.0
30	170.4		1,244.7	132.3	92.2	161.3	525.1	71.2	85.2	30.1	21.0	20.0
31	128.3		482.0		306.7		382.8	62.1		28.1		20.0
Average	74.0	181.1	315.2	217.0	130.5	80.2	294.1	202.5	52.0	36.5	25.7	20.2
Maximum	268.6	680.5	1,244.7	436.9	306.7	165.4	933.0	519.1	85.2	80.2	31.1	22.0
Minimum	29.1	78.2	119.3	124.3	85.2	49.1	71.2	62.1	42.1	25.1	21.0	18.0

Average annual discharge = 136 (m^3/sec)

Annual inflow volume = 4,284 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1982

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.0	31.1	235.5	283.6	271.6	150.3	365.8	970.1	67.1	37.1	36.1	32.1
2	19.0	29.1	215.5	266.6	323.7	106.2	151.3	440.0	66.1	35.1	35.1	38.1
3	19.0	28.1	123.3	254.6	256.6	91.2	123.3	243.5	62.1	31.1	34.1	42.1
4	21.0	47.1	97.2	251.5	220.5	96.2	90.2	191.4	61.1	28.1	33.1	37.1
5	29.1	37.1	249.5	234.5	225.5	103.2	89.2	858.9	58.1	26.1	33.1	35.1
6	23.0	33.1	211.5	215.5	218.5	122.3	85.2	294.6	56.1	23.0	33.1	35.1
7	21.0	30.1	142.3	200.4	286.6	131.3	110.2	1,335.9	54.1	21.0	33.1	34.1
8	20.0	32.1	125.3	131.3	228.5	130.3	128.3	388.8	55.1	20.0	33.1	37.1
9	19.0	27.1	105.2	130.3	189.4	122.3	86.2	573.2	53.1	20.0	33.1	80.2
10	19.0	31.1	376.8	144.3	181.4	125.3	79.2	788.7	50.1	23.0	34.1	88.2
11	19.0	70.2	197.4	136.3	354.8	120.3	65.1	471.0	48.1	21.0	34.1	45.1
12	19.0	53.1	157.3	130.3	252.5	119.3	80.2	359.8	47.1	127.3	33.1	41.1
13	19.0	29.1	127.3	131.3	180.4	136.3	137.3	419.9	50.1	55.1	32.1	47.1
14	19.0	32.1	134.3	135.3	149.3	124.3	95.2	289.6	52.1	41.1	31.1	50.1
15	19.0	30.1	138.3	136.3	154.3	211.5	79.2	297.6	48.1	31.1	86.2	43.1
16	19.0	31.1	222.5	410.9	131.3	182.4	93.2	300.7	43.1	33.1	354.8	40.1
17	19.0	36.1	230.5	796.7	124.3	153.3	102.2	189.4	41.1	31.1	76.2	37.1
18	18.0	31.1	171.4	474.0	113.2	126.3	108.2	141.3	39.1	24.1	80.2	35.1
19	18.0	38.1	157.3	308.7	128.3	104.2	232.5	176.4	42.1	31.1	70.2	35.1
20	18.0	219.5	146.3	245.5	102.2	103.2	340.7	130.3	38.1	31.1	58.1	34.1
21	17.0	129.3	146.3	204.4	97.2	124.3	258.6	114.2	68.1	30.1	60.1	33.1
22	29.1	74.2	427.9	197.4	98.2	97.2	143.3	111.2	233.5	35.1	47.1	33.1
23	48.1	60.1	519.1	183.4	278.6	91.2	445.0	108.2	94.2	38.1	40.1	35.1
24	25.1	56.1	902.0	220.5	212.5	80.2	905.0	218.5	70.2	42.1	38.1	38.1
25	22.0	49.1	856.9	201.4	136.3	63.1	166.4	125.3	54.1	34.1	36.1	34.1
26	25.1	44.1	427.9	213.5	140.3	57.1	239.5	111.2	49.1	31.1	35.1	33.1
27	27.1	43.1	331.7	340.7	169.4	125.3	110.2	90.2	44.1	35.1	35.1	32.1
28	30.1	139.3	308.7	592.3	171.4	122.3	193.4	82.2	41.1	175.4	34.1	38.1
29	27.1		283.6	485.1	147.3	88.2	186.4	79.2	41.1	67.1	34.1	63.1
30	27.1		300.7	306.7	180.4	190.4	281.6	91.2	40.1	44.1	33.1	46.1
31	33.1		303.7		171.4		539.2	79.2		38.1		41.1
Average	22.8	53.3	270.1	265.4	190.2	120.0	197.1	324.9	58.9	40.7	52.9	41.7
Maximum	48.1	219.5	902.0	796.7	354.8	211.5	905.0	1,335.9	233.5	175.4	354.8	88.2
Minimum	17.0	27.1	97.2	130.3	97.2	57.1	65.1	79.2	38.1	20.0	31.1	32.1

Average annual discharge = 137 (m^3/sec)

Annual inflow volume = 4,330 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1983

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	37.1	91.2	291.6	223.5	281.6	169.4	416.9	289.6	222.5	56.1	44.1	29.1
2	33.1	82.2	759.6	235.5	217.5	181.4	279.6	314.7	1,174.5	55.1	43.1	29.1
3	32.1	75.2	365.8	207.4	212.5	183.4	345.7	213.5	440.0	56.1	44.1	29.1
4	31.1	65.1	254.6	328.7	226.5	153.3	459.0	416.9	408.9	56.1	43.1	27.1
5	31.1	61.1	206.4	277.6	226.5	132.3	286.6	251.5	289.6	55.1	43.1	27.1
6	31.1	59.1	159.3	211.5	223.5	117.3	271.6	323.7	265.6	55.1	42.1	27.1
7	35.1	56.1	143.3	283.6	237.5	114.2	138.3	482.0	239.5	56.1	41.1	26.1
8	42.1	53.1	138.3	442.0	242.5	158.3	134.3	306.7	217.5	56.1	43.1	26.1
9	37.1	49.1	143.3	291.6	240.5	169.4	114.2	337.7	197.4	57.1	42.1	26.1
10	34.1	47.1	171.4	265.6	264.6	151.3	147.3	259.6	242.5	57.1	37.1	25.1
11	32.1	45.1	311.7	265.6	291.6	204.4	118.3	203.4	155.3	56.1	37.1	25.1
12	31.1	44.1	216.5	425.9	243.5	159.3	95.2	274.6	140.3	50.1	37.1	25.1
13	29.1	43.1	168.4	1,151.5	208.5	141.3	104.2	209.5	125.3	102.2	36.1	25.1
14	28.1	47.1	144.3	590.3	241.5	122.3	131.3	178.4	114.2	160.3	36.1	25.1
15	29.1	231.5	156.3	961.1	225.5	162.4	94.2	175.4	227.5	72.2	36.1	25.1
16	31.1	110.2	152.3	976.1	188.4	208.5	127.3	142.3	229.5	56.1	36.1	25.1
17	29.1	80.2	135.3	575.2	156.3	179.4	143.3	171.4	134.3	51.1	36.1	25.1
18	27.1	68.1	115.2	491.1	248.5	123.3	119.3	672.5	106.2	48.1	35.1	25.1
19	26.1	63.1	919.0	382.8	260.6	116.3	119.3	345.7	97.2	48.1	34.1	24.1
20	25.1	60.1	612.3	340.7	276.6	105.2	103.2	275.6	82.2	56.1	35.1	24.1
21	25.1	60.1	286.6	311.7	281.6	96.2	105.2	275.6	77.2	65.1	35.1	24.1
22	28.1	55.1	224.5	291.6	248.5	95.2	154.3	240.5	74.2	53.1	35.1	24.1
23	27.1	54.1	169.4	303.7	261.6	116.3	556.2	269.6	72.2	48.1	34.1	26.1
24	26.1	282.6	158.3	281.6	161.3	108.2	247.5	345.7	90.2	49.1	34.1	24.1
25	26.1	156.3	459.0	259.6	145.3	101.2	282.6	677.5	81.2	48.1	34.1	25.1
26	26.1	103.2	621.3	289.6	195.4	114.2	445.0	624.4	68.1	46.1	33.1	25.1
27	189.4	91.2	402.9	351.8	183.4	149.3	629.4	351.8	65.1	46.1	31.1	24.1
28	440.0	83.2	259.6	311.7	171.4	133.3	275.6	260.6	62.1	44.1	31.1	24.1
29	300.7		230.5	280.6	172.4	156.3	179.4	162.4	62.1	43.1	31.1	24.1
30	198.4		212.5	297.6	171.4	170.4	192.4	152.3	57.1	42.1	30.1	24.1
31	115.2		206.4		151.3		192.4	206.4		40.1		24.1
Average	65.6	82.8	283.7	396.9	221.2	143.1	226.1	303.6	194.0	57.6	37.0	25.4
Maximum	440.0	282.6	919.0	1,151.5	291.6	208.5	629.4	677.5	1,174.5	160.3	44.1	29.1
Minimum	25.1	43.1	115.2	207.4	145.3	95.2	94.2	142.3	57.1	40.1	30.1	24.1

Average annual discharge = 170 (m^3/sec)

Annual inflow volume = 5,368 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1984

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.1	20.0	42.1	300.7	48.1	67.1	97.2	197.4	564.4	89.2	41.1	35.1
2	24.1	19.0	42.1	325.7	59.1	69.1	98.2	117.3	533.2	87.2	39.1	35.1
3	23.0	20.0	43.1	269.6	68.1	61.1	76.2	92.2	609.8	83.2	37.1	34.1
4	23.0	20.0	43.1	156.3	71.2	78.2	92.2	81.2	442.4	81.2	36.1	33.1
5	22.0	20.0	39.1	151.3	68.1	57.1	95.2	527.5	334.7	78.2	35.1	32.1
6	22.0	20.0	36.1	95.2	75.2	78.2	113.2	182.4	334.7	75.2	34.1	31.1
7	23.0	20.0	36.1	96.2	79.2	68.1	95.2	153.3	397.1	74.2	33.1	31.1
8	23.0	21.0	35.1	79.2	79.2	55.1	172.4	697.7	317.7	72.2	33.1	30.1
9	23.0	20.0	35.1	79.2	83.2	40.1	147.3	427.9	265.6	69.1	35.1	30.1
10	23.0	20.0	35.1	75.2	75.2	59.1	101.2	245.5	239.5	69.1	39.1	29.1
11	23.0	19.0	36.1	68.1	80.2	109.2	115.2	519.1	216.5	67.1	35.1	29.1
12	23.0	19.0	34.1	71.2	83.2	78.2	101.2	348.8	201.4	66.1	34.1	28.1
13	21.0	19.0	37.1	74.2	89.2	63.1	83.2	462.3	164.4	65.1	34.1	61.1
14	21.0	18.0	35.1	89.2	72.2	55.1	65.1	618.3	234.5	63.1	34.1	53.1
15	20.0	18.0	35.1	104.2	74.2	57.1	137.3	348.8	186.4	58.1	34.1	42.1
16	20.0	18.0	39.1	89.2	60.1	52.1	114.2	731.7	149.3	60.1	34.1	38.1
17	20.0	18.0	29.1	88.2	54.1	57.1	123.3	328.7	144.3	59.1	34.1	36.1
18	20.0	42.1	154.3	73.2	57.1	382.9	147.3	254.6	157.3	59.1	34.1	36.1
19	19.0	62.1	107.2	77.2	65.1	219.5	164.4	658.4	144.3	57.1	35.1	34.1
20	19.0	112.2	58.1	76.2	57.1	132.3	190.4	385.8	123.3	57.1	35.1	34.1
21	19.0	53.1	53.1	73.2	49.1	107.2	123.3	348.8	134.3	56.1	35.1	33.1
22	18.0	40.1	53.1	63.1	56.1	87.2	186.4	629.4	153.3	54.1	58.1	33.1
23	18.0	35.1	57.1	57.1	63.1	82.2	117.3	342.7	115.2	53.1	97.2	32.1
24	18.0	34.1	62.1	59.1	60.1	87.2	100.2	525.1	162.4	51.1	59.1	32.1
25	18.0	36.1	125.3	69.1	68.1	134.3	97.2	462.0	117.3	53.1	49.1	31.1
26	18.0	35.1	93.2	70.2	76.2	150.3	80.2	317.7	105.2	53.1	40.1	31.1
27	18.0	34.1	70.2	75.2	61.1	136.3	109.2	422.9	103.2	50.1	39.1	31.1
28	17.0	33.1	70.2	81.2	80.2	134.3	320.5	328.7	101.2	48.1	37.1	31.1
29	18.0	34.1	75.2	77.2	85.2	112.2	199.4	300.7	102.2	47.1	36.1	31.1
30	18.0		75.2	58.1	64.1	111.2	216.5	254.6	93.2	46.1	36.1	32.1
31	18.0		98.2		62.1		154.3	346.0		42.1		53.1
Average	20.5	30.4	57.6	104.1	68.5	99.4	130.1	376.0	231.6	62.7	39.8	34.9
Maximum	24.1	112.2	154.3	325.7	89.2	382.9	320.5	731.7	609.8	89.2	97.2	61.1
Minimum	17.0	18.0	29.1	57.1	48.1	40.1	65.1	81.2	93.2	42.1	33.1	28.1

Average annual discharge = 105 (m^3/sec)

Annual inflow volume = 3,317 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1985

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	69.1	49.1	63.1	58.1	72.2	58.1	69.1	203.4	63.1	51.1	46.1	45.1
2	48.1	47.1	61.1	56.1	192.4	60.1	54.1	203.4	61.1	51.1	46.1	45.1
3	40.1	47.1	64.1	56.1	79.2	65.1	43.1	277.7	59.1	52.1	46.1	45.1
4	39.1	48.1	60.1	70.2	64.1	61.1	40.1	453.8	57.1	51.1	46.1	44.1
5	54.1	91.2	58.1	59.1	58.1	65.1	41.1	413.9	73.2	81.2	46.1	44.1
6	52.1	62.1	63.1	69.1	57.1	66.1	48.1	323.7	61.1	74.2	45.1	44.1
7	44.1	57.1	65.1	115.2	62.1	65.1	165.4	1,506.3	57.1	71.2	44.1	44.1
8	42.1	56.1	53.1	163.4	71.2	100.2	228.5	408.9	61.1	62.1	44.1	73.2
9	40.1	54.1	52.1	189.4	95.2	63.1	85.2	272.6	59.1	158.3	44.1	69.1
10	38.1	52.1	48.1	154.3	154.3	82.2	111.2	245.5	58.1	132.3	45.1	49.1
11	37.1	52.1	48.1	115.2	92.2	142.3	74.2	219.5	59.1	80.2	46.1	46.1
12	37.1	51.1	47.1	94.2	87.2	55.1	136.3	218.5	63.1	70.2	46.1	44.1
13	37.1	52.1	46.1	81.2	77.2	59.1	241.5	162.4	63.1	65.1	46.1	45.1
14	37.1	52.1	44.1	79.2	74.2	61.1	177.4	143.3	65.1	62.1	45.1	44.1
15	37.1	52.1	43.1	71.2	61.1	68.1	176.4	135.3	67.1	63.1	45.1	47.1
16	37.1	52.1	43.1	68.1	57.1	62.1	399.9	121.3	58.1	66.1	45.1	93.2
17	37.1	52.1	41.1	69.1	53.1	59.1	323.7	112.2	67.1	60.1	45.1	93.2
18	36.1	52.1	47.1	77.2	52.1	56.1	194.4	105.2	104.2	59.1	44.1	63.1
19	44.1	52.1	44.1	73.2	50.1	58.1	188.4	96.2	68.1	56.1	44.1	54.1
20	44.1	52.1	41.1	70.2	69.1	59.1	255.6	99.2	57.1	55.1	44.1	50.1
21	67.1	53.1	43.1	74.2	82.2	61.1	138.3	93.2	56.1	53.1	44.1	46.1
22	52.1	50.1	43.1	72.2	75.2	55.1	291.6	87.2	76.2	52.1	45.1	46.1
23	46.1	50.1	47.1	67.1	73.2	62.1	118.3	273.6	72.2	51.1	45.1	45.1
24	44.1	53.1	55.1	60.1	83.2	59.1	185.4	89.2	81.2	51.1	46.1	45.1
25	43.1	57.1	50.1	55.1	118.3	53.1	1,080.3	95.2	62.1	51.1	46.1	320.7
26	90.2	55.1	55.1	50.1	83.2	56.1	559.2	80.2	56.1	50.1	46.1	887.9
27	94.2	55.1	92.2	52.1	65.1	98.2	337.7	76.2	54.1	49.1	46.1	218.5
28	67.1	57.1	97.2	56.1	65.1	104.2	264.6	68.1	53.1	48.1	46.1	106.2
29	61.1		87.2	55.1	65.1	80.2	281.6	65.1	53.1	47.1	46.1	89.2
30	55.1		69.1	61.1	64.1	71.2	462.0	73.2	53.1	46.1	46.1	81.2
31	52.1		61.1		61.1		408.9	69.1		46.1		72.2
Average	49.1	54.1	55.9	79.8	77.9	68.9	231.7	219.1	63.3	63.5	45.4	98.1
Maximum	94.2	91.2	97.2	189.4	192.4	142.3	1,080.3	1,506.3	104.2	158.3	46.1	887.9
Minimum	36.1	47.1	41.1	50.1	50.1	53.1	40.1	65.1	53.1	46.1	44.1	44.1

Average annual discharge = 93 (m^3/sec)

Annual inflow volume = 2,928 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1986

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	65.1	38.1	99.2	226.5	184.4	151.3	165.4	825.8	104.2	68.1	55.1	106.2
2	61.1	38.1	98.2	190.4	168.4	122.3	102.2	388.8	99.2	64.1	55.1	106.2
3	57.1	38.1	98.2	184.4	164.4	127.3	96.2	377.2	98.2	61.1	54.1	107.2
4	55.1	38.1	97.2	175.4	151.3	127.3	114.2	1,735.8	95.2	61.1	55.1	110.2
5	53.1	37.1	98.2	188.4	151.3	125.3	117.3	802.7	91.2	65.1	54.1	110.2
6	52.1	37.1	99.2	210.5	161.3	117.3	109.2	476.5	89.2	58.1	54.1	104.2
7	52.1	37.1	100.2	225.5	171.4	113.2	371.8	490.7	84.2	54.1	54.1	101.2
8	52.1	36.1	98.2	231.5	178.4	118.3	160.3	354.8	82.2	55.1	55.1	97.2
9	50.1	37.1	97.2	226.5	306.7	128.3	160.3	354.8	88.2	91.2	55.1	93.2
10	50.1	40.1	99.2	234.5	263.5	137.3	140.3	306.7	111.2	53.1	55.1	89.2
11	49.1	48.1	174.4	248.5	167.4	147.3	139.3	258.6	96.2	76.2	55.1	239.5
12	48.1	52.1	575.2	256.6	184.4	130.3	158.3	226.5	83.2	74.2	56.1	1,114.4
13	46.1	286.5	759.6	235.5	192.4	158.3	101.2	235.5	97.2	63.1	56.1	530.1
14	43.1	141.8	1,506.3	250.5	192.4	154.3	98.2	195.4	85.2	62.1	56.1	252.5
15	40.1	129.9	609.3	222.5	182.4	134.3	109.2	317.7	76.2	90.2	615.3	183.4
16	38.1	115.2	436.9	196.4	176.4	131.3	228.5	209.5	73.2	80.2	311.7	171.4
17	38.1	113.2	396.9	172.4	161.3	118.3	213.5	168.4	70.2	219.5	125.3	158.3
18	37.1	226.5	556.2	171.4	153.3	129.3	493.1	276.6	68.1	115.2	105.2	154.3
19	40.1	128.3	413.9	174.4	164.4	134.3	331.7	199.4	68.1	87.2	93.2	140.3
20	40.1	112.2	328.7	180.4	181.4	122.3	179.4	154.3	67.1	76.2	87.2	130.3
21	39.1	167.4	314.7	181.4	196.4	136.3	151.3	137.3	66.1	71.2	85.2	126.3
22	40.1	177.4	328.7	185.4	167.4	156.3	229.5	131.3	68.1	68.1	83.2	123.3
23	59.1	134.3	260.6	161.7	134.3	169.4	199.4	126.3	66.1	65.1	82.2	119.3
24	46.1	125.3	222.5	220.9	125.3	183.4	173.4	123.3	83.2	61.1	79.2	117.3
25	44.1	118.3	196.4	473.6	124.3	283.6	167.4	164.4	62.1	59.1	78.2	115.2
26	43.1	113.2	182.4	745.9	124.3	206.5	166.4	164.4	78.2	56.1	192.4	114.2
27	42.1	108.2	224.5	740.6	119.3	198.8	714.5	228.5	70.2	54.1	323.7	109.2
28	40.1	103.2	294.6	340.7	136.3	126.3	454.0	128.3	123.3	55.1	149.3	106.2
29	39.1		244.5	244.5	171.4	156.3	220.5	114.2	126.3	55.1	125.3	102.2
30	39.1		215.5	215.5	147.3	212.5	391.8	114.2	104.2	54.1	113.2	100.2
31	38.1		202.4		162.4		490.7	112.2		55.1		93.2
Average	46.4	99.2	304.2	257.1	169.8	148.6	224.1	319.4	85.9	71.9	114.0	171.8
Maximum	65.1	286.5	1,506.3	745.9	306.7	283.6	714.5	1,735.8	126.3	219.5	615.3	1,114.4
Minimum	37.1	36.1	97.2	161.7	119.3	113.2	96.2	112.2	62.1	53.1	54.1	89.2

Average annual discharge = 168 (m^3/sec)

Annual inflow volume = 5,312 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1987

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	79.2	60.1	103.2	176.4	152.3	192.4	100.2	95.2	121.3	34.0	42.1	34.1
2	76.2	59.1	99.2	218.5	127.3	191.4	102.2	89.2	65.1	37.2	41.1	34.1
3	76.2	59.1	93.2	256.6	110.2	263.6	98.2	77.2	56.1	49.9	42.1	35.1
4	76.2	57.1	97.2	229.5	100.2	272.6	97.2	204.4	55.1	41.1	41.1	35.1
5	81.2	55.1	102.2	175.4	104.2	204.4	102.2	195.4	70.2	36.3	41.1	35.1
6	79.2	55.1	81.2	163.4	144.3	202.4	121.3	98.2	56.1	34.3	41.1	34.1
7	76.2	55.1	136.3	160.3	114.2	187.4	121.3	112.2	64.1	33.5	40.1	34.1
8	75.2	56.1	166.4	161.3	294.6	202.4	104.2	93.2	58.1	33.5	41.1	34.1
9	74.2	59.1	132.3	337.7	258.6	405.9	102.2	103.2	125.3	33.2	41.1	34.1
10	74.2	56.1	114.2	207.4	388.8	331.7	101.2	96.2	110.2	239.9	40.1	34.1
11	73.2	53.1	104.2	162.4	242.5	203.4	110.2	102.2	82.2	170.2	40.1	34.1
12	73.2	53.1	108.2	149.3	197.4	168.4	110.2	144.3	60.1	209.9	39.1	34.1
13	73.2	54.1	114.2	132.3	177.4	144.3	99.2	155.3	55.1	148.3	38.1	34.1
14	72.2	54.1	103.2	119.3	166.4	144.3	89.2	106.2	54.1	143.2	38.1	33.1
15	71.2	55.1	105.2	119.3	154.3	152.3	87.2	93.2	53.1	100.1	37.1	33.1
16	70.2	55.1	196.4	117.3	151.3	141.3	142.3	88.2	55.1	78.8	37.1	33.1
17	73.2	156.3	151.3	119.3	142.3	122.3	100.2	91.2	49.1	65.5	37.1	33.1
18	71.2	121.3	122.3	132.3	141.3	112.2	109.2	164.4	47.1	137.6	36.1	33.1
19	67.1	132.3	119.3	130.3	149.3	110.2	95.2	88.2	46.1	138.4	36.1	32.1
20	67.1	67.1	118.3	132.3	169.4	117.3	98.2	122.3	46.1	98.7	35.1	32.1
21	65.1	64.1	195.4	144.3	209.0	124.3	90.2	233.5	46.1	79.7	35.1	32.1
22	65.1	67.1	365.8	152.3	277.9	105.2	97.2	164.4	55.1	71.2	35.1	32.1
23	63.1	70.2	405.9	158.3	805.5	102.2	108.2	137.3	50.1	63.0	35.1	32.1
24	63.1	371.8	269.6	155.3	394.2	104.2	135.3	211.5	45.1	61.3	35.1	32.1
25	63.1	308.7	225.5	122.3	251.0	102.2	151.3	120.3	42.1	57.0	35.1	31.1
26	63.1	134.3	436.9	121.3	235.1	101.2	239.5	78.2	40.1	53.9	35.1	31.1
27	63.1	131.3	282.6	121.3	214.5	102.2	122.3	71.2	38.1	51.6	34.1	31.1
28	63.1	112.2	144.3	128.3	211.5	102.2	99.2	88.2	37.1	47.4	34.1	31.1
29	63.1		203.4	143.3	194.4	103.2	90.2	95.2	36.1	46.5	34.1	31.1
30	63.1		181.4	158.3	189.4	101.2	90.2	71.2	35.1	45.1	34.1	31.1
31	62.1		168.4		188.4		115.2	105.2		44.2		32.1
Average	70.2	94.1	169.3	160.2	214.8	164.0	110.7	119.2	58.5	80.1	37.7	33.0
Maximum	81.2	371.8	436.9	337.7	805.5	405.9	239.5	233.5	125.3	239.9	42.1	35.1
Minimum	62.1	53.1	81.2	117.3	100.2	101.2	87.2	71.2	35.1	33.2	34.1	31.1

Average annual discharge = 109 (m^3/sec)

Annual inflow volume = 3,452 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1988

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	32.1	34.3	82.8	192.8	116.3	82.3	111.7	1,330.2	103.2	83.7	45.1	42.3
2	32.1	34.1	78.6	174.2	99.0	77.7	110.0	706.2	91.3	79.2	76.6	42.3
3	31.8	33.8	84.3	142.6	80.6	54.7	194.8	587.1	93.3	75.5	44.8	42.0
4	31.8	34.1	89.6	124.8	77.2	51.3	262.4	487.9	90.5	93.6	44.8	42.0
5	31.5	34.3	100.7	111.7	75.2	48.5	180.7	411.3	84.5	79.2	44.8	42.0
6	31.5	34.3	106.0	104.3	78.6	43.7	154.5	365.9	82.8	73.2	44.8	41.7
7	31.2	34.3	199.6	111.7	73.8	43.1	98.1	329.0	82.3	71.8	44.8	41.1
8	31.2	34.1	142.6	116.9	62.1	34.9	60.9	519.0	95.6	69.8	45.1	40.6
9	30.9	43.7	101.5	124.3	57.8	34.9	48.2	584.3	117.2	68.9	44.8	40.0
10	30.7	37.5	87.6	120.3	68.9	38.6	52.7	329.0	90.5	69.8	45.1	39.4
11	30.7	35.8	1,097.6	114.5	76.0	38.6	113.4	354.6	85.4	69.2	44.8	39.4
12	31.2	35.8	1,046.5	128.2	79.7	38.0	70.4	268.9	82.3	67.2	44.8	39.1
13	31.5	34.1	312.0	132.2	77.7	38.3	726.1	414.1	80.9	65.8	44.8	38.9
14	32.4	33.8	201.3	139.8	80.6	38.9	700.5	274.8	78.9	64.9	44.5	38.0
15	31.2	34.1	164.5	140.4	67.7	43.1	1,616.6	516.2	115.8	64.1	44.2	37.4
16	30.9	32.9	228.6	139.0	68.6	45.9	3,431.7	283.6	139.3	62.9	44.0	36.9
17	30.4	32.6	215.9	124.8	69.2	46.2	924.6	297.8	95.6	62.9	44.0	36.6
18	30.1	31.8	216.7	138.4	62.4	67.2	558.7	300.6	79.4	61.8	44.0	37.4
19	29.5	31.8	177.6	164.5	56.4	53.3	553.1	278.2	73.8	60.4	43.7	39.4
20	29.2	32.4	166.8	168.8	57.8	57.9	1,225.3	239.7	73.5	59.0	43.4	44.8
21	30.4	69.2	159.6	120.3	62.4	61.5	672.2	251.5	71.0	93.3	43.4	44.2
22	50.5	57.3	163.1	112.3	65.2	78.0	1,023.8	225.2	79.4	55.6	43.7	115.1
23	39.7	44.8	169.6	110.0	62.6	72.0	777.1	211.1	68.3	54.2	43.4	211.0
24	34.3	37.2	174.2	99.0	60.9	69.8	714.7	196.8	230.9	53.0	43.4	87.6
25	33.5	41.7	170.2	94.2	60.9	67.5	470.8	303.5	470.8	51.9	43.4	66.4
26	32.9	40.9	411.3	101.5	62.9	73.5	374.4	183.8	184.3	51.0	43.4	59.0
27	32.6	47.1	244.2	103.8	69.2	128.8	442.5	187.2	127.1	49.6	43.4	49.3
28	33.2	303.5	203.9	112.8	67.2	94.7	499.2	156.5	105.2	48.8	43.4	41.1
29	36.6	117.5	212.5	123.7	68.6	490.7	1,636.5	137.3	97.3	47.6	43.4	36.6
30	34.9		227.7	114.5	67.7	148.6	553.0	127.6	94.4	46.8	43.1	34.3
31	35.2		225.2		66.3		1,316.0	116.3		45.7		34.3
Average	32.7	49.9	234.3	126.9	71.0	75.4	634.7	354.0	112.1	64.5	45.2	51.0
Maximum	50.5	303.5	1,097.6	192.8	116.3	490.7	3,431.7	1,330.2	470.8	93.6	76.6	211.0
Minimum	29.2	31.8	78.6	94.2	56.4	34.9	48.2	116.3	68.3	45.7	43.1	34.3

Average annual discharge = 156 (m^3/sec)

Annual inflow volume = 4,920 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1989

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	33.3	45.1	61.1	593.1	88.4	96.1	114.9	649.8	105.2	54.0	40.3	36.9
2	38.6	40.4	61.3	300.7	129.8	98.8	137.4	478.0	106.0	52.3	39.8	35.4
3	41.9	40.8	60.0	230.7	193.2	104.9	89.3	305.5	100.4	50.8	39.3	34.1
4	37.7	42.7	57.3	194.9	171.3	105.7	82.4	213.7	89.3	50.3	45.4	33.2
5	47.3	48.7	60.0	168.1	120.0	160.4	114.9	249.9	86.7	50.5	107.4	32.3
6	399.8	54.2	61.2	149.4	102.3	114.7	116.1	195.0	88.8	49.9	59.8	31.4
7	155.2	47.4	61.9	148.0	92.8	98.4	87.7	157.4	84.3	49.4	46.8	30.6
8	114.0	44.6	67.2	146.1	93.8	85.8	70.3	148.1	76.8	47.4	43.7	29.7
9	100.8	44.0	73.4	269.5	93.0	90.6	82.4	221.6	74.5	45.6	42.2	30.3
10	86.4	43.5	85.0	279.8	101.7	85.8	58.7	125.4	73.9	43.9	41.7	31.0
11	78.3	43.0	75.4	175.9	104.3	99.1	82.4	139.9	72.9	42.2	41.3	34.9
12	74.1	42.9	75.6	154.5	106.0	94.7	50.9	162.7	93.7	112.3	41.1	35.3
13	70.8	43.5	74.7	141.0	111.5	99.8	127.8	162.3	78.8	174.0	40.3	33.9
14	68.8	43.4	79.0	139.2	117.9	99.3	160.2	137.8	85.9	77.8	39.5	33.6
15	67.4	43.6	101.9	136.4	119.8	86.0	341.0	122.1	77.8	54.7	39.2	33.6
16	66.0	44.6	81.0	126.2	117.2	93.0	173.1	132.2	80.1	49.3	39.2	34.0
17	64.1	47.9	80.0	132.7	117.6	87.2	100.0	129.0	75.6	47.4	39.1	34.4
18	64.1	53.9	117.3	130.3	118.1	79.3	90.4	139.6	74.7	47.1	39.4	34.7
19	62.4	49.7	137.7	127.1	117.3	77.6	90.4	160.9	87.0	46.8	39.9	35.8
20	61.1	47.0	156.8	123.1	119.3	71.0	102.4	353.9	99.3	45.9	39.6	44.0
21	60.1	44.8	125.5	121.9	121.8	69.4	68.4	185.5	95.3	45.3	39.0	67.8
22	59.1	43.2	472.7	111.1	119.1	67.3	53.0	143.8	109.1	44.7	38.6	52.1
23	58.3	41.0	462.0	111.6	105.2	64.1	81.1	170.9	126.5	44.1	38.4	76.2
24	57.5	39.0	244.1	115.6	98.9	67.7	187.0	135.1	112.1	43.7	48.8	73.5
25	55.4	45.0	208.7	162.5	87.5	68.8	159.0	156.9	77.4	43.3	58.9	59.8
26	54.9	47.7	187.0	150.7	78.4	80.9	116.3	117.5	62.5	42.8	46.3	55.5
27	54.7	52.5	225.9	119.9	85.5	88.1	101.1	246.5	59.2	42.0	40.0	51.1
28	54.6	60.0	225.3	102.8	95.6	94.2	97.7	225.3	55.9	41.4	39.2	49.9
29	52.9		207.4	106.6	105.6	87.0	1,464.1	146.0	56.4	41.1	38.7	50.1
30	51.3		182.2	103.5	98.3	114.6	1,747.1	123.9	55.8	40.9	38.1	50.8
31	50.1		254.3		84.8		2,078.9	111.2		40.6		51.0
Average	75.5	45.9	142.7	169.1	110.2	91.0	271.8	198.3	84.1	53.6	44.4	42.5
Maximum	399.8	60.0	472.7	593.1	193.2	160.4	2,078.9	649.8	126.5	174.0	107.4	76.2
Minimum	33.3	39.0	57.3	102.8	78.4	64.1	50.9	111.2	55.8	40.6	38.1	29.7

Average annual discharge = 111 (m^3/sec)

Annual inflow volume = 3,514 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1990

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	50.5	55.1	143.3	210.9	123.9	108.6	191.6	99.8	165.0	71.2	38.0	23.6
2	49.9	48.4	116.0	198.9	126.8	100.9	114.2	767.5	142.6	59.9	39.6	24.6
3	49.9	42.5	100.0	189.4	126.2	101.7	142.1	142.0	134.3	57.3	37.5	25.3
4	50.7	39.3	91.4	186.5	124.7	100.7	472.3	277.3	173.1	54.4	35.9	25.3
5	51.8	37.6	84.4	191.1	138.2	93.1	160.6	309.0	251.0	50.7	34.6	25.3
6	52.2	39.5	81.0	257.2	120.5	84.1	188.1	275.5	186.7	48.6	33.3	25.3
7	55.9	80.2	76.0	444.3	126.4	76.2	342.3	244.7	146.5	47.6	31.9	25.2
8	53.8	299.9	75.1	314.0	133.6	77.5	144.4	435.9	159.3	46.1	30.7	25.1
9	51.9	222.8	77.4	213.8	143.0	82.8	351.5	1,111.4	98.7	45.4	29.7	25.0
10	50.7	122.8	113.3	181.2	151.6	74.1	180.9	531.3	101.4	44.4	28.7	25.1
11	49.5	92.5	311.2	158.7	136.6	73.8	116.2	352.1	92.3	43.1	27.8	25.0
12	48.7	79.3	141.1	145.7	154.8	110.6	95.3	265.9	87.3	42.3	27.5	25.0
13	47.6	174.4	107.1	154.7	146.6	130.7	92.5	312.0	121.0	48.7	27.0	24.8
14	47.6	208.4	119.5	164.5	147.7	79.8	81.8	370.5	146.7	42.9	26.8	25.4
15	46.6	112.7	129.0	142.8	168.5	86.9	105.7	234.7	108.0	41.2	26.5	54.8
16	45.1	96.0	144.7	142.0	186.3	69.7	134.6	202.5	106.0	40.1	26.2	142.3
17	45.1	84.3	454.0	173.1	158.2	69.9	151.8	186.1	87.6	50.1	26.0	115.9
18	53.8	71.8	419.0	180.1	165.3	71.4	113.4	170.9	82.4	129.0	25.8	60.4
19	48.1	64.8	425.8	166.9	172.9	80.4	122.6	156.4	183.8	54.7	25.6	43.7
20	43.0	61.2	772.5	146.0	138.5	96.2	219.2	122.5	97.9	45.0	25.4	39.7
21	43.3	59.9	1,275.8	145.3	122.9	90.5	151.3	113.2	83.3	42.8	25.1	37.5
22	46.5	54.9	1,965.3	131.8	112.9	91.0	115.0	112.5	88.4	42.0	35.4	37.5
23	45.5	52.0	753.6	135.9	120.1	102.1	81.7	141.2	82.6	41.7	28.4	36.6
24	45.4	86.5	462.2	148.2	136.9	144.1	93.7	114.7	96.5	41.9	27.1	42.9
25	42.6	154.8	385.2	158.1	147.8	363.5	78.7	102.7	86.1	41.6	26.2	42.6
26	40.5	229.4	323.5	165.2	147.8	124.7	279.1	100.2	69.4	41.1	25.1	38.7
27	134.8	213.0	288.2	160.8	151.0	104.9	265.9	96.7	67.3	40.8	24.3	40.1
28	120.0	178.2	265.0	146.8	146.4	135.4	125.2	174.9	62.2	40.4	23.6	928.1
29	64.9		266.7	138.2	147.1	102.3	77.4	371.9	74.0	40.2	23.4	2,284.9
30	56.0		303.7	130.4	136.8	154.3	108.3	307.6	70.8	39.7	22.6	530.3
31	52.1		234.2		135.7		118.0	238.0		39.4		260.4
Average	54.3	109.4	338.9	180.7	141.8	106.1	161.8	272.3	115.1	48.8	28.8	164.1
Maximum	134.8	299.9	1,965.3	444.3	186.3	363.5	472.3	1,111.4	251.0	129.0	39.6	2,284.9
Minimum	40.5	37.6	75.1	130.4	112.9	69.7	77.4	96.7	62.2	39.4	22.6	23.6

Average annual discharge = 144 (m^3/sec)

Annual inflow volume = 4,547 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1991

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	184.3	86.1	128.7	286.6	176.3	71.2	73.2	107.9	230.7	64.3	36.3	24.6
2	161.8	92.4	154.4	408.8	179.2	81.2	73.1	87.8	193.6	62.9	35.5	24.6
3	146.0	101.5	159.3	443.7	164.7	95.3	89.8	82.4	154.5	61.0	34.9	24.6
4	135.0	113.2	739.6	303.0	147.7	90.8	82.2	106.7	145.0	60.2	34.3	24.6
5	125.1	115.3	404.1	282.1	144.5	93.8	77.3	159.8	209.3	58.7	33.8	24.5
6	120.6	126.6	272.2	288.5	144.6	99.6	147.0	94.7	188.2	57.7	33.2	24.4
7	115.9	134.1	237.2	269.3	157.9	97.4	101.0	86.7	96.2	56.7	33.2	24.3
8	113.0	127.1	317.9	479.9	150.2	99.0	94.5	109.7	84.4	55.1	33.2	24.2
9	107.9	137.3	288.4	866.3	126.7	102.3	103.7	92.1	76.6	53.4	33.2	24.1
10	102.2	390.9	211.4	538.8	119.0	131.5	121.9	110.5	74.2	52.4	33.0	24.1
11	95.8	658.5	197.0	336.6	91.2	147.4	180.0	96.2	121.3	49.0	32.9	23.9
12	95.1	692.4	209.3	299.5	75.9	110.7	217.8	76.3	111.4	50.7	32.6	23.9
13	85.4	266.7	218.7	398.7	74.1	111.6	248.1	71.0	107.7	50.0	32.1	23.8
14	76.0	213.4	206.2	1,193.5	84.1	112.4	454.2	67.8	330.0	46.2	31.4	23.6
15	69.3	244.7	198.9	661.3	93.3	153.6	266.4	65.7	437.0	46.5	30.7	23.5
16	63.9	162.9	198.4	360.9	103.9	150.7	169.1	62.1	460.4	47.8	29.9	23.3
17	59.9	143.4	196.3	294.4	106.8	147.2	118.6	96.7	396.7	47.9	29.2	23.2
18	56.5	131.4	262.1	252.8	111.7	163.6	127.8	92.8	195.3	47.8	28.3	23.2
19	53.7	123.9	377.8	231.4	116.8	211.5	145.8	90.0	156.5	47.8	27.9	23.5
20	51.4	118.6	230.6	213.2	141.2	153.6	261.2	100.6	136.3	47.8	26.6	23.9
21	48.9	112.6	228.0	202.6	187.2	140.0	417.1	97.9	112.5	47.7	26.2	36.8
22	47.8	111.0	256.0	190.2	166.7	108.0	279.2	82.8	124.7	45.3	25.8	106.6
23	44.9	111.8	338.8	208.2	134.3	121.0	184.9	179.0	103.6	47.1	25.3	45.8
24	42.1	122.0	245.8	176.9	123.0	101.0	127.2	102.5	80.0	46.6	25.1	40.6
25	39.9	245.3	206.7	172.7	127.2	99.5	220.6	97.4	74.8	44.5	25.1	38.3
26	57.7	199.3	206.2	170.5	109.9	92.3	112.5	95.9	130.3	41.0	25.0	38.4
27	121.7	173.9	218.2	168.0	83.9	86.0	102.3	100.2	90.2	39.7	24.8	38.9
28	123.9	170.8	233.1	152.2	81.7	83.6	92.4	276.8	77.8	39.1	24.7	41.2
29	126.1		251.3	164.8	77.2	79.5	110.8	400.5	72.8	38.2	24.6	41.1
30	83.0		269.2	164.6	70.3	73.4	152.5	302.6	66.7	37.6	24.6	36.8
31	82.2		279.2		63.6		115.7	267.2		36.9		30.9
Average	91.5	193.8	256.2	339.3	120.5	113.6	163.5	124.5	161.3	49.3	29.8	31.5
Maximum	184.3	692.4	739.6	1,193.5	187.2	211.5	454.2	400.5	460.4	64.3	36.3	106.6
Minimum	39.9	86.1	128.7	152.2	63.6	71.2	73.1	62.1	66.7	36.9	24.6	23.2

Average annual discharge = 139 (m^3/sec)

Annual inflow volume = 4,380 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1992

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	35.1	220.6	107.2	278.5	254.3	138.9	152.2	146.4	358.5	255.3	193.1	140.2
2	27.5	149.5	87.3	267.9	242.4	153.0	147.4	196.5	507.0	251.1	188.9	140.7
3	26.5	128.0	80.7	262.7	356.2	183.3	158.7	926.0	452.3	245.3	184.9	140.7
4	25.5	112.7	69.3	258.4	291.2	158.1	159.4	314.7	319.4	236.1	180.9	140.4
5	24.8	101.6	62.3	272.2	244.3	145.4	137.4	329.7	306.6	227.3	176.9	139.7
6	25.6	135.1	59.4	423.4	215.6	159.8	130.1	400.1	357.9	228.5	174.0	139.7
7	32.5	235.2	45.7	835.7	215.7	154.5	132.2	218.8	349.3	230.0	169.7	139.8
8	43.6	137.1	55.2	295.0	224.5	155.3	148.0	232.7	304.5	221.2	166.1	140.1
9	33.9	123.1	56.6	282.4	222.8	146.9	150.3	537.2	5,362.1	216.6	163.3	140.0
10	31.3	113.3	56.1	736.8	210.9	146.3	147.7	317.8	6,565.2	212.4	160.6	140.3
11	45.3	106.7	58.5	269.4	210.7	182.7	202.3	248.1	1,363.6	212.3	157.5	140.7
12	42.4	102.5	63.5	253.9	220.3	168.9	158.3	228.1	870.0	208.2	154.0	145.6
13	36.8	499.1	128.6	253.6	239.7	161.8	146.1	208.6	755.3	206.5	151.4	150.8
14	33.7	240.4	131.1	245.6	242.8	146.9	188.6	262.0	704.3	206.1	149.3	146.5
15	30.8	177.8	84.5	243.7	242.1	154.1	162.9	272.2	661.0	205.7	147.2	145.0
16	34.4	154.5	73.8	243.4	237.6	149.7	154.3	844.4	554.8	205.1	145.2	144.0
17	26.5	141.7	70.6	241.7	234.2	151.8	192.0	813.9	570.4	203.0	143.1	144.0
18	25.2	135.2	81.7	306.2	204.1	137.3	226.2	469.0	482.6	201.8	140.8	144.4
19	25.5	127.4	92.0	231.7	180.1	140.5	181.8	415.4	448.9	399.4	172.7	144.9
20	25.1	115.8	102.6	250.6	166.9	145.5	215.5	370.3	420.1	245.8	298.6	145.4
21	25.1	103.3	116.7	675.3	166.2	164.9	210.0	377.2	399.7	215.1	182.1	145.8
22	24.9	94.0	170.1	400.8	158.2	135.0	213.6	392.4	378.2	207.6	150.8	146.3
23	27.0	89.0	1,167.2	260.4	176.7	129.1	158.9	280.1	359.9	203.5	146.9	146.1
24	31.0	83.0	641.7	261.3	187.4	135.9	274.1	275.0	342.2	200.1	146.0	145.4
25	41.7	77.6	914.3	269.3	189.9	123.0	353.0	329.2	323.1	198.3	142.8	144.9
26	55.9	75.7	1,506.9	269.1	241.0	120.8	266.2	326.7	308.4	197.6	142.2	144.4
27	157.0	75.9	974.8	268.1	261.0	128.2	151.0	265.0	296.3	197.2	142.7	144.0
28	256.8	76.5	442.9	272.2	206.4	137.0	150.4	254.5	284.2	196.6	142.5	143.5
29	575.2	131.4	507.4	347.6	173.7	175.3	241.4	243.7	271.0	196.2	141.0	143.1
30	1,323.7		322.2	300.5	164.1	141.5	200.9	355.9	261.0	196.4	140.0	142.3
31	350.4		285.9		150.7		176.6	469.9		196.9		183.3
Average	112.9	140.1	278.0	325.9	217.1	149.0	183.5	365.2	831.3	220.1	163.2	144.6
Maximum	1,323.7	499.1	1,506.9	835.7	356.2	183.3	353.0	926.0	6,565.2	399.4	298.6	183.3
Minimum	24.8	75.7	45.7	231.7	150.7	120.8	130.1	146.4	261.0	196.2	140.0	139.7

Average annual discharge = 260 (m^3/sec)

Annual inflow volume = 8,235 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1993

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	244.9	81.6	114.7	155.8	201.0	201.1	195.8	195.4	241.6	46.4	30.6	27.8
2	183.0	80.6	104.5	150.8	216.3	138.7	165.8	151.9	173.3	45.5	30.1	27.8
3	183.9	78.6	102.2	144.4	198.0	189.7	122.2	237.9	210.5	44.7	29.6	27.7
4	177.1	78.8	97.7	143.4	184.5	151.5	126.6	179.8	128.5	43.7	29.0	27.3
5	141.5	74.2	98.4	150.4	185.7	135.3	222.1	144.8	100.7	42.9	27.4	27.0
6	176.9	72.8	99.7	161.8	185.1	137.0	168.8	159.7	119.1	41.4	206.9	26.7
7	184.2	77.5	98.0	172.2	189.1	139.3	169.2	205.2	122.1	39.6	135.0	26.4
8	184.2	88.1	97.1	169.5	181.3	145.6	360.8	120.6	178.4	38.6	47.9	26.2
9	172.9	84.0	100.3	171.8	195.4	148.7	425.9	114.4	179.1	37.8	89.0	25.8
10	141.7	79.2	107.0	190.5	229.6	144.3	810.4	159.4	142.8	37.4	39.1	25.4
11	141.1	75.0	296.4	207.0	195.9	154.6	580.8	140.1	193.5	37.2	33.1	25.6
12	137.6	74.7	588.3	222.4	152.0	159.2	418.7	144.7	117.9	37.4	32.7	25.6
13	138.5	71.9	365.4	215.3	137.6	160.3	238.0	118.1	146.3	37.5	32.4	25.5
14	130.1	65.8	249.4	222.5	136.4	168.1	188.3	109.7	81.8	37.6	30.4	25.6
15	122.6	64.4	213.7	233.5	136.8	172.3	258.7	194.3	69.0	37.9	29.1	25.7
16	151.6	71.6	179.8	184.3	175.2	179.5	316.2	122.3	62.3	37.1	29.8	25.6
17	266.9	143.8	161.3	186.2	153.7	198.6	158.0	134.9	59.8	36.1	30.3	25.6
18	175.7	107.7	158.9	189.1	144.6	196.5	294.7	108.1	58.2	35.2	30.9	25.5
19	146.2	90.8	142.3	189.5	123.9	192.0	181.0	90.8	55.2	34.4	45.3	25.4
20	129.2	89.8	131.1	189.3	114.5	139.9	141.2	193.1	52.5	33.5	34.7	25.2
21	122.2	74.8	129.7	191.3	112.1	137.5	147.1	109.7	51.7	32.5	31.7	25.4
22	114.4	69.7	123.8	194.8	130.6	153.3	310.8	74.0	53.0	31.4	30.7	25.6
23	110.5	68.1	471.4	193.3	144.9	195.1	633.1	66.7	104.1	30.5	30.2	25.8
24	105.6	65.2	1,734.8	194.7	140.7	481.7	620.8	86.5	110.4	29.6	29.8	25.9
25	102.7	144.7	493.1	200.1	146.7	351.3	1,104.4	83.0	60.9	28.8	29.4	26.0
26	99.9	254.7	241.4	211.2	150.5	229.4	438.9	74.7	56.2	29.3	29.1	26.1
27	95.9	156.4	172.7	199.2	148.6	178.8	308.9	88.0	53.9	29.9	28.9	26.1
28	93.9	134.7	203.3	213.6	144.1	142.5	260.8	72.9	51.6	30.5	28.5	26.1
29	91.9		193.7	206.8	170.2	127.0	221.4	64.4	50.9	31.1	28.3	26.1
30	89.8		184.5	212.2	167.5	115.2	242.5	62.5	48.7	31.8	28.0	26.0
31	87.1		172.4		141.3		215.6	161.9		31.3		26.0
Average	143.3	93.6	246.0	188.9	162.4	178.8	324.1	128.1	104.5	36.1	42.9	26.1
Maximum	266.9	254.7	1,734.8	233.5	229.6	481.7	1,104.4	237.9	241.6	46.4	206.9	27.8
Minimum	87.1	64.4	97.1	143.4	112.1	115.2	122.2	62.5	48.7	28.8	27.4	25.2

Average annual discharge = 140 (m^3/sec)

Annual inflow volume = 4,417 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1994

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.0	33.9	65.0	118.9	134.2	113.8	522.9	321.0	456.3	78.3	50.8	40.6
2	25.8	30.7	62.8	80.7	169.7	98.3	172.1	276.6	436.8	46.7	48.0	42.0
3	25.6	27.3	63.4	71.1	148.4	88.3	818.0	238.4	210.9	47.2	47.4	43.5
4	25.4	25.3	83.7	259.4	133.6	80.8	331.0	380.8	284.9	80.8	46.9	50.9
5	25.3	24.2	78.3	946.2	121.7	72.4	173.2	319.1	366.5	84.2	46.5	59.0
6	25.2	36.4	76.4	990.9	124.6	69.4	142.3	332.4	330.3	88.6	46.1	118.0
7	25.2	44.9	77.6	341.4	126.0	73.6	876.3	1,189.6	256.4	83.4	45.7	150.3
8	25.0	36.5	81.0	198.3	203.7	92.6	280.8	396.1	205.0	77.6	45.6	566.2
9	24.8	40.4	82.1	180.4	277.9	102.3	240.1	273.7	202.1	74.3	45.0	201.4
10	24.5	36.5	82.3	157.4	159.3	163.6	661.3	612.6	205.6	71.3	44.5	118.8
11	25.5	35.7	78.3	140.6	199.9	134.4	346.7	292.9	235.9	68.2	44.0	82.3
12	27.4	34.3	74.4	128.3	139.3	167.5	237.2	254.3	211.4	65.1	43.4	77.2
13	46.7	32.6	64.1	123.5	123.6	164.5	208.5	218.8	214.7	62.2	42.8	72.2
14	43.6	33.1	73.7	104.7	142.1	109.9	380.1	640.4	206.0	59.5	42.3	67.6
15	43.8	34.0	99.1	141.3	191.4	94.6	242.5	307.0	200.8	56.4	41.7	69.9
16	42.4	35.2	70.7	106.5	132.2	83.2	165.3	317.2	184.9	53.1	41.0	62.8
17	41.9	36.3	54.6	103.2	119.1	89.2	207.7	1,206.6	176.4	51.6	40.5	58.5
18	41.3	37.6	51.7	100.4	117.1	91.8	683.4	506.3	168.4	50.7	39.3	60.2
19	40.5	39.2	58.0	101.3	122.6	95.2	184.1	358.5	156.4	50.0	38.0	61.2
20	41.1	44.4	185.2	93.8	126.1	120.9	1,294.4	342.1	142.6	48.8	37.4	62.0
21	36.7	531.8	103.0	81.4	121.3	122.5	354.4	466.0	121.4	47.7	36.8	63.3
22	33.0	175.1	81.9	85.4	122.7	114.2	1,160.6	590.8	103.3	46.7	36.3	68.8
23	28.5	108.3	70.8	87.1	144.4	145.4	684.5	570.9	91.6	45.7	35.7	80.5
24	25.9	95.1	66.8	81.2	124.5	137.7	1,220.6	352.7	79.4	43.4	35.2	98.3
25	24.9	91.5	73.9	68.1	124.0	230.2	246.1	322.2	79.3	69.2	33.9	106.7
26	28.0	83.4	81.9	80.6	120.3	410.3	212.6	639.7	79.3	149.9	34.2	92.8
27	97.8	72.6	82.9	89.0	124.7	172.1	222.1	363.9	77.9	120.4	33.6	153.1
28	77.6	66.2	82.1	91.9	123.8	153.3	851.3	321.2	76.9	101.1	34.8	323.2
29	49.9		75.4	124.5	126.4	132.3	380.5	295.2	77.0	84.9	38.0	171.3
30	43.1		75.9	146.0	123.7	277.2	1,093.1	288.0	77.7	74.1	39.2	104.5
31	37.9		147.5		114.6		462.2	281.5		62.8		96.3
Average	36.5	68.7	80.8	180.8	141.4	133.4	485.7	428.3	190.5	69.2	41.2	110.4
Maximum	97.8	531.8	185.2	990.9	277.9	410.3	1,294.4	1,206.6	456.3	149.9	50.8	566.2
Minimum	24.5	24.2	51.7	68.1	114.6	69.4	142.3	218.8	76.9	43.4	33.6	40.6

Average annual discharge = 165 (m^3/sec)

Annual inflow volume = 5,203 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1995

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	86.1	64.3	146.3	220.3	163.7	109.0	118.4	707.0	242.1	61.2	34.9	45.5
2	90.5	64.4	144.4	192.2	150.3	111.2	93.3	720.8	196.7	60.7	34.6	39.9
3	85.5	65.0	139.8	180.7	146.6	109.3	113.2	574.7	170.7	68.5	34.3	37.5
4	81.9	66.3	141.1	159.5	138.3	111.2	114.5	687.3	138.0	65.1	33.2	36.3
5	80.8	66.1	146.2	150.2	144.8	115.2	127.5	561.4	123.0	52.6	32.1	34.7
6	79.5	65.5	145.3	143.0	135.8	120.9	141.9	476.9	118.6	51.3	31.8	32.8
7	76.5	65.2	144.5	146.1	144.8	135.7	128.4	412.7	118.5	50.4	31.6	30.5
8	74.5	64.9	135.0	142.4	146.0	131.4	186.0	333.1	119.3	49.5	31.4	32.3
9	71.8	64.8	124.5	182.4	151.3	130.3	202.0	282.7	153.0	49.0	31.2	45.1
10	78.4	65.3	122.7	256.3	159.8	133.5	153.5	328.1	126.7	48.7	31.1	44.9
11	76.4	266.3	121.2	190.6	162.6	119.9	162.4	238.3	123.2	44.4	30.9	37.8
12	72.0	426.8	114.3	246.0	164.0	122.7	126.7	218.6	121.8	33.6	30.7	36.6
13	64.9	138.7	104.1	206.5	162.9	121.7	118.3	247.4	113.7	33.3	30.6	37.2
14	65.5	181.3	110.1	203.4	161.9	120.7	127.7	299.4	98.8	33.5	30.4	37.3
15	69.8	246.4	104.4	237.5	158.8	119.7	140.8	272.8	96.7	42.3	29.9	36.7
16	71.4	163.7	104.3	294.0	146.5	128.6	165.3	236.7	90.2	66.7	29.7	36.7
17	68.6	144.8	104.3	243.9	134.4	136.4	210.8	247.8	72.9	50.6	29.0	36.6
18	65.3	181.7	104.4	226.7	146.0	142.8	199.7	223.1	71.1	53.6	28.5	35.8
19	66.2	135.5	117.8	226.8	133.8	201.1	450.3	217.8	67.4	42.9	28.3	35.3
20	69.5	135.8	131.9	213.7	121.1	206.5	441.8	566.9	65.9	42.2	28.0	34.8
21	69.9	131.5	151.6	216.3	117.2	275.5	332.0	421.7	64.5	41.8	28.0	34.0
22	66.4	110.1	157.1	220.7	127.4	206.1	470.2	359.9	63.8	41.4	27.7	33.3
23	66.5	97.5	218.7	228.9	128.8	154.3	648.7	245.8	63.1	41.0	27.2	32.8
24	67.4	95.8	238.3	247.8	115.8	134.2	586.3	299.6	89.1	40.5	26.8	32.3
25	65.6	98.1	201.3	236.3	109.3	106.4	1,073.3	198.8	71.2	40.0	28.1	31.7
26	64.5	98.1	403.8	238.2	111.2	102.8	1,544.3	187.0	62.6	39.3	29.5	31.2
27	63.7	212.4	244.6	239.1	109.4	96.0	1,754.8	243.6	62.7	38.2	30.9	30.7
28	64.0	183.2	436.2	212.9	109.7	107.0	2,420.2	223.6	62.6	37.2	36.5	31.2
29	62.8		454.6	197.9	110.9	104.8	1,211.6	248.5	62.6	36.4	69.3	29.6
30	63.2		307.2	177.3	107.5	113.9	788.6	266.1	61.9	35.6	53.7	29.1
31	64.5		255.2		107.0		687.5	385.6		35.1		27.0
Average	71.4	132.1	179.9	209.3	136.4	134.3	485.2	352.7	103.1	46.0	32.7	35.1
Maximum	90.5	426.8	454.6	294.0	164.0	275.5	2,420.2	720.8	242.1	68.5	69.3	45.5
Minimum	62.8	64.3	104.1	142.4	107.0	96.0	93.3	187.0	61.9	33.3	26.8	27.0

Average annual discharge = 161 (m^3/sec)

Annual inflow volume = 5,062 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1996

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	27.8	46.1	168.5	322.5	213.3	161.5	362.6	228.6	159.9	91.8	40.1	28.2
2	27.2	45.8	123.1	271.1	178.7	150.2	238.0	190.1	162.8	93.0	39.2	27.4
3	26.8	61.0	133.2	231.7	157.5	132.0	192.3	288.1	186.2	275.9	38.0	26.7
4	26.5	71.7	101.1	194.2	153.4	130.8	340.2	260.6	156.8	304.7	37.2	31.6
5	26.2	65.1	108.2	203.5	148.9	126.8	283.0	279.2	160.8	135.6	36.2	32.5
6	26.0	59.9	129.0	219.2	143.8	118.7	240.8	394.0	163.6	63.8	36.0	28.9
7	25.8	62.7	173.5	256.2	129.5	126.0	172.1	262.8	169.1	60.5	36.7	26.8
8	25.4	68.9	190.3	348.2	133.1	135.3	152.5	253.6	137.5	67.6	37.6	26.6
9	24.4	129.4	156.2	203.2	130.1	158.0	150.3	242.0	135.4	76.4	38.7	26.4
10	23.5	129.2	152.7	186.4	127.6	134.0	153.2	247.8	130.9	73.2	39.8	26.4
11	36.0	74.3	160.9	183.1	122.8	134.1	179.1	259.1	114.8	69.7	40.8	26.0
12	49.9	80.8	301.5	181.4	123.1	139.2	181.3	447.9	104.6	63.4	41.9	25.8
13	65.1	88.3	282.3	176.7	118.6	228.1	190.3	922.9	96.4	53.9	38.5	25.6
14	82.5	131.6	280.3	174.9	112.5	189.6	237.7	957.6	153.5	46.8	33.2	25.3
15	585.7	566.4	427.1	186.7	140.1	227.5	174.1	639.2	114.6	39.7	30.1	24.9
16	322.2	233.7	604.1	185.4	147.6	316.9	149.9	527.4	90.1	32.5	29.2	24.7
17	153.2	175.7	916.3	211.9	131.5	246.2	134.2	452.1	77.6	26.6	28.8	24.5
18	109.5	127.8	1,202.2	209.7	99.7	196.1	118.4	369.8	77.3	22.4	28.4	24.4
19	76.0	139.4	782.6	209.6	93.3	309.0	120.3	321.7	73.6	21.4	26.9	24.2
20	64.8	165.1	525.0	195.2	85.4	622.5	238.2	232.4	69.0	27.7	25.8	24.0
21	54.0	191.4	452.8	186.2	169.5	1,087.0	245.1	182.6	65.4	44.0	30.9	23.8
22	44.9	218.8	368.0	177.8	259.8	460.6	160.5	222.5	120.8	65.0	36.3	23.5
23	67.0	247.5	302.8	170.0	272.3	346.8	175.2	987.4	107.5	57.4	34.3	23.1
24	64.7	679.5	265.8	158.7	225.3	331.7	162.5	657.8	94.8	50.4	30.4	22.6
25	50.7	442.5	218.2	178.1	421.5	261.4	135.9	495.2	92.6	47.4	28.0	22.4
26	48.7	324.8	246.8	163.1	312.4	231.2	124.4	341.6	90.0	46.1	27.8	22.4
27	49.2	310.8	300.7	162.2	247.5	248.0	104.5	272.6	88.4	44.9	27.9	22.5
28	49.5	254.1	396.6	164.5	227.2	230.9	197.4	226.2	86.2	43.7	28.1	22.5
29	48.6	218.3	769.9	168.5	208.0	294.9	262.9	195.1	85.4	42.6	28.4	22.6
30	47.4		494.8	201.4	195.7	425.2	164.2	215.9	87.2	41.8	29.1	22.4
31	46.4		368.5		155.5		257.7	178.3		41.2		22.4
Average	76.6	186.6	358.2	202.7	173.7	263.3	193.5	379.1	115.1	70.0	33.5	25.2
Maximum	585.7	679.5	1,202.2	348.2	421.5	1,087.0	362.6	987.4	186.2	304.7	41.9	32.5
Minimum	23.5	45.8	101.1	158.7	85.4	118.7	104.5	178.3	65.4	21.4	25.8	22.4

Average annual discharge = 173 (m^3/sec)

Annual inflow volume = 5,479 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1997

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.1	23.2	32.7	340.7	98.3	99.4	132.3	194.2	349.4	103.0	88.9	97.1
2	22.2	22.9	80.6	457.7	90.3	103.3	108.5	231.5	342.6	127.6	84.9	92.2
3	22.2	26.5	95.4	389.9	111.0	105.8	95.2	166.2	307.1	117.4	81.6	88.6
4	22.1	26.0	73.7	555.1	104.2	112.7	136.0	115.8	213.6	117.2	77.2	85.1
5	22.0	37.9	59.2	297.2	102.8	99.1	122.4	112.6	223.1	161.5	73.8	81.5
6	21.9	31.9	56.8	208.1	90.6	105.7	116.5	120.4	283.9	124.8	70.1	78.0
7	21.8	30.3	52.6	140.5	192.7	120.6	146.9	147.5	332.8	114.1	66.6	74.5
8	21.5	29.3	46.6	130.7	191.5	137.3	162.7	147.1	566.5	117.6	62.0	79.9
9	21.2	28.1	54.7	130.9	164.0	167.8	327.5	155.7	331.9	110.6	102.7	242.1
10	21.0	27.4	55.7	131.6	117.2	120.4	208.8	165.6	261.3	99.7	145.6	145.3
11	20.8	36.5	48.3	130.3	108.4	107.5	168.9	226.2	205.9	122.8	90.5	122.0
12	20.6	31.8	44.3	147.7	111.3	103.2	128.3	610.8	181.4	99.8	89.7	113.5
13	20.5	24.3	36.5	133.3	102.9	111.0	126.5	349.7	209.8	102.8	92.6	109.9
14	20.3	22.5	25.1	158.3	97.9	111.8	159.1	302.8	193.1	101.1	96.6	108.1
15	20.2	20.3	25.0	234.6	92.4	114.1	144.9	237.6	166.7	92.4	90.1	107.3
16	20.0	19.2	112.6	160.6	87.9	109.2	181.0	221.8	150.7	110.3	84.3	106.9
17	19.9	18.3	85.8	134.0	86.9	108.8	158.4	193.8	135.0	97.4	78.6	99.4
18	19.1	18.0	76.6	121.1	83.4	116.1	167.4	177.8	125.0	91.1	72.4	91.0
19	19.6	17.9	298.3	108.2	80.8	107.6	439.5	160.1	119.2	86.0	66.2	84.8
20	51.3	18.0	146.5	93.2	79.5	111.7	180.5	226.1	117.1	132.6	59.6	77.7
21	62.5	18.0	112.9	91.4	91.6	122.2	187.4	185.9	142.3	191.2	53.8	70.7
22	51.0	18.2	99.7	93.5	90.7	108.1	237.7	381.7	139.1	120.6	51.4	63.7
23	26.8	17.1	70.4	82.7	80.0	119.9	188.1	268.0	117.5	97.5	52.5	56.7
24	23.0	16.0	57.5	88.1	73.9	119.6	187.8	222.1	114.6	93.3	55.0	55.1
25	21.9	32.0	49.3	104.0	73.8	121.9	189.7	244.7	107.5	86.3	71.2	53.1
26	20.5	68.3	42.1	105.6	69.7	115.4	354.6	432.3	95.6	107.8	159.0	51.7
27	20.5	39.1	64.3	107.3	81.6	179.5	737.9	5,702.3	92.8	128.8	167.8	50.8
28	25.3	30.1	143.3	99.6	94.5	198.2	263.6	1,556.4	95.2	98.0	128.2	48.9
29	23.1		521.9	94.7	90.0	235.8	335.9	759.8	126.8	110.7	109.8	55.3
30	24.4		296.4	95.7	84.7	166.0	286.2	524.8	107.1	114.5	102.8	54.5
31	24.4		274.9		80.4		246.6	439.6		99.9		51.8
Average	24.9	26.7	104.5	172.2	100.2	125.3	213.8	483.3	198.5	112.2	87.5	87.0
Maximum	62.5	68.3	521.9	555.1	192.7	235.8	737.9	5,702.3	566.5	191.2	167.8	242.1
Minimum	19.1	16.0	25.0	82.7	69.7	99.1	95.2	112.6	92.8	86.0	51.4	48.9

Average annual discharge = 146 (m^3/sec)

Annual inflow volume = 4,593 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1998

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	51.7	53.2	364.9	208.9	291.8	116.1	259.7	97.2	101.7	46.3	28.5	19.5
2	49.0	63.9	404.9	236.6	288.0	111.6	196.1	79.7	86.3	45.8	28.2	20.2
3	48.8	62.8	471.8	282.6	280.5	94.7	143.6	76.5	99.7	45.2	28.2	20.9
4	47.5	60.3	2,264.9	287.4	267.9	104.0	201.2	71.1	104.9	47.6	28.2	21.6
5	48.6	59.5	1,064.3	284.1	257.1	91.6	131.1	93.3	103.9	45.2	27.7	22.3
6	47.2	61.8	609.6	284.4	225.1	87.5	214.1	141.7	79.5	44.6	28.5	23.1
7	45.8	64.2	475.3	270.8	161.2	92.4	131.4	98.9	71.7	42.5	27.2	23.9
8	51.3	68.5	449.1	1,174.5	223.1	86.8	106.0	74.3	69.2	34.7	26.1	24.0
9	52.9	71.2	395.2	664.9	191.3	75.4	103.9	68.7	102.9	34.5	25.1	23.3
10	56.0	77.1	339.9	379.8	136.9	76.4	218.5	88.0	84.1	34.5	24.3	23.4
11	60.2	84.1	303.9	351.7	125.4	93.6	198.6	98.7	90.2	34.9	25.2	24.2
12	64.3	93.1	323.6	298.4	114.8	249.6	381.9	106.9	104.0	35.5	24.5	23.3
13	78.3	102.8	317.1	258.1	109.8	132.6	369.3	119.8	80.7	34.7	25.4	23.1
14	97.1	157.2	261.1	243.4	128.1	93.4	385.6	168.6	70.1	34.4	24.8	23.0
15	214.5	765.8	227.4	240.7	124.7	73.3	433.9	205.1	69.7	34.2	25.7	22.8
16	134.7	364.5	227.8	238.4	130.4	63.4	536.4	103.8	66.7	32.7	25.0	23.4
17	95.5	535.7	231.9	231.9	145.8	63.2	330.6	94.3	63.1	35.1	25.1	23.2
18	83.0	914.7	223.6	225.3	134.6	73.6	206.0	83.7	64.0	35.0	23.7	23.1
19	76.0	421.1	238.9	239.2	129.3	74.3	156.5	82.0	62.7	34.2	23.0	22.2
20	70.3	338.8	245.5	250.7	130.2	62.9	112.4	99.2	61.2	35.2	22.4	22.0
21	66.3	290.7	222.5	271.3	129.9	69.8	113.2	83.6	60.8	33.4	21.1	21.5
22	62.4	319.0	274.9	284.7	127.7	81.5	112.7	83.2	60.5	31.8	20.9	20.6
23	58.8	330.1	254.1	298.8	124.3	82.6	113.9	86.7	57.6	30.7	20.2	20.7
24	55.3	694.9	220.5	314.2	116.3	84.9	104.6	86.6	55.0	29.6	20.1	20.1
25	52.1	631.9	216.1	338.3	118.9	85.9	100.2	82.1	53.1	30.1	20.0	20.2
26	48.9	453.0	196.3	722.9	114.1	83.6	149.6	96.8	53.1	29.4	20.5	20.3
27	49.6	398.0	187.8	398.3	123.5	88.4	96.9	87.5	49.8	29.5	20.4	19.7
28	51.7	375.3	191.6	326.3	139.8	93.5	86.8	78.9	48.2	27.7	19.7	19.8
29	51.1		214.6	316.0	176.3	116.8	82.6	78.3	46.1	27.6	19.6	20.5
30	50.3		200.3	304.7	123.6	125.0	112.8	114.3	45.9	27.7	19.5	20.6
31	51.0		195.7		116.8		145.8	123.3		28.3		21.8
Average	66.8	282.6	381.1	340.9	161.5	94.3	194.7	98.5	72.2	35.2	24.0	21.9
Maximum	214.5	914.7	2,264.9	1,174.5	291.8	249.6	536.4	205.1	104.9	47.6	28.5	24.2
Minimum	45.8	53.2	187.8	208.9	109.8	62.9	82.6	68.7	45.9	27.6	19.5	19.5

Average annual discharge = 147 (m^3/sec)

Annual inflow volume = 4,632 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1999

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.0	58.6	59.7	103.3	86.0	36.6	116.9	298.2	119.6	119.6	26.4	26.2
2	21.5	55.3	61.8	100.6	71.2	38.6	105.2	209.3	182.9	96.3	28.1	26.3
3	21.7	52.2	66.0	76.2	70.4	39.2	103.3	197.5	103.2	76.5	29.5	26.8
4	21.1	49.0	75.6	78.7	63.4	38.9	60.6	173.0	86.7	70.7	37.4	27.2
5	21.4	46.0	93.9	85.1	64.3	55.1	50.9	192.3	97.5	77.4	62.1	26.2
6	22.6	44.4	83.6	78.9	65.0	38.1	50.9	254.3	167.5	67.0	56.4	25.8
7	37.9	41.7	233.9	86.1	66.6	39.6	45.6	582.3	101.2	63.8	62.5	25.4
8	35.6	38.6	300.5	87.7	62.3	49.4	39.6	274.6	92.3	61.8	50.9	26.4
9	34.6	41.3	276.8	93.2	61.3	52.0	39.3	209.7	156.7	60.4	45.2	25.9
10	32.9	45.1	183.0	78.2	57.3	57.0	39.3	281.3	87.9	61.0	44.2	25.8
11	30.7	50.6	135.2	97.4	47.8	50.2	112.7	206.6	91.9	60.6	43.9	25.7
12	28.6	58.9	115.3	109.4	54.1	61.4	104.0	213.6	80.2	60.5	39.8	26.0
13	25.4	60.3	96.1	121.3	58.0	55.0	95.9	260.8	75.6	58.0	39.8	25.3
14	22.0	67.3	84.0	97.1	47.5	48.8	71.4	169.1	75.4	56.5	39.1	25.0
15	20.2	61.9	75.0	83.2	40.4	47.9	51.6	132.5	163.9	54.2	38.8	24.8
16	18.7	54.6	66.2	75.5	37.1	47.5	51.6	107.5	135.2	54.3	38.9	24.8
17	19.9	53.5	59.3	76.1	46.3	46.5	200.1	89.5	145.7	53.4	38.8	24.7
18	21.3	76.6	52.9	86.6	58.1	68.1	359.0	80.4	101.7	50.2	38.8	24.0
19	22.6	128.0	47.9	80.8	57.0	76.0	299.1	78.5	240.6	47.5	38.8	23.7
20	27.7	104.9	58.3	76.8	56.4	115.6	217.0	106.7	170.3	45.3	36.5	23.8
21	124.9	63.7	67.2	72.7	72.9	111.5	155.9	83.4	95.9	44.0	36.1	23.6
22	126.1	61.9	44.0	67.0	77.4	65.8	126.4	75.2	73.2	39.1	35.2	23.7
23	89.5	61.1	39.1	73.6	65.2	56.8	91.5	109.5	105.6	35.5	34.6	23.9
24	257.3	63.7	40.3	72.8	63.4	54.5	77.4	70.3	149.9	32.7	34.2	23.7
25	171.1	68.7	47.6	75.1	70.2	88.6	99.9	83.8	119.6	32.1	33.8	23.9
26	100.5	65.4	56.3	73.6	54.5	59.6	61.8	132.2	91.2	31.7	37.7	23.8
27	73.8	66.3	58.3	85.4	59.0	62.2	51.5	151.6	79.6	24.9	31.6	23.9
28	62.4	60.5	62.3	74.6	50.3	55.7	50.2	111.7	97.8	24.0	27.6	24.0
29	59.0		67.0	73.6	51.3	64.3	132.5	75.7	140.5	23.3	26.7	24.0
30	57.1		73.9	86.6	48.1	66.9	139.1	84.5	234.3	25.1	26.6	23.2
31	59.6		89.6		42.7		166.6	109.4		25.2		23.4
Average	54.5	60.7	92.6	84.2	58.9	58.2	108.6	167.9	122.1	52.7	38.7	24.9
Maximum	257.3	128.0	300.5	121.3	86.0	115.6	359.0	582.3	240.6	119.6	62.5	27.2
Minimum	18.7	38.6	39.1	67.0	37.1	36.6	39.3	70.3	73.2	23.3	26.4	23.2

Average annual discharge = 77 (m^3/sec)

Annual inflow volume = 2,433 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2000

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.1	212.1	50.1	94.0	60.2	47.6	153.8	1,725.7	152.3	58.1	42.5	27.3
2	21.9	160.9	48.9	93.2	71.9	45.9	191.9	867.1	149.5	56.1	41.5	28.6
3	21.1	100.3	45.5	100.4	78.1	43.7	176.4	449.8	111.8	57.0	42.4	28.1
4	19.5	82.8	48.1	93.8	77.0	46.6	138.5	340.6	118.6	56.0	41.5	26.9
5	17.9	73.8	100.0	73.1	64.3	48.5	68.1	279.6	103.9	55.0	38.7	28.1
6	17.8	69.4	67.1	74.1	63.9	38.7	58.5	262.8	108.9	51.6	36.2	26.5
7	17.8	61.7	62.9	76.7	60.4	51.1	64.0	260.0	134.7	50.7	35.6	27.7
8	17.3	53.6	63.8	62.0	64.7	52.9	132.3	234.6	103.1	49.7	35.1	26.1
9	17.7	51.4	65.8	60.3	72.4	109.1	166.4	364.8	148.5	49.7	34.5	28.3
10	17.4	122.5	70.8	70.9	76.1	64.1	100.2	319.7	110.3	49.8	33.3	28.0
11	17.8	117.7	67.8	78.6	82.7	69.4	105.4	277.4	112.9	48.0	30.2	30.4
12	169.1	106.8	62.5	85.5	85.1	52.4	88.2	245.7	80.8	46.1	30.5	30.0
13	239.0	80.3	60.1	93.1	153.2	39.1	104.3	207.0	66.2	47.5	27.2	32.4
14	170.8	66.0	55.7	81.1	100.2	33.8	133.4	218.9	56.7	45.5	27.3	30.6
15	80.7	64.4	54.7	88.1	92.7	82.0	139.9	229.1	56.0	43.4	27.4	32.8
16	60.0	62.4	54.9	69.8	114.5	65.8	82.0	237.9	53.8	43.2	27.3	33.8
17	46.3	58.8	54.5	72.7	87.3	57.6	150.2	186.4	50.3	44.6	25.9	36.4
18	43.4	57.1	50.3	75.0	86.4	69.4	78.4	179.4	42.4	42.1	27.1	47.6
19	46.3	55.6	45.4	72.7	106.2	71.8	66.5	142.9	52.2	39.4	25.5	46.9
20	56.7	51.2	42.1	72.1	80.9	120.6	132.9	145.1	205.2	37.4	27.1	37.8
21	50.9	51.2	39.3	75.0	71.7	85.7	129.2	145.4	135.0	37.7	25.8	32.4
22	45.7	50.7	40.9	86.5	72.6	63.2	617.9	126.6	121.5	38.0	24.9	28.3
23	42.3	49.5	41.0	68.1	76.4	89.8	730.0	125.9	86.9	36.5	26.1	26.4
24	39.9	44.4	43.1	66.9	66.6	67.9	363.1	115.6	78.8	35.0	27.4	23.2
25	37.7	42.4	45.8	80.1	62.9	65.8	263.7	108.2	86.9	35.1	26.4	23.9
26	39.0	44.2	74.4	79.9	57.7	73.1	262.0	102.0	196.5	35.4	26.5	22.7
27	38.2	45.1	112.7	78.4	52.1	122.7	183.2	99.6	111.7	34.4	28.3	24.2
28	36.1	44.7	97.8	61.1	46.5	209.2	193.8	114.2	87.3	35.0	26.9	23.8
29	35.1	44.7	117.6	57.5	44.5	96.0	187.5	169.6	72.0	37.7	27.3	22.5
30	34.7		112.3	57.6	50.4	316.8	161.4	184.1	63.6	42.5	29.1	23.0
31	35.5		88.8		62.4		640.5	139.0		43.4		21.9
Average	50.2	73.3	64.0	76.6	75.6	80.0	195.6	277.6	102.0	44.6	30.9	29.3
Maximum	239.0	212.1	117.6	100.4	153.2	316.8	730.0	1,725.7	205.2	58.1	42.5	47.6
Minimum	17.3	42.4	39.3	57.5	44.5	33.8	58.5	99.6	42.4	34.4	24.9	21.9

Average annual discharge = 92 (m^3/sec)

Annual inflow volume = 2,907 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2001

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.4	19.8	24.2	46.4	50.6	49.4	103.5	290.9	118.2	44.3	25.3	18.8
2	23.2	21.4	23.8	37.5	50.6	120.6	71.6	257.7	130.5	46.2	27.6	19.9
3	25.7	20.6	23.0	39.0	50.5	166.3	85.1	266.2	115.7	51.1	34.1	19.0
4	25.9	19.7	22.6	48.4	49.8	113.2	72.8	454.2	126.6	64.9	44.7	18.0
5	25.4	20.9	22.2	41.7	51.2	136.0	76.3	317.1	95.3	54.8	37.4	19.0
6	24.9	19.7	22.2	40.3	59.8	123.0	51.9	329.1	103.9	49.3	41.5	18.0
7	23.5	18.7	21.1	42.6	67.5	135.0	59.7	390.5	84.6	46.6	41.5	19.2
8	21.8	18.8	20.9	46.3	69.4	122.7	103.4	252.0	102.1	43.4	36.8	18.3
9	21.8	18.9	20.7	50.2	65.6	134.3	86.7	224.3	81.2	43.8	33.4	19.1
10	20.8	18.7	20.6	50.5	68.2	140.7	78.5	233.5	78.8	43.9	32.5	18.1
11	22.2	19.7	19.0	47.6	70.9	82.0	629.2	193.9	81.3	43.7	33.3	17.2
12	21.4	20.8	18.9	50.2	73.9	71.9	155.3	161.5	154.5	44.8	31.0	17.5
13	21.1	19.9	21.2	52.2	71.9	65.3	212.0	148.3	114.1	42.9	30.4	18.0
14	22.8	19.0	23.1	48.5	68.7	117.0	134.2	367.1	203.8	44.0	29.3	18.0
15	22.0	20.1	22.3	51.9	78.0	116.6	142.9	338.9	187.2	41.2	28.3	17.3
16	22.6	21.3	24.8	59.8	62.7	178.3	379.3	282.3	112.3	40.1	28.6	19.2
17	21.3	20.5	23.8	108.7	83.8	444.3	266.7	187.8	98.9	40.7	27.6	20.3
18	20.6	20.6	20.7	152.1	60.9	172.5	168.4	163.9	88.9	37.6	25.2	21.1
19	21.2	20.2	19.7	85.0	61.3	107.4	139.6	161.0	81.3	36.9	23.5	25.0
20	21.5	21.0	23.8	88.8	144.8	85.9	131.3	164.1	75.7	35.3	24.7	23.2
21	21.1	22.2	46.5	63.3	106.7	138.4	130.3	184.9	71.0	34.3	25.2	22.8
22	22.0	21.1	37.9	53.8	76.5	179.5	407.0	176.5	64.6	33.5	23.1	21.8
23	21.6	20.9	30.0	44.0	73.9	149.7	636.7	214.8	60.8	31.8	21.7	21.2
24	20.7	23.2	26.4	45.7	60.6	160.5	522.0	161.4	57.9	31.6	22.5	21.1
25	21.7	27.0	25.1	47.7	53.1	102.8	300.7	138.0	55.2	29.2	21.1	20.1
26	21.7	26.9	25.3	44.8	48.5	121.4	196.2	131.7	58.9	29.3	20.3	19.9
27	21.7	27.1	23.8	45.3	43.7	107.9	185.3	123.7	54.7	27.9	20.9	19.8
28	20.5	26.5	26.9	42.5	45.3	64.6	155.6	126.8	50.2	26.0	20.0	19.6
29	20.5		46.4	51.4	62.7	56.9	605.4	117.2	47.1	24.5	18.9	18.2
30	20.7		59.5	46.4	48.5	233.5	528.7	112.0	44.8	24.3	19.8	19.2
31	19.6		44.7		54.2		359.4	143.6		24.6		18.6
Average	22.1	21.3	26.8	55.7	65.6	133.2	231.5	219.8	93.3	39.1	28.3	19.6
Maximum	25.9	27.1	59.5	152.1	144.8	444.3	636.7	454.2	203.8	64.9	44.7	25.0
Minimum	19.6	18.7	18.9	37.5	43.7	49.4	51.9	112.0	44.8	24.3	18.9	17.2

Average annual discharge = 80 (m^3/sec)

Annual inflow volume = 2,529 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2002

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.7	26.8	43.2	91.4	46.9	56.2	80.8	82.5	189.9	42.9	28.6	21.2
2	18.9	28.0	45.1	89.3	47.9	48.8	66.3	101.1	242.8	42.6	27.9	21.1
3	19.5	26.3	50.6	82.5	49.5	71.9	58.3	77.5	164.5	42.2	27.8	20.9
4	18.6	25.9	40.9	82.0	59.4	55.2	62.5	100.3	313.6	41.5	26.6	21.5
5	17.7	25.1	39.1	82.0	86.5	51.8	56.7	122.7	218.4	42.1	27.2	20.5
6	17.1	25.8	37.9	81.4	90.9	58.4	50.9	233.5	156.0	43.6	28.5	20.4
7	17.4	28.8	38.9	121.3	84.9	52.4	41.6	175.4	130.5	43.7	27.6	19.4
8	17.7	33.5	38.2	108.6	76.9	50.3	39.6	136.2	158.5	42.8	27.2	19.3
9	17.3	30.2	52.3	92.1	81.1	56.2	34.5	114.5	118.5	42.1	26.1	19.5
10	17.8	27.2	214.6	83.7	82.6	79.8	42.5	92.5	104.5	41.5	26.1	20.1
11	16.9	25.7	144.4	79.5	92.2	78.7	43.4	100.3	91.3	40.6	26.4	19.9
12	16.9	25.5	108.9	80.5	94.5	75.0	35.5	575.1	105.3	40.8	26.6	19.0
13	15.8	25.5	101.7	85.3	89.7	81.0	34.5	869.3	96.5	45.8	25.3	20.0
14	19.3	25.3	95.3	91.5	87.0	178.9	33.1	519.9	154.2	46.4	24.5	21.0
15	53.8	25.4	89.7	87.1	95.9	127.0	38.0	405.6	156.7	42.5	24.4	20.6
16	120.9	26.7	85.0	85.1	105.3	117.5	40.6	235.7	131.7	40.3	24.8	20.3
17	87.5	30.3	90.5	80.7	94.6	193.3	65.4	174.2	194.0	38.6	23.5	19.5
18	59.1	34.7	88.1	80.2	94.3	158.4	83.3	138.8	154.7	37.4	23.6	20.4
19	48.3	37.2	91.9	82.3	88.0	122.5	81.2	119.7	121.1	37.0	23.2	19.9
20	40.7	33.6	99.1	84.7	76.0	97.9	148.2	131.8	97.3	41.5	22.9	22.7
21	37.7	51.3	97.7	83.1	70.9	114.2	269.2	115.1	83.9	38.5	22.5	23.4
22	37.9	80.6	107.2	74.7	69.3	82.1	124.1	155.7	69.7	37.6	22.2	23.1
23	35.3	537.5	86.0	72.4	70.6	90.4	183.9	140.8	58.3	36.5	22.4	21.7
24	35.5	200.0	101.4	72.7	67.1	241.1	105.1	180.2	72.4	35.6	23.2	21.5
25	33.2	136.4	219.0	73.2	65.9	188.5	114.1	235.3	58.4	34.0	22.4	22.3
26	33.5	89.8	150.1	72.2	60.1	109.0	92.3	216.0	55.5	32.6	22.2	22.0
27	31.1	62.1	121.8	60.3	64.7	88.7	113.2	210.1	50.8	31.7	23.0	20.9
28	29.7	44.9	105.9	53.5	68.8	111.6	94.0	152.3	47.3	31.1	22.2	21.3
29	30.3		103.5	47.2	95.5	155.0	91.4	127.8	44.2	29.8	21.0	21.5
30	28.1		100.6	43.2	72.6	100.5	113.0	284.1	43.8	28.5	21.4	21.1
31	27.8		94.9		55.7		73.8	194.9		27.9		20.2
Average	32.9	63.2	93.0	80.1	77.0	103.1	81.0	210.3	122.8	38.7	24.7	20.9
Maximum	120.9	537.5	219.0	121.3	105.3	241.1	269.2	869.3	313.6	46.4	28.6	23.4
Minimum	15.8	25.1	37.9	43.2	46.9	48.8	33.1	77.5	43.8	27.9	21.0	19.0

Average annual discharge = 79 (m^3/sec)

Annual inflow volume = 2,493 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2003

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.0	26.1	451.9	168.7	296.0	27.9	76.1	196.8	76.5	72.8	27.6	18.4
2	19.0	26.6	1,159.5	163.6	152.6	34.1	67.8	284.8	81.3	60.3	26.4	20.6
3	19.1	23.5	587.7	156.1	98.4	29.9	67.9	207.3	107.5	55.3	26.0	19.3
4	19.2	20.8	419.7	164.0	87.3	25.9	73.9	126.8	176.0	47.7	27.4	21.3
5	18.6	21.6	334.5	143.2	75.0	25.9	144.7	90.6	132.0	43.8	26.3	23.3
6	18.3	20.9	303.6	126.8	63.0	26.3	157.8	73.1	112.3	43.6	26.2	21.4
7	17.8	21.7	283.3	140.5	64.9	93.5	172.7	67.9	88.7	42.2	23.7	23.2
8	18.7	21.9	247.7	155.3	61.2	95.1	92.1	80.7	101.9	39.1	24.6	21.5
9	20.0	21.3	223.4	166.3	59.2	110.4	173.6	62.1	126.1	43.9	24.3	21.8
10	18.7	20.3	202.2	175.5	55.5	104.1	113.0	55.8	93.7	41.5	23.0	24.3
11	17.5	19.8	178.1	182.4	52.6	84.6	127.1	55.5	85.6	38.2	24.1	25.5
12	17.0	19.6	163.1	188.5	52.1	77.4	104.8	55.3	81.9	39.4	22.7	24.5
13	15.7	18.7	167.6	190.2	48.9	68.7	105.8	51.5	112.2	35.3	24.8	28.4
14	15.6	18.3	177.9	194.0	49.8	68.4	85.1	46.1	90.3	33.8	23.4	56.6
15	15.1	19.1	178.0	187.9	50.4	69.6	111.6	43.7	93.7	33.6	25.8	73.7
16	15.7	23.7	201.6	278.0	51.4	70.7	164.8	42.2	75.1	32.8	24.3	54.8
17	15.1	348.6	190.6	224.9	52.4	72.6	85.8	53.7	69.2	30.6	37.4	44.9
18	15.8	3,498.6	175.0	200.4	56.2	68.9	82.5	128.8	67.2	29.5	48.6	37.7
19	15.5	1,625.5	175.6	205.1	48.5	69.6	71.5	204.6	61.8	29.6	32.1	34.6
20	15.6	414.7	181.3	227.3	56.4	90.7	114.4	233.4	60.5	29.5	27.5	30.6
21	15.2	280.7	198.5	174.0	56.1	125.6	140.7	190.1	57.3	29.2	25.5	32.5
22	15.6	240.2	216.2	158.4	54.0	95.6	129.5	120.9	54.2	27.0	25.1	30.7
23	15.1	256.3	193.9	170.1	49.1	85.9	121.5	114.7	64.2	27.3	22.8	31.6
24	15.7	239.0	195.2	184.1	40.6	82.5	242.2	89.2	185.6	26.7	24.5	29.6
25	14.7	214.2	211.0	176.9	38.1	95.9	139.7	74.6	367.7	24.5	22.5	27.3
26	13.9	209.9	198.2	175.6	36.9	93.2	143.2	74.9	274.0	25.7	20.4	29.1
27	14.3	207.6	202.5	177.9	39.2	87.0	160.2	76.6	157.9	25.3	18.3	26.9
28	13.5	344.9	202.3	146.8	37.8	80.2	125.5	74.8	116.3	24.1	20.3	28.7
29	21.0		281.7	139.4	28.1	74.2	119.4	85.5	93.2	23.9	22.4	26.9
30	22.2		233.3	155.0	26.7	66.4	157.0	130.5	79.5	25.7	20.3	27.6
31	27.7		185.0		27.4		111.9	83.6		26.2		25.0
Average	17.3	293.7	268.4	176.6	63.4	73.4	122.1	105.7	111.5	35.8	25.6	30.4
Maximum	27.7	3,498.6	1,159.5	278.0	296.0	125.6	242.2	284.8	367.7	72.8	48.6	73.7
Minimum	13.5	18.3	163.1	126.8	26.7	25.9	67.8	42.2	54.2	23.9	18.3	18.4

Average annual discharge = 109 (m^3/sec)

Annual inflow volume = 3,436 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2004

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.1	125.4	74.2	36.4	335.8	44.8	57.2	170.1	57.5	36.0	35.5	86.4
2	28.9	96.3	63.5	35.2	182.9	52.1	70.2	97.6	88.1	36.8	34.0	64.5
3	28.6	93.7	56.0	33.9	124.9	46.7	60.3	199.2	59.8	38.3	33.9	52.5
4	28.7	80.2	53.2	35.2	113.4	41.3	81.1	129.9	51.4	40.0	32.9	45.2
5	28.7	69.2	50.7	38.6	100.4	41.0	67.4	85.8	46.3	39.1	29.8	42.5
6	28.4	61.6	52.4	43.6	88.1	39.9	64.4	104.3	52.1	37.4	29.7	41.2
7	28.4	54.1	50.8	44.2	86.5	84.5	61.2	302.9	44.9	37.7	31.6	36.9
8	27.8	52.0	51.7	39.5	82.5	64.1	92.3	232.2	45.5	41.5	30.0	36.3
9	26.9	76.4	66.2	50.1	80.3	83.1	203.3	153.9	44.4	45.6	32.4	33.9
10	25.5	103.9	70.9	48.5	76.1	66.7	105.0	114.3	43.0	51.0	29.8	33.7
11	26.4	85.5	66.8	42.8	73.0	51.3	87.5	133.8	40.5	120.9	32.7	33.3
12	27.5	78.7	61.4	41.5	72.7	51.8	148.3	87.9	42.2	97.8	30.1	32.4
13	29.2	82.6	57.7	39.5	69.4	49.3	86.3	63.2	47.0	79.2	28.0	32.4
14	30.5	78.2	58.0	36.7	70.5	51.7	151.0	58.5	50.6	69.5	30.4	31.9
15	31.6	84.0	58.3	38.6	71.2	77.3	85.0	72.9	95.9	59.3	28.2	30.5
16	32.4	77.7	65.3	41.0	72.5	61.7	80.8	80.1	147.7	56.3	30.6	27.7
17	63.9	75.9	67.1	38.1	73.0	59.3	49.3	221.2	89.6	49.4	28.2	28.4
18	113.6	121.8	66.1	36.6	76.6	97.1	87.9	160.1	68.0	48.3	30.6	27.7
19	60.7	106.6	64.9	36.9	67.3	69.5	58.7	108.5	57.8	47.5	28.2	27.9
20	47.8	85.8	58.6	41.0	75.2	79.2	48.3	100.2	55.9	47.0	28.9	104.9
21	46.2	83.9	57.8	37.8	74.0	89.4	52.4	77.4	96.9	48.2	29.5	60.1
22	192.4	76.2	48.2	34.3	70.6	106.3	45.3	72.6	67.3	49.4	28.2	43.0
23	238.3	76.2	45.2	42.1	65.1	76.5	41.0	84.0	53.4	52.9	26.6	37.8
24	155.9	80.8	43.5	40.7	55.2	107.1	35.0	83.8	48.7	50.3	28.4	39.5
25	105.3	80.8	36.8	41.3	52.9	155.4	29.4	95.6	50.8	51.6	32.3	39.0
26	89.2	79.8	37.8	43.7	52.1	97.8	27.1	91.9	53.9	54.5	31.8	36.8
27	77.3	78.8	35.4	50.0	55.9	90.9	47.0	61.3	57.4	63.3	31.3	38.2
28	70.5	87.9	33.8	73.5	54.9	63.3	64.6	72.4	49.3	54.6	35.9	36.0
29	71.5	79.0	33.0	89.9	44.0	54.5	78.5	57.3	42.6	47.1	39.6	36.9
30	115.3		32.6	338.1	42.7	47.4	156.7	63.9	37.1	40.2	185.1	37.4
31	173.0		33.9		44.3		148.2	58.4		38.9		43.6
Average	67.0	83.2	53.3	53.0	84.0	70.0	79.7	112.8	59.5	52.6	36.1	41.9
Maximum	238.3	125.4	74.2	338.1	335.8	155.4	203.3	302.9	147.7	120.9	185.1	104.9
Minimum	25.1	52.0	32.6	33.9	42.7	39.9	27.1	57.3	37.1	36.0	26.6	27.7

Average annual discharge = 66 (m^3/sec)

Annual inflow volume = 2,091 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2005

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	346.3	65.1	191.7	195.2	163.7	83.0	228.4	99.3	47.0	39.2	51.2	38.3
2	146.5	63.9	193.2	206.9	159.6	76.4	233.4	95.9	43.8	39.4	48.9	40.4
3	97.9	63.1	195.6	211.6	189.7	74.5	192.7	102.4	43.6	40.6	46.1	37.2
4	84.1	57.5	206.1	216.5	177.6	73.8	157.2	95.4	42.2	40.6	49.5	39.3
5	72.8	69.8	226.0	225.5	187.2	78.1	167.4	116.5	47.5	41.9	46.6	36.1
6	63.7	71.2	229.1	216.9	182.9	74.8	162.9	93.2	56.2	41.4	44.1	32.8
7	54.6	171.0	222.6	222.2	172.8	79.5	119.6	95.5	129.8	42.7	47.1	34.9
8	46.4	157.5	209.7	226.0	177.5	83.0	155.6	97.9	97.0	41.8	44.7	31.7
9	43.9	608.1	218.0	213.4	176.5	79.3	181.6	105.6	106.1	48.4	47.2	34.2
10	41.9	376.1	203.6	177.8	158.6	79.4	187.1	107.1	71.5	49.8	44.5	32.0
11	39.3	645.3	210.3	156.0	138.4	86.7	300.3	104.9	67.3	56.6	41.5	32.3
12	40.2	697.2	205.7	156.4	128.2	88.2	417.6	99.8	78.7	100.9	44.2	31.0
13	39.9	402.5	216.3	157.3	128.4	87.3	401.0	154.6	68.4	63.4	41.3	33.6
14	41.1	322.6	209.9	164.6	117.8	74.8	294.9	97.8	53.3	55.3	43.9	30.8
15	38.7	301.9	230.5	169.4	104.2	73.9	277.9	86.4	53.8	50.9	41.1	33.2
16	39.5	303.8	268.0	176.0	109.7	86.0	330.2	124.7	48.9	61.2	43.7	30.8
17	36.3	249.1	305.6	165.5	105.0	88.6	215.8	119.8	71.0	76.2	40.9	29.1
18	38.5	268.1	352.9	171.7	101.2	101.9	178.6	100.3	302.5	64.0	38.0	31.0
19	35.4	367.8	606.1	188.4	104.8	110.0	169.7	82.4	158.8	59.5	40.5	29.0
20	37.6	259.7	483.0	192.5	94.7	122.1	175.3	84.2	94.1	58.8	37.8	29.6
21	34.5	213.4	433.3	180.9	97.2	127.1	200.3	74.1	70.5	54.7	40.3	29.4
22	50.6	215.7	557.3	195.2	85.9	138.4	193.5	69.6	57.1	55.2	37.6	31.8
23	85.3	219.2	420.5	224.0	86.0	152.3	155.7	65.6	78.0	51.2	40.1	30.6
24	60.7	209.7	378.1	203.2	93.6	164.5	151.2	60.4	53.8	52.3	37.3	29.3
25	45.2	196.7	312.6	207.7	87.4	165.8	140.0	76.9	50.0	48.7	40.2	32.0
26	39.7	190.5	284.6	234.9	81.6	180.6	136.2	65.0	46.0	49.4	37.8	29.2
27	35.7	190.1	294.9	204.0	81.9	181.0	187.4	91.5	50.6	49.2	40.7	31.9
28	66.6	186.0	287.5	191.3	77.8	168.1	119.7	72.2	45.5	49.3	40.3	29.7
29	67.6		250.2	163.8	84.6	185.1	113.1	60.9	40.0	51.2	41.3	29.6
30	59.8		221.2	154.5	96.1	189.9	146.1	51.9	39.3	48.7	41.5	30.3
31	55.4		206.3		96.2		98.9	45.9		49.8		27.6
Average	64.1	255.1	284.9	192.3	124.1	111.8	199.7	90.3	73.7	52.7	42.7	32.2
Maximum	346.3	697.2	606.1	234.9	189.7	189.9	417.6	154.6	302.5	100.9	51.2	40.4
Minimum	34.5	57.5	191.7	154.5	77.8	73.8	98.9	45.9	39.3	39.2	37.3	27.6

Average annual discharge = 126 (m^3/sec)

Annual inflow volume = 3,978 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2006

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	28.6	50.3	139.8	124.0	107.8	66.0	86.9	249.7	271.7	62.4	30.8	56.7
2	59.4	51.2	121.6	126.3	104.6	62.8	53.6	223.7	376.4	57.8	29.7	48.9
3	77.5	51.1	104.4	124.9	99.6	61.4	83.4	270.0	479.3	54.4	31.0	44.0
4	69.0	52.2	90.4	103.7	102.6	99.3	63.4	1,119.4	407.4	51.8	28.7	75.3
5	53.6	51.9	77.6	115.9	122.6	87.8	76.9	963.0	286.4	47.0	27.4	1,397.0
6	45.7	51.6	63.7	120.0	121.2	88.6	75.4	699.6	226.9	47.8	28.0	614.5
7	42.4	51.1	62.9	124.4	130.8	62.8	144.4	513.1	195.9	46.1	27.6	299.2
8	43.7	54.6	62.2	119.5	130.6	50.5	143.5	686.7	173.6	44.0	27.8	237.4
9	39.6	55.8	62.4	117.9	141.6	51.8	142.1	480.6	168.8	43.9	30.0	212.9
10	35.4	55.0	62.7	238.5	129.8	53.7	185.3	401.7	155.2	44.4	32.4	212.2
11	36.6	52.7	63.9	131.0	126.9	56.4	163.3	295.6	160.6	43.0	32.6	211.8
12	33.4	53.6	66.9	104.8	123.8	58.5	278.1	250.0	164.5	42.6	49.4	189.3
13	33.8	52.3	89.2	86.6	127.4	60.9	464.7	247.9	158.5	45.9	144.1	173.9
14	29.7	64.3	124.3	84.1	127.8	60.1	238.6	268.1	129.3	44.4	91.8	162.5
15	32.9	171.7	126.2	79.1	109.7	66.7	169.3	298.5	117.4	44.9	68.9	154.6
16	160.6	146.8	141.3	73.7	125.9	153.0	120.0	254.4	123.5	41.0	72.1	143.6
17	255.8	102.4	97.5	71.5	166.0	167.9	89.7	243.1	115.0	37.4	90.4	133.7
18	196.1	77.1	88.7	75.2	118.7	114.7	71.3	219.9	109.5	37.9	200.1	134.2
19	96.5	87.1	88.2	71.2	106.9	88.3	64.3	192.4	99.9	45.6	170.7	125.5
20	68.8	64.9	157.3	72.4	103.0	69.9	73.1	341.8	124.5	76.0	116.2	122.6
21	62.7	65.0	208.7	74.3	129.0	63.2	80.6	264.1	99.5	53.6	90.4	122.1
22	56.6	62.4	137.7	81.9	112.5	62.7	117.8	223.0	92.8	46.1	85.9	142.0
23	52.8	64.3	131.9	101.5	124.5	59.6	316.6	244.4	84.8	42.6	97.6	109.7
24	48.3	64.5	121.2	90.4	120.3	64.9	493.1	202.9	83.0	39.9	79.4	96.2
25	46.7	82.9	128.4	97.3	123.0	74.2	237.8	207.9	77.4	37.0	65.5	85.9
26	43.6	349.1	150.7	109.5	110.8	102.9	306.8	200.3	73.5	35.2	62.2	87.3
27	44.1	255.1	132.0	122.2	111.8	130.1	508.2	235.7	74.7	37.6	63.4	98.2
28	46.4	166.7	124.2	122.9	103.9	190.4	611.6	271.2	73.1	34.2	60.9	89.7
29	47.2		115.3	112.4	91.5	160.5	389.9	223.9	69.9	33.2	62.3	81.5
30	47.1		113.5	116.2	82.0	178.4	318.3	240.2	63.9	31.4	59.6	76.6
31	48.5		114.4		75.3		245.5	208.3		28.8		73.2
Average	64.0	89.6	108.7	106.4	116.5	88.9	206.9	346.5	161.2	44.4	68.6	187.5
Maximum	255.8	349.1	208.7	238.5	166.0	190.4	611.6	1,119.4	479.3	76.0	200.1	1,397.0
Minimum	28.6	50.3	62.2	71.2	75.3	50.5	53.6	192.4	63.9	28.8	27.4	44.0

Average annual discharge = 133 (m^3/sec)

Annual inflow volume = 4,197 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2007

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	67.8	36.6	205.6	411.3	163.3	106.5	222.3	118.0	84.3	47.1	22.9	21.0
2	64.7	35.7	169.6	366.7	160.8	114.3	294.6	110.5	79.9	46.3	26.4	21.1
3	60.6	34.9	147.0	332.4	158.6	127.0	205.3	93.3	73.7	45.8	23.2	21.1
4	62.8	35.5	149.9	291.0	161.9	146.3	165.4	97.2	66.0	43.3	25.3	20.7
5	66.7	38.2	169.2	268.9	163.9	155.3	124.3	94.6	83.9	42.9	23.3	18.8
6	64.4	35.0	157.4	256.5	157.6	127.1	144.8	123.9	74.3	39.5	23.7	18.7
7	62.5	35.0	156.8	249.5	149.6	129.5	145.3	103.4	73.5	39.4	23.8	19.0
8	63.4	36.2	159.2	235.5	169.6	132.6	403.6	87.3	83.1	37.3	23.9	19.3
9	59.6	35.4	160.5	233.2	175.8	144.4	215.6	77.0	86.4	36.0	26.2	18.8
10	61.8	39.7	152.4	226.3	169.0	148.0	151.9	70.4	77.6	35.5	23.4	19.1
11	56.5	127.5	147.9	222.5	156.0	151.5	124.4	67.2	87.4	35.8	21.6	19.3
12	54.7	190.5	493.7	221.9	142.5	158.1	183.0	67.6	74.3	31.6	23.1	19.2
13	52.1	121.9	628.3	221.3	152.4	168.3	134.5	107.2	62.4	32.8	21.5	20.9
14	46.9	99.7	384.7	219.7	160.9	203.7	89.1	476.4	63.0	31.3	21.6	23.0
15	46.1	95.4	301.5	225.1	175.6	203.6	165.8	287.5	67.6	28.1	22.6	19.6
16	42.1	81.1	271.3	224.1	195.4	168.0	116.5	164.8	69.3	31.2	21.9	19.9
17	41.8	79.8	253.4	223.4	192.2	171.4	85.4	141.2	82.2	29.3	21.1	19.7
18	40.1	75.1	253.8	244.2	186.0	166.7	87.5	127.1	76.5	30.3	20.3	19.4
19	39.6	65.3	274.6	227.9	257.2	130.7	89.9	89.6	64.7	27.3	21.0	19.8
20	39.4	60.5	2,310.0	228.7	234.6	127.4	186.8	135.5	90.6	26.4	20.4	18.5
21	38.3	57.3	1,279.8	218.5	194.3	116.1	231.7	114.2	117.8	26.6	19.4	20.8
22	39.7	96.2	663.8	203.7	164.8	117.7	209.0	127.0	93.8	26.3	20.1	18.5
23	40.3	74.0	465.0	201.3	156.9	152.9	192.6	134.7	84.2	23.3	19.2	20.7
24	40.7	59.9	414.5	206.6	146.8	130.2	230.3	216.7	82.9	25.1	21.0	19.5
25	37.7	59.5	391.7	181.7	131.5	149.8	157.2	118.3	61.5	25.1	18.9	18.4
26	40.9	58.0	379.7	166.8	122.4	162.5	128.1	141.8	58.6	23.8	19.4	19.4
27	41.0	172.3	376.5	181.7	121.7	136.1	131.4	107.1	56.8	24.8	19.8	19.7
28	37.0	299.3	378.5	181.7	126.0	215.7	111.5	88.3	56.7	23.6	19.0	17.5
29	38.1		390.1	174.5	126.4	310.9	201.5	98.3	56.1	25.0	19.6	17.0
30	35.3		400.9	174.7	111.0	225.4	148.8	89.1	48.7	25.0	20.6	17.2
31	36.6		404.1		114.4		120.4	83.7		24.9		16.9
Average	49.0	79.8	403.0	234.0	161.3	156.6	167.7	127.7	74.6	32.0	21.8	19.4
Maximum	67.8	299.3	2,310.0	411.3	257.2	310.9	403.6	476.4	117.8	47.1	26.4	23.0
Minimum	35.3	34.9	147.0	166.8	111.0	106.5	85.4	67.2	48.7	23.3	18.9	16.9

Average annual discharge = 128 (m^3/sec)

Annual inflow volume = 4,027 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2008

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.5	35.1	128.5	78.6	83.8	82.5	198.1	284.3	139.4	44.0	37.1	28.8
2	17.0	35.1	132.0	84.8	92.3	117.0	159.8	296.9	136.6	41.1	35.3	31.5
3	17.9	38.7	122.7	100.6	96.3	113.4	129.6	909.2	149.4	42.2	33.5	31.6
4	15.3	47.0	102.6	122.7	109.7	110.2	141.3	546.9	166.5	37.4	33.2	28.8
5	16.8	70.4	106.0	196.9	97.2	108.7	127.0	502.8	149.3	37.0	34.1	29.7
6	15.4	68.9	103.8	398.8	94.4	139.4	308.3	400.0	138.9	62.7	28.8	29.6
7	17.9	53.9	117.8	160.8	89.9	182.5	251.7	330.4	172.6	51.1	33.4	31.5
8	30.3	82.3	104.4	127.8	84.1	169.3	193.3	326.1	148.8	63.2	35.8	34.3
9	130.5	66.3	106.6	121.5	85.0	188.3	156.1	375.4	145.7	48.4	31.3	253.7
10	180.3	57.0	105.5	130.1	78.6	148.4	136.2	290.0	122.2	47.5	32.5	102.4
11	114.5	50.6	98.4	212.1	83.9	181.5	166.1	330.9	116.1	42.5	28.3	70.2
12	60.6	51.2	97.6	236.7	77.0	262.0	199.0	327.1	118.4	39.3	27.7	57.9
13	49.3	53.4	98.3	174.9	87.9	185.2	190.1	294.7	119.8	38.6	33.6	46.8
14	40.3	55.4	96.4	134.8	83.9	256.9	210.0	288.2	108.7	37.0	40.5	43.5
15	32.4	56.7	92.9	159.8	90.7	636.7	167.5	300.1	81.7	103.7	47.5	42.5
16	28.0	57.8	100.1	280.2	112.5	386.8	150.7	296.9	78.8	93.4	39.1	44.1
17	211.3	65.3	104.5	188.4	125.9	243.9	140.4	250.4	99.3	72.7	32.1	45.7
18	607.4	61.9	102.2	149.4	98.9	201.3	196.2	207.5	90.6	55.4	31.4	48.6
19	151.2	65.6	95.0	133.7	97.7	240.6	158.4	199.6	82.5	42.8	31.1	50.1
20	99.4	70.3	88.1	121.9	116.0	221.5	257.7	209.1	81.7	48.7	34.1	345.4
21	77.8	77.9	74.3	117.3	102.0	180.5	232.9	201.8	75.7	44.7	38.8	344.4
22	65.7	76.6	71.0	120.5	123.1	230.0	242.7	236.8	85.3	44.5	33.4	180.5
23	58.5	149.0	66.0	115.8	169.9	165.7	169.9	193.4	93.7	37.7	35.6	128.4
24	53.7	157.0	67.0	102.5	139.2	186.2	158.8	195.2	74.0	41.7	31.2	99.2
25	47.9	109.8	67.6	103.5	190.1	154.8	155.6	157.4	66.4	36.9	33.1	85.3
26	46.5	95.9	68.1	105.8	145.5	155.6	226.8	156.3	56.2	39.1	28.3	77.4
27	43.4	97.0	68.4	99.3	105.1	169.2	175.0	135.9	50.1	36.9	32.8	70.8
28	42.6	105.5	66.4	95.0	113.9	257.5	167.1	129.4	47.1	38.3	30.9	63.3
29	39.6	117.7	61.4	92.1	88.8	211.9	181.4	123.5	47.3	36.0	31.7	57.3
30	37.9		68.6	87.9	88.4	207.1	415.3	137.1	46.7	37.5	32.5	49.4
31	38.0		73.3		80.4		225.1	143.0		38.9		42.5
Average	77.6	73.4	92.1	145.1	104.3	203.2	193.2	283.1	103.0	47.8	33.6	83.7
Maximum	607.4	157.0	132.0	398.8	190.1	636.7	415.3	909.2	172.6	103.7	47.5	345.4
Minimum	15.3	35.1	61.4	78.6	77.0	82.5	127.0	123.5	46.7	36.0	27.7	28.8

Average annual discharge = 120 (m^3/sec)

Annual inflow volume = 3,802 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2009

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	41.9	68.7	103.4	75.1	121.0	91.9	81.0	109.9	161.9	44.3	26.0	22.8
2	41.3	65.0	96.0	108.7	126.2	87.5	88.5	115.4	170.6	47.1	26.4	24.8
3	41.4	65.5	97.7	186.2	117.6	93.3	88.0	144.6	214.8	44.4	25.6	22.8
4	44.6	64.7	192.0	161.9	140.8	92.0	86.4	102.9	213.7	69.5	23.4	24.8
5	48.5	69.7	139.6	147.2	145.9	91.6	78.3	113.7	140.9	54.2	25.7	23.4
6	43.0	153.1	133.9	173.7	128.0	83.1	74.0	120.8	115.3	49.5	25.7	24.8
7	38.2	120.7	118.1	344.6	103.2	60.3	55.4	163.8	100.2	45.8	25.8	25.6
8	38.2	97.0	102.4	286.4	104.1	61.0	53.9	117.2	92.5	43.9	26.0	22.1
9	41.1	93.7	88.2	307.4	104.0	51.5	59.3	99.3	88.9	43.6	31.7	21.6
10	41.2	100.4	78.0	222.4	103.4	51.7	78.8	142.6	89.3	43.2	88.0	23.4
11	41.9	128.4	79.3	193.6	101.9	54.4	77.8	112.7	112.7	40.7	46.3	23.9
12	39.3	123.2	72.4	171.5	94.9	55.7	92.6	104.8	109.5	39.9	32.6	24.4
13	39.5	118.8	74.4	158.4	90.6	56.4	188.6	132.5	89.1	38.5	29.3	24.3
14	39.6	417.1	75.1	149.8	99.1	56.7	120.0	132.9	84.9	37.8	29.6	23.7
15	40.2	216.9	78.5	135.8	107.6	54.9	92.1	344.8	80.0	36.5	30.4	22.0
16	43.7	179.8	79.6	130.4	102.6	123.6	79.5	328.0	93.6	34.0	28.1	22.0
17	50.1	157.8	76.1	137.3	105.5	116.1	75.1	265.2	81.1	33.5	28.7	21.9
18	73.8	156.0	79.6	135.8	123.8	84.4	181.6	171.4	60.9	31.8	30.2	22.0
19	150.0	138.8	79.9	137.0	133.4	68.8	111.9	133.6	59.2	31.3	28.2	20.3
20	105.5	158.9	77.6	132.2	127.2	56.5	94.8	146.0	56.7	31.5	30.2	19.7
21	75.4	136.8	78.1	134.0	134.4	51.4	122.8	106.0	55.1	31.1	26.3	21.0
22	67.3	123.4	71.3	143.5	106.4	51.8	217.0	119.3	53.9	32.0	26.0	21.2
23	61.0	129.8	69.5	123.5	96.4	53.8	199.1	99.4	50.1	31.6	25.9	20.5
24	62.8	187.3	70.8	112.4	92.7	55.4	190.6	114.8	49.6	30.9	25.8	21.4
25	67.8	146.6	102.6	103.3	93.5	61.7	123.4	98.0	46.1	30.9	26.0	21.0
26	89.6	132.3	116.5	101.1	90.5	55.8	96.9	182.9	45.7	29.0	26.1	21.1
27	122.1	120.4	80.3	105.1	85.7	64.7	115.8	123.8	44.5	27.9	26.9	21.8
28	101.0	109.3	113.1	105.2	88.5	70.6	250.0	90.5	46.9	27.7	24.8	19.6
29	77.7		102.8	117.3	86.4	76.3	256.3	87.1	46.5	28.1	26.9	19.8
30	67.7		127.7	114.0	83.5	92.1	216.5	80.9	49.7	26.8	24.9	18.6
31	67.9		89.3		85.3		120.2	128.0		26.7		19.2
Average	61.4	135.0	95.0	155.2	107.2	70.8	121.5	139.8	90.1	37.5	29.9	22.1
Maximum	150.0	417.1	192.0	344.6	145.9	123.6	256.3	344.8	214.8	69.5	88.0	25.6
Minimum	38.2	64.7	69.5	75.1	83.5	51.4	53.9	80.9	44.5	26.7	23.4	18.6

Average annual discharge = 88 (m^3/sec)

Annual inflow volume = 2,789 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2010

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.0	18.0	269.8	102.0	93.3	120.0	91.1	492.6	258.8	77.8	38.7	25.7
2	19.5	17.4	209.4	98.7	93.4	109.6	102.2	731.7	176.6	73.8	38.9	25.6
3	19.5	16.8	164.8	89.2	98.9	112.9	93.5	570.0	196.7	65.4	38.8	25.0
4	19.5	16.8	154.5	84.4	104.1	120.2	91.7	401.1	152.4	64.5	35.7	24.6
5	19.4	17.6	182.0	83.2	121.6	125.7	99.2	531.3	153.2	64.4	35.5	25.3
6	19.7	19.8	142.7	83.3	191.1	93.3	105.0	681.3	138.5	57.0	36.5	22.6
7	19.7	72.4	130.3	82.8	130.0	84.9	96.8	513.5	124.6	58.4	35.9	22.1
8	19.8	604.2	124.5	89.3	154.6	104.5	92.3	368.6	132.6	57.5	35.0	22.4
9	19.8	1,174.5	118.8	88.0	119.2	79.8	92.5	326.5	134.3	59.7	35.2	22.9
10	20.0	344.9	121.6	90.1	103.9	86.5	111.7	278.4	125.5	58.9	30.5	23.3
11	20.0	227.6	119.4	104.9	115.0	82.7	117.0	302.5	128.0	56.8	30.0	23.7
12	20.3	183.7	118.2	100.1	97.6	72.9	136.6	346.3	129.8	56.6	29.8	24.1
13	20.4	153.2	118.1	110.7	99.3	91.9	104.2	355.1	161.4	55.1	30.2	24.4
14	20.3	125.8	117.8	100.2	106.2	88.1	92.8	336.1	150.7	55.7	26.8	24.9
15	20.4	103.9	120.6	98.4	98.3	110.7	84.5	500.4	142.0	55.1	27.5	25.2
16	20.4	98.2	124.5	98.1	92.2	91.5	89.3	414.7	123.3	55.2	27.3	25.3
17	18.8	89.6	129.4	103.5	93.4	90.8	87.4	325.5	107.5	55.3	26.1	24.5
18	17.8	82.7	133.0	104.4	109.6	93.0	148.3	318.3	113.8	53.3	28.7	24.4
19	18.2	81.3	132.4	131.5	142.7	90.0	137.7	302.9	111.9	51.2	27.7	22.1
20	17.8	78.7	138.1	128.5	113.2	80.5	274.3	357.8	100.0	51.0	25.2	22.1
21	18.1	81.5	134.8	124.9	98.8	84.7	293.6	296.8	93.6	45.7	25.6	21.8
22	17.5	96.2	137.4	114.4	115.7	91.0	325.9	260.5	102.8	166.3	25.5	21.5
23	17.9	102.8	138.4	99.3	105.5	96.6	252.7	255.3	116.3	106.1	25.9	21.2
24	15.4	102.1	141.9	90.3	103.2	112.6	146.9	291.2	129.3	70.1	25.6	21.1
25	15.8	96.2	134.4	76.4	108.1	114.8	115.4	290.0	115.1	56.0	26.0	21.2
26	15.1	97.8	127.1	69.1	110.7	126.3	243.8	272.8	94.5	49.7	26.1	21.1
27	14.8	158.0	129.2	83.3	111.6	106.3	436.6	222.8	83.9	45.8	26.0	21.1
28	15.4	153.1	129.7	102.6	220.0	99.9	1,466.2	193.8	84.6	45.8	26.0	21.1
29	18.6		122.5	101.3	222.4	101.5	795.9	179.1	79.6	41.9	26.2	21.1
30	32.7		150.1	96.0	151.5	91.1	689.7	164.4	78.1	42.2	25.9	24.3
31	23.3		127.6		124.5		456.9	154.6		41.8		37.8
Average	19.2	157.7	140.1	97.6	121.0	98.5	241.0	356.0	128.0	61.1	30.0	23.7
Maximum	32.7	1,174.5	269.8	131.5	222.4	126.3	1,466.2	731.7	258.8	166.3	38.9	37.8
Minimum	14.8	16.8	117.8	69.1	92.2	72.9	84.5	154.6	78.1	41.8	25.2	21.1

Average annual discharge = 123 (m^3/sec)

Annual inflow volume = 3,876 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2011

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.4	20.8	87.2	152.8	172.4	123.8	133.6	69.8	329.7	140.9	86.6	59.4
2	19.9	19.3	105.9	153.5	189.1	94.5	90.0	46.3	213.5	142.9	86.0	55.0
3	21.1	18.0	250.2	133.6	189.9	99.0	93.2	88.6	161.5	130.0	80.6	53.2
4	22.8	16.7	436.5	120.9	188.1	80.8	89.0	127.6	210.7	125.6	78.5	51.2
5	24.6	15.6	272.4	122.7	170.9	92.8	78.8	88.1	200.4	121.4	77.5	49.2
6	26.8	14.2	209.1	114.6	194.0	103.3	66.1	53.4	186.7	129.5	77.6	47.3
7	27.2	448.3	188.5	102.5	171.8	94.8	89.7	269.9	207.5	126.8	77.9	45.7
8	25.9	264.4	193.8	93.7	143.7	97.2	96.3	182.4	369.7	117.3	77.2	44.2
9	24.9	127.9	184.2	95.5	146.6	93.7	105.2	198.5	332.3	120.6	78.3	43.8
10	23.4	73.1	177.8	102.5	149.5	120.0	116.6	174.7	343.4	118.2	77.4	43.5
11	23.1	55.4	171.5	235.6	166.5	114.8	78.4	265.2	236.8	104.9	77.9	43.2
12	22.1	55.7	164.8	238.1	141.0	156.5	60.4	304.2	182.5	104.3	72.3	42.9
13	20.1	235.2	158.2	202.1	153.5	119.6	61.0	243.2	180.9	103.4	74.8	42.4
14	18.1	692.7	154.4	176.5	142.1	99.1	146.5	189.9	213.5	104.3	68.7	42.4
15	31.8	291.6	161.7	165.8	141.5	101.5	98.4	191.9	370.9	100.8	69.4	42.0
16	31.9	195.5	185.6	159.4	157.5	92.7	267.6	195.1	1,199.6	96.2	73.8	41.9
17	27.2	182.2	196.9	583.4	155.0	114.9	125.3	187.4	425.7	94.6	69.6	41.6
18	27.9	145.9	201.2	450.8	142.1	117.0	108.8	167.8	301.4	92.3	71.7	38.8
19	30.1	117.4	572.6	317.3	143.7	112.7	76.6	158.9	259.2	93.3	72.5	39.4
20	26.4	101.4	401.3	266.7	154.2	107.0	66.0	194.7	237.6	89.7	76.1	42.2
21	27.2	95.2	238.3	242.0	152.9	89.7	75.3	165.8	225.1	89.6	71.2	42.0
22	28.6	87.2	189.7	210.4	120.4	83.7	89.5	145.1	221.8	90.4	66.5	39.6
23	25.8	88.6	184.0	215.2	128.4	106.6	69.8	132.4	224.8	96.8	70.3	38.5
24	27.9	104.5	179.7	219.0	110.9	72.3	214.4	242.0	210.8	100.7	71.0	39.3
25	27.5	103.3	178.8	213.8	123.2	136.5	184.1	321.0	178.5	98.7	70.5	39.1
26	26.5	100.5	178.4	211.8	126.5	174.0	136.9	175.2	181.0	88.3	70.3	39.1
27	25.8	103.9	165.5	207.5	124.6	117.4	103.7	294.4	159.2	85.9	70.0	39.2
28	24.3	89.3	183.8	206.8	119.9	180.8	89.9	315.3	151.1	84.3	67.2	38.9
29	19.7		208.1	201.9	113.0	128.9	170.0	257.2	149.3	85.3	64.7	38.9
30	22.4		188.4	184.8	119.7	122.4	106.6	199.1	141.3	86.2	64.3	34.9
31	22.2		155.4		121.3		84.6	166.8		87.2		35.3
Average	25.1	138.0	210.4	203.4	147.5	111.6	108.8	187.5	266.9	104.8	73.7	43.0
Maximum	31.9	692.7	572.6	583.4	194.0	180.8	267.6	321.0	1,199.6	142.9	86.6	59.4
Minimum	18.1	14.2	87.2	93.7	110.9	72.3	60.4	46.3	141.3	84.3	64.3	34.9

Average annual discharge = 135 (m^3/sec)

Annual inflow volume = 4,249 (Mm^3)

APPENDIX D

SYNTHETIC MEAN DAILY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 3
(WITHOUT PROJECT)

River: Poonch **Station:** EFlow Site 3 **Year:** 1960

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	30.1	41.9	27.0	135.4	108.5	61.0	87.4	64.2	149.9	41.7	22.1	18.2
2	30.1	53.2	25.6	131.9	114.5	51.1	73.6	64.4	143.1	39.9	21.5	18.2
3	30.1	46.0	25.6	127.8	118.6	62.4	80.8	79.7	238.2	38.8	20.4	17.4
4	29.6	42.9	27.6	131.9	130.8	62.4	56.2	62.4	111.4	37.8	21.5	16.4
5	29.6	42.9	24.5	123.7	105.3	56.2	66.4	60.3	120.6	47.0	21.5	16.4
6	28.6	42.9	44.0	119.6	79.7	54.2	137.0	56.2	91.0	36.8	21.5	16.4
7	27.6	47.0	40.9	110.4	70.5	74.6	141.1	546.9	80.8	34.8	21.5	15.3
8	27.6	47.0	80.8	109.4	70.5	72.6	318.2	405.0	73.6	33.7	21.5	15.3
9	26.6	48.0	162.5	99.2	84.8	72.6	137.0	364.5	67.5	32.7	21.5	14.3
10	26.6	46.0	214.7	85.9	87.9	60.3	1,559.3	387.7	61.3	31.7	21.5	14.3
11	28.6	46.0	804.5	85.9	87.9	61.3	2,476.4	129.8	74.6	30.7	21.5	14.3
12	26.6	47.0	218.8	91.0	91.0	67.5	584.7	143.1	57.2	29.6	21.5	13.3
13	28.6	48.0	170.7	91.0	94.0	59.3	335.3	309.7	56.2	29.6	22.5	13.3
14	27.6	47.0	150.3	110.4	91.0	47.0	1,388.6	159.5	52.1	28.6	21.5	13.3
15	29.6	47.0	145.2	99.2	79.7	65.4	676.7	448.8	51.1	28.6	21.5	12.3
16	27.6	46.0	324.0	121.6	72.6	62.4	303.6	1,018.3	48.0	33.7	20.4	14.3
17	26.6	44.0	253.5	126.8	94.0	47.0	189.1	180.9	74.6	29.6	20.4	25.6
18	26.6	39.9	178.9	145.2	118.6	45.0	330.2	387.4	65.4	27.6	20.4	19.4
19	26.6	37.8	157.4	255.6	87.9	44.0	160.5	176.8	57.2	27.6	20.4	16.4
20	147.2	37.8	214.7	123.7	82.8	44.0	215.7	324.0	57.2	26.6	19.4	14.3
21	71.6	33.7	150.3	107.3	81.8	46.0	125.7	216.7	51.1	26.6	19.4	13.3
22	49.1	33.7	199.3	102.2	74.6	47.0	107.3	190.1	49.1	26.6	18.4	12.3
23	44.0	31.7	178.9	114.5	63.4	50.1	99.2	303.6	47.0	25.6	18.4	12.3
24	42.9	29.6	143.1	116.5	62.4	64.4	92.0	164.6	75.6	25.6	19.4	12.3
25	46.0	29.6	142.1	107.3	66.4	59.3	90.0	153.3	71.6	25.6	18.4	12.3
26	44.0	28.6	148.2	108.4	62.4	56.2	202.4	167.6	54.2	25.6	18.4	12.3
27	44.0	28.6	145.2	94.0	59.3	61.3	103.2	154.4	50.1	24.5	18.4	11.2
28	42.9	26.6	250.4	90.0	56.2	59.3	79.7	169.7	51.1	24.5	19.4	11.2
29	44.0	27.6	182.0	91.0	49.1	51.1	73.6	150.3	46.0	24.5	21.5	11.2
30	49.1		142.1	98.1	52.1	57.3	78.7	147.2	44.0	23.5	19.4	18.4
31	45.1		136.5		59.9		81.0	195.6		22.6		62.8
Average	38.9	40.3	164.8	115.2	82.5	57.4	337.1	238.2	75.7	30.4	20.5	16.4
Maximum	147.2	53.2	804.5	255.6	130.8	74.6	2,476.4	1,018.3	238.2	47.0	22.5	62.8
Minimum	26.6	26.6	24.5	85.9	49.1	44.0	56.2	56.2	44.0	22.6	18.4	11.2

Average annual discharge = 102 (m^3/sec)

Annual inflow volume = 3,230 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1961

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	27.0	147.2	81.8	90.0	98.1	61.3	170.7	292.4	399.7	182.0	70.5	49.1
2	19.4	279.1	77.7	93.0	97.1	67.5	104.3	497.8	540.8	105.3	56.2	32.7
3	17.4	174.8	72.6	100.2	101.2	71.6	125.7	277.0	162.5	95.1	51.1	45.0
4	11.2	176.8	64.4	91.0	103.2	76.7	130.8	172.8	167.6	91.0	47.0	44.0
5	9.2	145.2	65.4	128.8	97.1	77.7	220.8	156.4	115.5	86.9	46.0	42.9
6	8.2	126.8	60.3	100.2	90.0	137.0	241.2	124.7	220.8	83.8	46.0	42.9
7	7.2	121.6	55.2	79.7	84.8	219.8	204.4	110.4	553.0	80.8	45.0	41.9
8	7.2	99.2	55.2	74.6	78.7	268.8	344.5	116.5	1,281.9	78.7	44.0	40.9
9	7.2	82.8	51.1	75.6	84.8	192.2	225.9	795.3	960.9	100.2	44.0	39.9
10	7.2	76.7	50.1	216.7	83.8	159.5	150.3	636.9	546.9	90.0	42.9	38.8
11	7.2	73.6	61.3	962.9	82.8	132.9	139.0	272.9	352.7	73.6	41.9	37.8
12	7.2	67.5	88.9	515.2	82.8	121.6	101.2	195.2	289.3	73.6	39.9	37.8
13	6.1	60.3	83.8	926.1	81.8	100.2	87.9	161.5	306.7	60.3	38.8	37.8
14	6.1	58.3	90.0	367.0	80.8	97.1	90.0	150.3	258.6	60.3	38.8	36.8
15	6.1	56.2	99.2	272.9	205.5	84.8	209.6	172.8	506.0	57.2	39.9	35.8
16	6.1	57.2	105.3	212.6	115.5	68.5	578.6	251.5	347.6	56.2	68.5	38.8
17	6.1	76.7	114.5	189.1	70.5	64.4	347.6	197.3	263.7	53.2	57.2	85.9
18	6.1	96.1	100.2	171.7	57.2	65.4	136.0	193.2	221.8	53.2	44.0	58.3
19	6.1	93.0	132.9	161.5	56.2	72.6	100.2	110.4	192.2	54.2	41.9	46.0
20	6.1	94.0	118.6	236.1	56.2	81.8	114.5	364.9	171.7	56.2	40.9	44.0
21	6.1	86.9	101.2	249.4	59.3	69.5	150.3	142.1	166.6	58.3	39.9	41.9
22	6.1	82.8	76.7	179.9	74.6	108.4	1,188.9	106.3	174.8	56.2	38.8	40.9
23	6.1	74.6	71.6	130.8	86.9	99.2	885.3	157.4	194.2	53.2	36.8	38.8
24	6.1	76.7	129.8	104.3	63.4	90.0	364.9	260.7	279.1	50.1	34.8	37.8
25	7.2	66.4	128.8	97.1	37.8	97.1	390.5	347.6	373.1	49.1	33.7	37.8
26	34.8	67.5	86.9	93.0	35.8	167.6	523.4	180.9	361.9	45.0	54.2	37.8
27	24.5	77.7	81.8	109.4	29.6	148.2	306.7	165.6	177.9	42.9	149.2	36.8
28	19.4	82.8	113.5	107.3	29.6	91.0	234.1	127.8	115.5	40.9	105.3	35.8
29	540.8		90.0	115.5	40.9	120.6	434.5	107.3	108.4	73.6	60.3	33.7
30	450.8		94.0	118.6	53.2	190.1	668.5	206.5	109.4	141.1	52.1	31.7
31	250.4		102.2		54.2		428.3	502.9		123.7		29.6
Average	49.6	99.2	87.3	212.4	76.6	113.4	303.2	243.7	330.7	75.0	51.7	41.3
Maximum	540.8	279.1	132.9	962.9	205.5	268.8	1,188.9	795.3	1,281.9	182.0	149.2	85.9
Minimum	6.1	56.2	50.1	74.6	29.6	61.3	87.9	106.3	108.4	40.9	33.7	29.6

Average annual discharge = 140 (m^3/sec)

Annual inflow volume = 4,423 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1962

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.5	20.4	63.4	137.0	130.8	67.5	61.3	106.3	81.8	70.5	28.6	21.5
2	24.5	19.4	59.3	91.0	103.2	58.3	49.1	114.5	68.5	72.6	29.6	20.4
3	23.5	19.4	79.7	75.6	80.8	58.3	45.0	77.7	90.0	69.5	28.6	24.5
4	23.5	19.4	165.6	82.8	77.7	66.4	40.9	74.6	137.0	67.5	27.6	22.5
5	23.5	18.4	142.1	77.7	65.4	58.3	39.9	129.8	175.8	61.3	26.6	22.5
6	22.5	18.4	124.7	86.9	62.4	63.4	39.9	228.0	90.0	57.2	25.6	22.5
7	22.5	24.5	95.1	158.4	60.3	64.4	51.1	166.6	63.4	55.2	25.6	21.5
8	22.5	33.7	86.9	194.2	68.5	72.6	72.6	103.2	27.6	55.2	24.5	22.5
9	22.5	25.6	73.6	592.9	78.7	73.6	63.4	194.2	28.6	55.2	22.5	21.5
10	22.5	24.5	72.6	327.1	149.2	65.4	104.3	226.9	67.5	55.2	22.5	21.5
11	23.5	30.7	71.6	202.4	108.4	94.0	66.4	86.9	286.2	53.2	21.5	21.5
12	28.6	35.8	63.4	173.8	86.9	65.4	113.5	62.4	243.3	50.1	22.5	22.5
13	25.6	31.7	60.3	164.6	128.8	230.0	77.7	85.9	80.8	50.1	21.5	21.5
14	23.5	29.6	68.5	151.3	100.2	78.7	97.1	80.8	49.1	50.1	21.5	24.5
15	22.5	29.6	66.4	151.3	95.1	64.4	61.3	131.9	50.1	47.0	21.5	23.5
16	22.5	31.7	68.5	137.0	87.9	48.0	177.9	604.6	97.1	45.0	20.4	23.5
17	21.5	132.9	65.4	119.6	92.0	51.1	264.8	129.8	108.4	45.0	20.4	42.9
18	21.5	66.4	65.4	139.0	91.0	55.2	207.5	119.6	86.9	42.9	22.5	69.5
19	21.5	48.0	63.4	148.2	49.1	62.4	140.0	99.2	72.6	39.9	29.6	31.7
20	20.4	44.0	66.4	151.3	59.3	58.3	173.8	100.2	210.6	38.8	69.5	26.6
21	20.4	42.9	72.6	148.2	75.6	66.4	1,272.9	256.6	90.0	37.8	156.4	25.6
22	20.4	42.9	72.6	164.6	90.0	63.4	344.5	160.5	399.7	34.8	82.8	25.6
23	20.4	40.9	67.5	188.1	86.9	66.4	169.7	90.0	270.9	33.7	42.9	25.6
24	19.4	219.8	74.6	165.6	80.8	57.2	137.0	75.6	94.0	34.8	34.8	23.5
25	19.4	170.7	72.6	153.3	78.7	74.6	119.6	69.5	80.8	32.7	29.6	25.6
26	19.4	134.9	73.6	156.4	76.7	93.0	153.3	144.1	160.5	32.7	25.6	38.8
27	21.5	100.2	75.6	155.4	74.6	75.6	239.2	119.6	159.5	32.7	24.5	168.7
28	22.5	77.7	74.6	134.9	73.6	60.3	169.7	269.9	192.2	31.7	27.6	49.1
29	21.5		82.8	131.9	74.6	59.3	116.5	140.0	109.4	30.7	24.5	32.7
30	20.4		91.0	128.8	69.5	86.9	140.0	168.7	73.6	29.6	25.6	33.7
31	19.4		88.9		59.3		86.9	109.4		28.6		24.5
Average	22.2	54.8	79.6	163.0	84.4	72.0	158.0	146.0	124.8	46.5	33.6	32.3
Maximum	28.6	219.8	165.6	592.9	149.2	230.0	1,272.9	604.6	399.7	72.6	156.4	168.7
Minimum	19.4	18.4	59.3	75.6	49.1	48.0	39.9	62.4	27.6	28.6	20.4	20.4

Average annual discharge = 85 (m^3/sec)

Annual inflow volume = 2,676 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1963

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.5	21.5	32.7	84.8	61.3	246.4	220.8	896.8	410.9	34.8	14.3	23.5
2	21.5	20.4	31.7	78.7	166.6	115.5	198.3	271.9	139.0	29.6	15.3	21.5
3	22.5	20.4	34.8	191.2	137.0	102.2	143.1	132.9	88.9	25.6	18.4	22.5
4	24.5	20.4	68.5	192.2	116.5	108.4	115.5	139.0	107.3	23.5	16.4	21.5
5	25.6	19.4	206.5	52.1	185.0	109.4	75.6	349.6	124.7	21.5	15.3	20.4
6	26.6	19.4	252.5	71.6	209.6	113.5	71.6	232.0	154.4	23.5	13.3	19.4
7	25.6	19.4	126.8	98.1	131.9	102.2	86.9	198.3	93.0	27.6	15.3	19.4
8	25.6	19.4	140.0	105.3	128.8	99.2	114.5	317.9	57.2	27.6	16.4	16.4
9	25.6	19.4	144.1	110.4	212.6	90.0	76.7	272.9	137.0	27.6	13.3	17.4
10	25.6	19.4	245.3	85.9	219.8	64.4	85.9	136.0	129.8	26.6	11.2	17.4
11	24.5	19.4	119.6	93.0	148.2	95.1	173.8	282.1	72.6	25.6	10.2	17.4
12	23.5	18.4	92.0	101.2	139.0	96.1	266.8	321.0	46.0	24.5	10.2	17.4
13	27.6	19.4	77.7	108.4	168.7	93.0	186.0	215.7	33.7	22.5	10.2	161.5
14	28.6	19.4	66.4	111.4	324.0	92.0	214.7	132.9	54.2	21.5	10.2	113.5
15	27.6	37.8	76.7	108.4	189.1	93.0	105.3	130.8	57.2	21.5	17.4	32.7
16	26.6	150.3	186.0	106.3	205.5	101.2	58.3	118.6	46.0	22.5	31.7	29.6
17	23.5	103.2	202.4	164.6	192.2	102.2	59.3	280.1	77.7	18.4	32.7	29.6
18	22.5	68.5	140.0	132.9	153.3	110.4	387.4	456.9	63.4	17.4	34.8	27.6
19	23.5	54.2	99.2	118.6	122.7	236.1	206.5	200.4	47.0	16.4	30.7	28.6
20	21.5	39.9	75.6	112.4	155.4	129.8	192.2	399.7	86.9	15.3	29.6	26.6
21	21.5	31.7	67.5	98.1	124.7	111.4	502.9	572.5	71.6	15.3	27.6	27.6
22	21.5	36.8	94.0	119.6	109.4	110.4	229.0	488.6	51.1	16.4	25.6	25.6
23	21.5	39.9	238.2	137.0	102.2	116.5	130.8	324.0	39.9	14.3	24.5	24.5
24	21.5	35.8	364.9	190.1	95.1	112.4	71.6	306.7	38.8	12.3	22.5	24.5
25	21.5	34.8	116.5	122.7	99.2	107.3	60.3	204.4	39.9	11.2	22.5	25.6
26	21.5	33.7	93.0	108.4	102.2	114.5	65.4	247.4	60.3	11.2	21.5	25.6
27	21.5	33.7	96.1	235.1	100.2	102.2	61.3	213.6	86.9	12.3	22.5	22.5
28	22.5	32.7	99.2	477.4	99.2	230.0	209.6	162.5	83.8	12.3	28.6	21.5
29	22.5		99.2	301.6	101.2	233.1	295.4	131.9	63.4	13.3	25.6	21.5
30	22.5		101.2	229.0	99.2	196.3	1,331.0	80.8	51.1	12.3	27.6	22.5
31	20.4		101.2		103.2		720.7	250.4		13.3		27.6
Average	23.6	36.0	125.5	141.5	145.3	124.5	216.7	273.2	87.1	19.9	20.5	30.7
Maximum	28.6	150.3	364.9	477.4	324.0	246.4	1,331.0	896.8	410.9	34.8	34.8	161.5
Minimum	20.4	18.4	31.7	52.1	61.3	64.4	58.3	80.8	33.7	11.2	10.2	16.4

Average annual discharge = 104 (m^3/sec)

Annual inflow volume = 3,292 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1964

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.6	79.7	75.6	91.0	106.3	58.3	82.8	163.6	352.7	64.4	29.6	20.4
2	23.5	76.7	74.6	96.1	120.6	60.3	144.1	158.4	223.9	61.3	28.6	20.4
3	23.5	73.6	95.1	349.6	121.6	60.3	286.2	144.1	172.8	61.3	27.6	20.4
4	23.5	69.5	90.0	187.1	118.6	61.3	157.4	134.9	144.1	60.3	26.6	20.4
5	25.6	65.4	79.7	140.0	103.2	60.3	162.5	144.1	143.1	59.3	25.6	20.4
6	80.8	66.4	76.7	126.8	104.3	65.4	126.8	169.7	98.1	58.3	23.5	20.4
7	428.3	69.5	73.6	123.7	97.1	62.4	180.9	174.8	74.6	56.2	22.5	20.4
8	1,544.6	68.5	74.6	119.6	101.2	56.2	182.0	177.9	77.7	54.2	22.5	20.4
9	616.4	69.5	76.7	114.5	99.2	50.1	96.1	233.1	71.6	52.1	22.5	20.4
10	149.2	71.6	81.8	114.5	104.3	49.1	99.2	659.3	272.9	51.1	22.5	71.6
11	161.5	72.6	86.9	128.8	103.2	48.0	108.4	174.8	134.9	50.1	22.5	120.6
12	150.3	71.6	84.8	150.3	82.8	56.2	108.4	229.0	154.4	50.1	22.5	69.5
13	102.2	70.5	91.0	152.3	90.0	56.2	268.8	137.0	166.6	48.0	21.5	37.8
14	84.8	73.6	102.2	145.2	163.6	146.2	269.9	197.3	166.6	47.0	20.4	36.8
15	70.5	71.6	96.1	147.2	88.9	132.9	1,576.3	1,336.1	148.2	45.0	19.4	36.8
16	62.4	71.6	101.2	276.0	86.9	119.6	558.1	798.4	156.4	44.0	19.4	35.8
17	58.3	81.8	104.3	187.1	77.7	106.3	518.3	659.3	145.2	40.9	19.4	34.8
18	56.2	204.4	144.1	123.7	76.7	82.8	347.6	596.0	109.4	38.8	19.4	34.8
19	54.2	134.9	258.6	98.1	76.7	79.7	190.1	404.8	112.4	37.8	19.4	34.8
20	51.1	123.7	170.7	94.0	73.6	79.7	150.3	502.9	110.4	35.8	19.4	34.8
21	81.8	109.4	145.2	92.0	115.5	78.7	117.6	795.3	103.2	35.8	19.4	34.8
22	173.8	99.2	130.8	94.0	112.4	83.8	92.0	431.4	96.1	34.8	19.4	34.8
23	128.8	99.2	120.6	96.1	88.9	88.9	82.8	303.6	88.9	33.7	19.4	34.8
24	108.4	93.0	128.8	98.1	66.4	90.0	97.1	804.5	83.8	33.7	19.4	35.8
25	101.2	88.9	148.2	120.6	55.2	84.8	1,799.1	502.9	79.7	32.7	19.4	32.7
26	97.1	84.8	126.8	207.5	55.2	79.7	738.1	327.1	98.1	32.7	19.4	29.6
27	96.1	88.9	116.5	169.7	53.2	88.9	500.9	260.7	78.7	31.7	19.4	26.6
28	93.0	78.7	111.4	158.4	51.1	86.9	404.8	219.8	73.6	31.7	19.4	24.5
29	85.9	76.7	119.6	130.8	49.1	88.9	518.3	191.2	68.5	31.7	19.4	21.5
30	83.8		108.4	113.5	49.1	88.9	330.2	200.4	65.4	30.7	20.4	20.4
31	78.7		94.0		54.2		196.3	208.5		30.7		20.4
Average	158.7	86.4	109.3	141.5	88.6	78.4	338.4	369.1	129.1	44.4	21.7	33.8
Maximum	1,544.6	204.4	258.6	349.6	163.6	146.2	1,799.1	1,336.1	352.7	64.4	29.6	120.6
Minimum	23.5	65.4	73.6	91.0	49.1	48.0	82.8	134.9	65.4	30.7	19.4	20.4

Average annual discharge = 134 (m^3/sec)

Annual inflow volume = 4,237 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1965

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.4	60.3	120.6	324.0	232.0	164.6	117.6	204.4	86.9	39.9	19.4	17.4
2	20.4	63.4	116.5	186.0	209.6	169.7	178.9	134.9	84.8	38.8	19.4	17.4
3	20.4	144.1	118.6	158.4	193.2	171.7	156.4	124.7	93.0	35.8	19.4	17.4
4	42.9	324.0	117.6	249.4	193.2	171.7	176.8	142.1	82.8	38.8	19.4	17.4
5	27.6	160.5	114.5	205.5	189.1	167.6	134.9	145.2	70.5	34.8	27.6	17.4
6	25.6	69.5	121.6	309.7	195.2	194.2	121.6	176.8	62.4	28.6	37.8	17.4
7	24.5	88.9	118.6	439.6	197.3	179.9	115.5	158.4	60.3	26.6	24.5	16.4
8	24.5	82.8	147.2	347.6	209.6	145.2	119.6	126.8	65.4	26.6	21.5	16.4
9	25.6	72.6	207.5	303.6	204.4	142.1	174.8	167.6	66.4	28.6	20.4	16.4
10	22.5	66.4	128.8	255.6	169.7	143.1	153.3	164.6	62.4	29.6	19.4	16.4
11	21.5	69.5	114.5	239.2	167.6	137.0	122.7	119.6	63.4	27.6	19.4	16.4
12	21.5	71.6	108.4	220.8	154.4	134.9	118.6	108.4	60.3	27.6	19.4	15.3
13	21.5	117.6	114.5	239.2	147.2	145.2	116.5	95.1	57.2	36.8	19.4	15.3
14	20.4	108.4	124.7	213.6	152.3	151.3	110.4	105.3	58.3	53.2	41.9	15.3
15	20.4	88.9	130.8	192.2	166.6	150.3	207.5	97.1	53.2	24.5	36.8	15.3
16	20.4	132.9	133.9	202.4	166.6	139.0	414.0	94.0	51.1	22.5	25.6	15.3
17	20.4	847.4	125.7	200.4	167.6	125.7	222.8	123.7	50.1	22.5	20.4	14.3
18	20.4	410.9	134.9	338.4	171.7	110.4	370.1	103.2	51.1	22.5	19.4	14.3
19	532.6	251.5	256.6	512.1	174.8	111.4	231.0	106.3	70.5	21.5	18.4	14.3
20	163.6	202.4	205.5	309.7	207.5	146.2	330.2	132.9	63.4	20.4	19.4	14.3
21	80.8	169.7	128.8	221.8	258.6	159.5	159.5	104.3	64.4	19.4	19.4	14.3
22	64.4	152.3	115.5	208.5	410.9	160.5	132.9	414.0	93.0	19.4	19.4	13.3
23	60.3	142.1	107.3	256.6	361.9	161.5	327.1	164.6	58.3	18.4	19.4	13.3
24	54.2	134.9	99.2	962.9	255.6	149.2	439.6	373.1	49.1	19.4	19.4	14.3
25	48.0	131.9	103.2	477.4	182.0	149.2	589.8	176.8	53.2	19.4	19.4	15.3
26	46.0	132.9	123.7	344.5	164.6	143.1	781.0	139.0	52.1	19.4	18.4	15.3
27	38.8	128.8	125.7	303.6	172.8	138.0	303.6	112.4	48.0	19.4	18.4	14.3
28	45.0	126.8	106.3	289.3	174.8	146.2	177.9	183.0	45.0	19.4	18.4	13.3
29	45.0		103.2	250.4	166.6	143.1	146.2	149.2	47.0	19.4	17.4	13.3
30	72.6		102.2	234.1	169.7	127.8	154.4	125.7	41.9	19.4	17.4	13.3
31	65.4		203.4		161.5		179.9	98.1		19.4		13.3
Average	56.1	162.6	131.6	299.9	198.3	149.3	228.6	150.7	62.2	26.4	21.9	15.3
Maximum	532.6	847.4	256.6	962.9	410.9	194.2	781.0	414.0	93.0	53.2	41.9	17.4
Minimum	20.4	60.3	99.2	158.4	147.2	110.4	110.4	94.0	41.9	18.4	17.4	13.3

Average annual discharge = 125 (m^3/sec)

Annual inflow volume = 3,937 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1966

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	13.3	12.3	90.0	164.6	151.3	101.2	158.4	1,038.6	134.9	127.8	40.9	28.6
2	13.3	12.3	80.8	148.2	129.8	84.8	103.2	526.5	95.1	124.7	41.9	27.6
3	13.3	12.3	78.7	154.4	119.6	78.7	117.6	417.1	502.9	128.8	41.9	27.6
4	13.3	12.3	139.0	160.5	132.9	79.7	252.5	370.1	179.9	211.6	42.9	27.6
5	13.3	12.3	167.6	141.1	143.1	93.0	147.2	382.3	158.4	160.5	40.9	27.6
6	13.3	12.3	117.6	128.8	142.1	81.8	104.3	518.3	139.0	169.7	38.8	27.6
7	13.3	12.3	98.1	214.7	152.3	79.7	73.6	995.7	189.1	124.7	39.9	27.6
8	12.3	53.2	101.2	142.1	159.5	98.1	80.8	460.0	2,203.9	118.6	60.3	26.6
9	12.3	71.6	100.2	122.7	159.5	109.4	74.6	332.2	2,858.2	112.4	49.1	26.6
10	12.3	63.4	99.2	114.5	153.3	100.2	70.5	317.9	439.6	297.5	35.8	26.6
11	12.3	57.2	115.5	110.4	317.9	71.6	58.3	309.7	332.2	207.5	34.8	26.6
12	12.3	327.1	120.6	107.3	219.8	65.4	197.3	219.8	261.7	148.2	34.8	26.6
13	12.3	384.4	121.6	127.8	185.0	79.7	237.2	234.1	251.5	129.8	34.8	26.6
14	12.3	191.2	121.6	216.7	147.2	80.8	185.0	207.5	232.0	121.6	34.8	25.6
15	12.3	100.2	124.7	170.7	121.6	80.8	93.0	297.5	220.8	119.6	33.7	25.6
16	12.3	68.5	125.7	164.6	104.3	117.6	123.7	195.2	208.5	116.5	33.7	25.6
17	12.3	50.1	120.6	177.9	107.3	117.6	91.0	179.9	228.0	114.5	33.7	25.6
18	12.3	40.9	269.9	141.1	108.4	143.1	88.9	187.1	210.6	111.4	32.7	25.6
19	12.3	37.8	161.5	118.6	111.4	244.3	82.8	289.3	242.3	108.4	31.7	25.6
20	12.3	35.8	143.1	115.5	115.5	191.2	190.1	373.1	202.4	260.7	31.7	24.5
21	12.3	211.6	114.5	121.6	112.4	145.2	88.9	185.0	193.2	101.2	31.7	24.5
22	12.3	145.2	164.6	148.2	112.4	179.9	267.8	123.7	177.9	76.7	30.7	24.5
23	12.3	64.4	297.5	120.6	116.5	282.1	407.9	112.4	190.1	76.7	29.6	24.5
24	12.3	57.2	234.1	122.7	117.6	410.9	246.4	116.5	164.6	77.7	29.6	24.5
25	12.3	55.2	188.1	108.4	116.5	289.3	876.1	115.5	150.3	80.8	29.6	44.0
26	12.3	277.0	179.9	108.4	132.9	133.9	1,000.8	92.0	146.2	80.8	29.6	45.0
27	12.3	182.0	439.6	131.9	142.1	106.3	250.4	100.2	144.1	72.6	29.6	38.8
28	12.3	133.9	221.8	194.2	122.7	140.0	300.5	106.3	139.0	60.3	29.6	36.8
29	12.3		171.7	202.4	146.2	169.7	217.7	78.7	132.9	58.3	28.6	33.7
30	12.3		172.8	189.1	206.5	267.8	387.4	86.9	126.8	51.1	28.6	35.8
31	12.3		162.5		150.3		997.7	104.3		41.9		46.0
Average	12.5	96.2	156.3	146.3	143.8	140.8	244.2	292.7	361.9	122.3	35.5	29.3
Maximum	13.3	384.4	439.6	216.7	317.9	410.9	1,000.8	1,038.6	2,858.2	297.5	60.3	46.0
Minimum	12.3	12.3	78.7	107.3	104.3	65.4	58.3	78.7	95.1	41.9	28.6	24.5

Average annual discharge = 149 (m^3/sec)

Annual inflow volume = 4,689 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1967

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	42.9	17.4	75.6	312.8	295.4	110.4	131.9	199.3	98.1	53.2	36.8	23.5
2	35.8	16.4	76.7	772.8	266.8	121.6	119.6	189.1	134.9	52.1	35.8	23.5
3	33.7	16.4	75.6	295.4	159.5	119.6	83.8	842.3	123.7	51.1	34.8	578.6
4	32.7	16.4	75.6	190.1	152.3	124.7	128.8	317.9	118.6	91.0	34.8	94.0
5	31.7	16.4	76.7	154.4	129.8	110.4	101.2	494.8	102.2	62.4	33.7	56.2
6	31.7	16.4	75.6	154.4	118.6	102.2	98.1	602.1	95.1	54.2	32.7	47.0
7	27.6	16.4	75.6	141.1	102.2	119.6	106.3	246.4	277.0	51.1	31.7	40.9
8	27.6	17.4	67.5	137.0	108.4	126.8	122.7	341.4	90.0	49.1	31.7	37.8
9	27.6	16.4	67.5	115.5	123.7	115.5	134.9	226.9	79.7	47.0	31.7	35.8
10	26.6	16.4	69.5	116.5	129.8	97.1	145.2	183.0	93.0	49.1	30.7	33.7
11	25.6	16.4	67.5	108.4	128.8	104.3	134.9	171.7	205.5	47.0	30.7	34.8
12	24.5	17.4	145.2	102.2	112.4	106.3	106.3	309.7	199.3	52.1	29.6	38.8
13	23.5	18.4	453.9	101.2	99.2	117.6	235.1	161.5	370.1	47.0	28.6	39.9
14	22.5	17.4	211.6	117.6	93.0	112.4	92.0	983.4	338.4	44.0	27.6	37.8
15	21.5	17.4	159.5	124.7	92.0	111.4	86.9	184.0	141.1	42.9	27.6	37.8
16	20.4	17.4	546.9	130.8	98.1	176.8	107.3	176.8	157.4	40.9	27.6	36.8
17	20.4	30.7	297.5	138.0	101.2	164.6	81.8	142.1	122.7	39.9	28.6	36.8
18	19.4	66.4	236.1	151.3	110.4	85.9	85.9	168.7	98.1	38.8	27.6	35.8
19	19.4	169.7	209.6	146.2	111.4	72.6	86.9	197.3	122.7	44.0	27.6	35.8
20	18.4	613.3	199.3	150.3	123.7	65.4	1,046.8	303.6	88.9	42.9	27.6	34.8
21	18.4	229.0	191.2	145.2	132.9	64.4	223.9	163.6	78.7	38.8	26.6	33.7
22	18.4	138.0	190.1	144.1	154.4	65.4	187.1	143.1	73.6	37.8	26.6	31.7
23	18.4	92.0	189.1	147.2	160.5	68.5	983.4	132.9	70.5	36.8	28.6	31.7
24	18.4	80.8	185.0	146.2	163.6	69.5	335.3	183.0	69.5	41.9	28.6	94.0
25	18.4	71.6	1,142.9	150.3	150.3	82.8	297.5	164.6	88.9	103.2	28.6	106.3
26	17.4	71.6	760.5	153.3	136.0	87.9	238.2	153.3	98.1	85.9	27.6	685.9
27	17.4	69.5	234.1	191.2	108.4	77.7	550.0	131.9	80.8	54.2	26.6	537.7
28	17.4	72.6	192.2	581.7	95.1	73.6	211.6	153.3	65.4	45.0	27.6	134.9
29	17.4		179.9	358.8	90.0	79.7	190.1	121.6	59.3	40.9	26.6	108.4
30	17.4		163.6	180.9	91.0	245.3	523.4	121.6	56.2	38.8	24.5	93.0
31	17.4		152.3		100.2		180.9	123.7		37.8		84.8
Average	23.5	70.5	220.8	195.3	130.3	106.0	230.9	259.2	126.6	50.4	29.6	105.9
Maximum	42.9	613.3	1,142.9	772.8	295.4	245.3	1,046.8	983.4	370.1	103.2	36.8	685.9
Minimum	17.4	16.4	67.5	101.2	90.0	64.4	81.8	121.6	56.2	36.8	24.5	23.5

Average annual discharge = 130 (m^3/sec)

Annual inflow volume = 4,091 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1968

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	79.7	127.8	146.2	106.3	138.0	81.8	80.8	191.2	106.3	48.0	109.4	25.6
2	75.6	114.5	142.1	101.2	143.1	82.8	84.8	193.2	98.1	45.0	137.0	24.5
3	72.6	108.4	141.1	97.1	116.5	82.8	81.8	147.2	92.0	44.0	65.4	23.5
4	68.5	104.3	139.0	97.1	101.2	116.5	99.2	327.1	90.0	85.9	56.2	23.5
5	62.4	98.1	141.1	106.3	98.1	101.2	93.0	271.9	84.8	73.6	54.2	23.5
6	70.5	158.4	139.0	132.9	91.0	82.8	105.3	676.7	81.8	61.3	51.1	23.5
7	68.5	132.9	138.0	132.9	84.8	82.8	86.9	189.1	79.7	222.8	47.0	23.5
8	59.3	112.4	139.0	127.8	72.6	97.1	98.1	204.4	75.6	85.9	44.0	22.5
9	55.2	103.2	139.0	125.7	62.4	98.1	217.7	279.1	82.8	58.3	41.9	22.5
10	60.3	101.2	136.0	119.6	58.3	110.4	177.9	260.7	74.6	68.5	39.9	23.5
11	67.5	100.2	140.0	111.4	62.4	106.3	138.0	876.1	69.5	57.2	38.8	31.7
12	65.4	100.2	139.0	110.4	68.5	187.1	228.0	358.8	81.8	46.0	45.0	84.8
13	68.5	99.2	134.9	108.4	78.7	104.3	151.3	284.2	71.6	42.9	42.9	40.9
14	63.4	108.4	137.0	222.8	86.9	98.1	247.4	419.1	68.5	83.8	37.8	30.7
15	59.3	102.2	128.8	384.4	75.6	99.2	128.8	321.0	65.4	80.8	37.8	28.6
16	58.3	98.1	126.8	189.1	73.6	99.2	128.8	238.2	69.5	60.3	35.8	26.6
17	58.3	99.2	130.8	158.4	70.5	100.2	103.2	240.2	66.4	52.1	34.8	25.6
18	56.2	100.2	285.2	145.2	72.6	97.1	97.1	401.7	64.4	52.1	33.7	24.5
19	55.2	108.4	428.3	143.1	76.7	100.2	134.9	535.7	63.4	45.0	33.7	23.5
20	373.1	572.5	286.2	142.1	92.0	100.2	136.0	300.5	62.4	41.9	31.7	23.5
21	317.9	180.9	230.0	144.1	121.6	97.1	208.5	208.5	57.2	40.9	31.7	22.5
22	180.9	167.6	179.9	141.1	193.2	95.1	154.4	349.6	55.2	38.8	30.7	23.5
23	128.8	156.4	164.6	171.7	172.8	94.0	201.4	226.9	53.2	37.8	30.7	23.5
24	125.7	149.2	151.3	150.3	102.2	94.0	144.1	189.1	51.1	37.8	28.6	23.5
25	122.7	146.2	141.1	140.0	79.7	139.0	101.2	195.2	51.1	36.8	27.6	25.6
26	125.7	152.3	235.1	134.9	77.7	166.6	84.8	154.4	51.1	35.8	26.6	25.6
27	205.5	309.7	160.5	139.0	82.8	115.5	94.0	132.9	50.1	34.8	26.6	24.5
28	349.6	229.0	132.9	138.0	79.7	129.8	195.2	121.6	55.2	33.7	26.6	23.5
29	223.9	168.7	114.5	138.0	77.7	110.4	1,215.4	114.5	53.2	32.7	26.6	22.5
30	142.1		106.3	139.0	78.7	91.0	225.9	112.4	50.1	34.8	26.6	22.5
31	136.0		108.4		82.8		171.7	111.4		35.8		21.5
Average	118.0	148.6	163.3	143.3	92.7	105.4	174.7	278.5	69.2	56.6	43.3	26.9
Maximum	373.1	572.5	428.3	384.4	193.2	187.1	1,215.4	876.1	106.3	222.8	137.0	84.8
Minimum	55.2	98.1	106.3	97.1	58.3	81.8	80.8	111.4	50.1	32.7	26.6	21.5

Average annual discharge = 119 (m^3/sec)

Annual inflow volume = 3,748 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1969

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.5	260.7	90.0	129.8	160.5	171.7	107.3	103.2	70.5	73.6	31.7	21.5
2	21.5	88.9	91.0	129.8	156.4	153.3	88.9	97.1	65.4	148.2	33.7	21.5
3	21.5	61.3	97.1	123.7	150.3	139.0	90.0	138.0	63.4	67.5	32.7	21.5
4	21.5	53.2	98.1	114.5	143.1	146.2	95.1	248.4	70.5	46.0	34.8	20.4
5	21.5	54.2	101.2	106.3	142.1	121.6	117.6	586.8	59.3	41.9	33.7	20.4
6	21.5	45.0	108.4	98.1	137.0	110.4	97.1	1,611.0	122.7	38.8	33.7	20.4
7	21.5	42.9	109.4	100.2	136.0	100.2	98.1	364.9	90.0	35.8	31.7	20.4
8	21.5	40.9	110.4	113.5	138.0	96.1	131.9	237.2	68.5	33.7	30.7	20.4
9	20.4	41.9	110.4	120.6	146.2	90.0	168.7	321.0	110.4	33.7	30.7	19.4
10	20.4	40.9	107.3	121.6	176.8	86.9	148.2	428.3	65.4	32.7	29.6	19.4
11	20.4	40.9	109.4	119.6	198.3	87.9	115.5	253.5	58.3	132.9	29.6	19.4
12	21.5	38.8	114.5	116.5	306.7	86.9	94.0	244.3	58.3	93.0	29.6	19.4
13	28.6	41.9	119.6	108.4	586.8	93.0	110.4	200.4	59.3	32.7	29.6	19.4
14	28.6	68.5	121.6	113.5	434.5	90.0	269.9	183.0	72.6	48.0	28.6	19.4
15	24.5	51.1	123.7	116.5	233.1	88.9	167.6	236.1	94.0	108.4	26.6	18.4
16	23.5	44.0	119.6	146.2	171.7	90.0	146.2	249.4	77.7	73.6	25.6	18.4
17	22.5	103.2	116.5	115.5	144.1	93.0	108.4	382.3	68.5	48.0	24.5	18.4
18	21.5	90.0	144.1	99.2	138.0	102.2	103.2	327.1	66.4	45.0	24.5	18.4
19	21.5	66.4	456.9	85.9	134.9	115.5	98.1	241.2	58.3	42.9	23.5	18.4
20	21.5	56.2	312.8	349.6	121.6	125.7	175.8	216.7	54.2	40.9	23.5	17.4
21	21.5	52.1	161.5	220.8	116.5	117.6	289.3	179.9	53.2	37.8	23.5	17.4
22	21.5	49.1	151.3	141.1	125.7	108.4	190.1	209.6	48.0	35.8	23.5	17.4
23	21.5	48.0	300.5	115.5	134.9	119.6	139.0	150.3	51.1	35.8	23.5	17.4
24	21.5	49.1	174.8	101.2	132.9	104.3	1,145.9	126.8	53.2	33.7	23.5	16.4
25	20.4	61.3	288.3	86.9	115.5	95.1	289.3	139.0	45.0	32.7	22.5	16.4
26	64.4	65.4	553.0	79.7	114.5	92.0	267.8	143.1	38.8	33.7	22.5	16.4
27	91.0	257.6	235.1	73.6	107.3	87.9	249.4	99.2	38.8	32.7	21.5	15.3
28	52.1	104.3	170.7	106.3	103.2	133.9	404.8	91.0	38.8	54.2	21.5	15.3
29	40.9		155.4	532.6	108.4	96.1	217.7	83.8	37.8	64.4	21.5	15.3
30	33.7		143.1	222.8	114.5	127.8	147.2	77.7	37.8	47.0	21.5	15.3
31	31.7		141.1		116.5		114.5	75.6		32.7		16.4
Average	28.0	72.1	168.9	140.3	169.2	109.0	193.1	259.5	63.2	53.5	27.1	18.4
Maximum	91.0	260.7	553.0	532.6	586.8	171.7	1,145.9	1,611.0	122.7	148.2	34.8	21.5
Minimum	20.4	38.8	90.0	73.6	103.2	86.9	88.9	75.6	37.8	32.7	21.5	15.3

Average annual discharge = 109 (m^3/sec)

Annual inflow volume = 3,441 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1970

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.4	23.5	83.8	53.2	62.4	40.9	162.5	67.5	1,368.8	67.5	31.7	18.4
2	16.4	22.5	49.1	52.1	65.4	42.9	376.2	86.9	274.0	65.4	31.7	18.4
3	16.4	21.5	40.9	54.2	54.2	44.0	212.6	61.3	166.6	61.3	29.6	18.4
4	16.4	20.4	38.8	60.3	52.1	186.0	231.0	108.4	774.9	57.2	29.6	18.4
5	16.4	20.4	37.8	69.5	55.2	112.4	124.7	194.2	259.6	55.2	28.6	18.4
6	16.4	20.4	34.8	79.7	61.3	59.3	124.7	79.7	219.8	76.7	28.6	18.4
7	16.4	19.4	31.7	80.8	78.7	45.0	113.5	66.4	332.2	68.5	28.6	18.4
8	15.3	19.4	30.7	73.6	52.1	35.8	112.4	70.5	558.1	56.2	27.6	18.4
9	15.3	19.4	31.7	76.7	44.0	31.7	109.4	124.7	271.9	55.2	26.6	18.4
10	15.3	19.4	32.7	82.8	45.0	31.7	276.0	450.8	231.0	55.2	25.6	17.4
11	16.4	19.4	51.1	90.0	47.0	32.7	108.4	120.6	419.1	47.0	24.5	17.4
12	17.4	18.4	45.0	84.8	51.1	64.4	74.6	122.7	321.0	44.0	24.5	17.4
13	17.4	18.4	87.9	76.7	57.2	297.5	115.5	624.6	263.7	42.9	24.5	17.4
14	17.4	18.4	143.1	75.6	60.3	95.1	88.9	262.7	262.7	41.9	24.5	17.4
15	17.4	19.4	179.9	73.6	48.0	174.8	61.3	261.7	177.9	40.9	22.5	17.4
16	17.4	19.4	199.3	110.4	52.1	95.1	86.9	206.5	172.8	38.8	22.5	17.4
17	16.4	19.4	112.4	72.6	57.2	53.2	110.4	238.2	169.7	38.8	22.5	17.4
18	17.4	18.4	98.1	61.3	61.3	48.0	118.6	537.7	175.8	37.8	21.5	17.4
19	16.4	18.4	84.8	65.4	55.2	40.9	63.4	240.2	254.5	36.8	20.4	17.4
20	16.4	19.4	69.5	60.3	57.2	37.8	81.8	196.3	265.8	36.8	20.4	17.4
21	16.4	21.5	71.6	61.3	61.3	37.8	74.6	937.4	167.6	36.8	19.4	18.4
22	16.4	23.5	73.6	80.8	55.2	40.9	75.6	263.7	158.4	126.8	19.4	17.4
23	16.4	26.6	75.6	84.8	102.2	52.1	54.2	327.1	121.6	115.5	19.4	17.4
24	16.4	24.5	77.7	90.0	63.4	40.9	51.1	317.9	84.8	76.7	19.4	17.4
25	192.2	25.6	83.8	96.1	49.1	40.9	42.9	422.2	65.4	70.5	19.4	17.4
26	94.0	35.8	78.7	102.2	42.9	60.3	39.9	723.7	70.5	61.3	19.4	17.4
27	37.8	29.6	123.7	79.7	32.7	57.2	145.2	332.2	69.5	50.1	19.4	17.4
28	28.6	349.6	126.8	79.7	31.7	180.9	116.5	245.3	64.4	42.9	19.4	17.4
29	24.5		93.0	63.4	37.8	150.3	74.6	422.2	64.4	35.8	19.4	16.4
30	24.5		69.5	56.2	36.8	99.2	94.0	257.6	66.4	34.8	19.4	16.4
31	24.5		59.3		46.0		80.8	1,067.2		32.7		16.4
Average	26.5	33.3	78.0	74.9	54.1	77.7	116.2	304.5	262.4	55.1	23.7	17.6
Maximum	192.2	349.6	199.3	110.4	102.2	297.5	376.2	1,067.2	1,368.8	126.8	31.7	18.4
Minimum	15.3	18.4	30.7	52.1	31.7	31.7	39.9	61.3	64.4	32.7	19.4	16.4

Average annual discharge = 94 (m^3/sec)

Annual inflow volume = 2,964 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1971

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.4	13.3	37.8	45.0	61.3	214.7	98.1	807.6	268.8	38.8	34.8	22.5
2	16.4	13.3	31.7	49.1	62.4	146.2	613.3	1,200.1	206.5	37.8	62.4	22.5
3	15.3	13.3	27.6	50.1	60.3	119.6	261.7	297.5	228.0	37.8	49.1	22.5
4	16.4	13.3	34.8	60.3	62.4	104.3	209.6	212.6	180.9	35.8	37.8	21.5
5	16.4	13.3	36.8	84.8	62.4	93.0	254.5	210.6	151.3	35.8	33.7	22.5
6	16.4	13.3	41.9	68.5	52.1	84.8	163.6	177.9	104.3	34.8	31.7	22.5
7	16.4	13.3	40.9	61.3	52.1	91.0	118.6	781.0	105.3	33.7	30.7	22.5
8	16.4	13.3	40.9	58.3	53.2	96.1	134.9	453.9	84.8	32.7	30.7	21.5
9	15.3	13.3	39.9	55.2	44.0	121.6	115.5	471.3	81.8	32.7	28.6	21.5
10	15.3	14.3	40.9	54.2	49.1	584.7	87.9	278.0	75.6	32.7	28.6	21.5
11	15.3	15.3	45.0	48.0	44.0	238.2	85.9	217.7	82.8	31.7	27.6	21.5
12	14.3	16.4	49.1	38.8	40.9	152.3	106.3	185.0	78.7	31.7	26.6	21.5
13	14.3	14.3	52.1	34.8	37.8	109.4	645.0	156.4	74.6	31.7	25.6	21.5
14	14.3	13.3	51.1	45.0	50.1	330.2	220.8	148.2	65.4	31.7	25.6	21.5
15	13.3	13.3	51.1	36.8	40.9	167.6	127.8	128.8	60.3	30.7	23.5	20.4
16	13.3	13.3	50.1	45.0	49.1	160.5	199.3	113.5	60.3	31.7	23.5	21.5
17	13.3	13.3	50.1	56.2	40.9	96.1	292.4	127.8	59.3	31.7	23.5	21.5
18	13.3	13.3	52.1	48.0	44.0	95.1	162.5	102.2	53.2	30.7	23.5	20.4
19	13.3	15.3	53.2	42.9	48.0	82.8	143.1	98.1	53.2	30.7	23.5	20.4
20	13.3	15.3	51.1	40.9	63.4	80.8	124.7	149.2	51.1	30.7	23.5	20.4
21	13.3	14.3	49.1	261.7	124.7	160.5	78.7	130.8	49.1	29.6	23.5	20.4
22	13.3	14.3	42.9	101.2	125.7	500.9	101.2	106.3	48.0	29.6	23.5	21.5
23	13.3	13.3	40.9	88.9	86.9	488.6	75.6	95.1	47.0	29.6	23.5	21.5
24	13.3	13.3	38.8	73.6	88.9	261.7	70.5	95.1	45.0	28.6	22.5	20.4
25	14.3	13.3	40.9	70.5	101.2	256.6	99.2	173.8	42.9	27.6	23.5	20.4
26	14.3	16.4	41.9	70.5	94.0	225.9	286.2	980.3	41.9	26.6	23.5	20.4
27	15.3	428.3	44.0	73.6	110.4	173.8	137.0	280.1	41.9	26.6	23.5	20.4
28	15.3	64.4	45.0	86.9	132.9	244.3	99.2	188.1	41.9	25.6	22.5	20.4
29	14.3		41.9	114.5	106.3	131.9	910.8	151.3	40.9	25.6	22.5	20.4
30	14.3		37.8	76.7	88.9	99.2	303.6	439.6	39.9	25.6	22.5	20.4
31	13.3		39.9		126.8		185.0	228.0		25.6		20.4
Average	14.6	30.5	43.3	68.0	71.1	190.4	210.1	296.3	85.5	31.2	28.2	21.2
Maximum	16.4	428.3	53.2	261.7	132.9	584.7	910.8	1,200.1	268.8	38.8	62.4	22.5
Minimum	13.3	13.3	27.6	34.8	37.8	80.8	70.5	95.1	39.9	25.6	22.5	20.4

Average annual discharge = 91 (m^3/sec)

Annual inflow volume = 2,881 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1972

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.4	483.5	53.2	100.2	76.7	105.3	99.2	73.6	153.3	60.3	49.1	28.9
2	20.4	206.5	60.3	96.1	65.4	100.2	68.5	68.5	113.5	54.2	46.0	27.6
3	19.4	78.7	68.5	87.9	60.3	83.8	245.3	61.3	98.1	52.1	44.0	25.6
4	20.4	54.2	73.6	83.8	59.3	76.7	145.2	50.1	116.5	49.1	42.9	24.5
5	19.4	44.0	99.2	167.6	61.3	66.4	166.6	266.8	85.9	47.0	41.9	23.5
6	19.4	40.9	70.5	110.4	69.5	56.2	153.3	1,949.4	85.9	49.1	40.9	23.5
7	19.4	36.8	61.3	91.0	85.9	48.0	161.5	40.9	125.7	52.1	39.9	22.5
8	19.4	31.7	317.9	79.7	77.7	49.1	85.9	198.3	152.3	56.2	39.9	22.5
9	19.4	27.6	228.0	97.1	87.9	42.9	1,426.0	276.0	306.7	45.0	39.9	23.5
10	19.4	25.6	120.6	76.7	86.9	39.9	422.2	120.6	497.8	45.0	39.9	130.8
11	19.4	25.6	97.1	66.4	92.0	44.0	570.4	99.2	124.7	44.0	38.8	88.9
12	19.4	330.2	91.0	75.6	94.0	54.2	358.8	98.1	93.0	42.9	37.8	37.8
13	19.4	171.7	285.2	80.8	101.2	54.2	199.3	114.5	79.7	38.8	36.8	31.7
14	19.4	78.7	138.0	86.9	107.3	61.3	119.6	167.6	83.8	37.8	34.8	30.7
15	19.4	59.3	113.5	87.9	99.2	65.4	112.4	106.3	68.5	35.8	33.7	32.7
16	19.4	54.2	105.3	149.2	95.1	66.4	88.9	117.6	124.7	36.8	32.7	29.6
17	19.4	52.1	113.5	245.3	96.1	71.6	138.0	211.6	178.9	36.8	31.7	31.7
18	19.4	50.1	103.2	190.1	108.4	72.6	97.1	117.6	75.6	65.4	30.7	42.9
19	19.4	51.1	111.4	159.5	105.3	63.4	116.5	289.3	252.5	163.6	29.6	37.8
20	19.4	58.3	226.9	127.8	112.4	49.1	96.1	274.0	180.9	76.7	29.6	55.2
21	22.5	64.4	169.7	97.1	111.4	49.1	75.6	155.4	110.4	56.2	27.6	38.8
22	140.0	61.3	124.7	83.8	100.2	60.3	65.4	100.2	79.7	233.1	29.6	32.7
23	46.0	58.3	121.6	77.7	217.7	68.5	58.3	88.9	71.6	113.5	32.7	30.7
24	25.6	64.4	129.8	81.8	289.3	63.4	81.8	98.1	70.5	83.8	34.8	32.7
25	22.5	62.4	145.2	82.8	116.5	72.6	72.6	122.7	65.4	66.4	35.8	37.8
26	21.5	61.3	167.6	79.7	86.9	111.4	83.8	81.8	61.3	55.2	38.8	45.0
27	20.4	58.3	270.9	80.8	77.7	76.7	61.3	75.6	60.3	48.0	37.8	100.2
28	20.4	62.4	193.2	143.1	79.7	222.8	57.2	112.4	58.3	41.9	32.7	102.2
29	20.4	52.1	183.0	153.3	80.8	107.3	64.4	270.9	58.3	38.8	31.7	76.7
30	20.4		189.1	103.2	83.8	98.1	147.2	205.5	68.5	37.8	30.7	58.3
31	109.4		122.7		104.3		99.2	190.1		35.8		49.1
Average	27.8	86.4	140.5	108.1	99.7	73.4	185.1	200.1	123.4	61.3	36.4	44.4
Maximum	140.0	483.5	317.9	245.3	289.3	222.8	1,426.0	1,949.4	497.8	233.1	49.1	130.8
Minimum	19.4	25.6	53.2	66.4	59.3	39.9	57.2	40.9	58.3	35.8	27.6	22.5

Average annual discharge = 99 (m^3/sec)

Annual inflow volume = 3,134 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1973

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	47.0	64.4	164.6	252.5	155.4	75.6	96.1	86.9	474.3	130.8	33.7	21.5
2	42.9	61.3	204.4	191.2	159.5	66.4	138.0	114.5	275.0	83.8	32.7	20.4
3	39.9	62.4	154.4	209.6	133.9	68.5	145.2	384.4	231.0	68.5	31.7	20.4
4	37.8	59.3	132.9	207.5	125.7	74.6	96.1	250.4	168.7	66.4	30.7	20.4
5	34.8	59.3	118.6	178.9	128.8	84.8	379.3	167.6	145.2	60.3	30.7	20.4
6	54.2	61.3	110.4	196.3	127.8	96.1	138.0	471.3	124.7	55.2	29.6	20.4
7	59.3	61.3	107.3	155.4	113.5	100.2	94.0	287.2	146.2	51.1	29.6	20.4
8	49.1	61.3	247.4	139.0	138.0	105.3	129.8	798.4	111.4	49.1	29.6	20.4
9	40.9	61.3	468.2	131.9	126.8	105.3	104.3	3,558.4	96.1	48.0	29.6	19.4
10	37.8	66.4	1,689.8	130.8	111.4	110.4	58.3	870.9	87.9	47.0	29.6	19.4
11	34.8	80.8	642.0	172.8	74.6	98.1	60.3	466.1	99.2	48.0	28.6	19.4
12	64.4	81.8	382.3	207.5	48.0	142.1	332.2	434.5	155.4	49.1	28.6	20.4
13	118.6	84.8	281.1	160.5	45.0	161.5	945.6	630.7	104.3	48.0	27.6	20.4
14	61.3	86.9	260.7	148.2	44.0	137.0	111.4	586.8	118.6	48.0	27.6	20.4
15	52.1	85.9	234.1	150.3	64.4	100.2	361.9	468.2	123.7	47.0	27.6	19.4
16	49.1	80.8	233.1	98.1	71.6	104.3	199.3	379.3	100.2	63.4	26.6	31.7
17	49.1	80.8	224.9	88.9	200.4	113.5	70.5	312.8	115.5	68.5	26.6	79.7
18	53.2	74.6	194.2	109.4	115.5	120.6	78.7	292.4	204.4	58.3	25.6	38.8
19	396.6	69.5	152.3	136.0	82.8	113.5	240.2	387.4	132.9	54.2	25.6	30.7
20	962.9	69.5	182.0	157.4	64.4	134.9	239.2	295.4	387.4	53.2	25.6	24.5
21	254.5	70.5	169.7	169.7	64.4	169.7	251.5	543.8	161.5	52.1	24.5	22.5
22	138.0	66.4	141.1	128.8	69.5	133.9	91.0	399.7	112.4	51.1	24.5	21.5
23	203.4	68.5	158.4	162.5	76.7	99.2	62.4	282.1	73.6	49.1	23.5	21.5
24	94.0	281.1	199.3	165.6	80.8	138.0	228.0	240.2	101.2	48.0	23.5	21.5
25	81.8	951.7	237.2	162.5	85.9	191.2	171.7	147.2	277.0	46.0	23.5	21.5
26	78.7	769.7	236.1	175.8	85.9	295.4	327.1	169.7	111.4	44.0	22.5	21.5
27	77.7	288.3	240.2	176.8	100.2	131.9	460.0	515.2	81.8	42.9	22.5	21.5
28	73.6	203.4	228.0	140.0	104.3	96.1	189.1	116.5	75.6	39.9	22.5	21.5
29	66.4		205.5	149.2	88.9	102.2	127.8	95.1	68.5	37.8	21.5	21.5
30	67.5		208.5	150.3	91.0	86.9	146.2	81.8	95.1	35.8	21.5	21.5
31	68.5		237.2		84.8		132.9	627.7		34.8		21.5
Average	112.6	146.9	272.4	160.1	98.8	118.6	200.2	466.5	152.0	54.2	26.9	24.1
Maximum	962.9	951.7	1,689.8	252.5	200.4	295.4	945.6	3,558.4	474.3	130.8	33.7	79.7
Minimum	34.8	59.3	107.3	88.9	44.0	66.4	58.3	81.8	68.5	34.8	21.5	19.4

Average annual discharge = 153 (m^3/sec)

Annual inflow volume = 4,833 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1974

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.5	25.6	67.5	97.1	63.4	49.1	80.8	111.4	82.8	68.5	16.4	13.3
2	21.5	42.9	81.8	85.9	63.4	42.9	80.8	134.9	77.7	42.9	16.4	13.3
3	20.4	352.7	93.0	94.0	60.3	57.2	128.8	431.4	52.1	36.8	16.4	20.4
4	19.4	106.3	97.1	96.1	64.4	49.1	130.8	309.7	58.3	34.8	16.4	21.5
5	19.4	75.6	95.1	78.7	62.4	52.1	85.9	220.8	42.9	34.8	16.4	19.4
6	18.4	68.5	77.7	75.6	61.3	154.4	76.7	170.7	46.0	33.7	16.4	16.4
7	17.4	61.3	76.7	72.6	60.3	68.5	73.6	120.6	45.0	32.7	16.4	16.4
8	17.4	53.2	87.9	69.5	65.4	47.0	75.6	87.9	77.7	30.7	15.3	15.3
9	16.4	50.1	97.1	124.7	69.5	58.3	93.0	75.6	48.0	27.6	16.4	15.3
10	16.4	45.0	85.9	82.8	63.4	49.1	303.6	66.4	47.0	27.6	15.3	15.3
11	16.4	44.0	83.8	72.6	60.3	61.3	168.7	86.9	45.0	26.6	15.3	14.3
12	16.4	42.9	75.6	72.6	42.9	49.1	119.6	141.1	39.9	25.6	15.3	14.3
13	17.4	41.9	67.5	76.7	38.8	34.8	160.5	144.1	38.8	25.6	15.3	14.3
14	27.6	40.9	64.4	81.8	36.8	37.8	110.4	206.5	34.8	24.5	15.3	14.3
15	25.6	47.0	62.4	85.9	38.8	39.9	250.4	180.9	34.8	24.5	15.3	18.4
16	24.5	55.2	66.4	79.7	54.2	39.9	175.8	100.2	38.8	23.5	15.3	34.8
17	22.5	63.4	68.5	71.6	68.5	39.9	204.4	72.6	33.7	23.5	14.3	27.6
18	21.5	67.5	59.3	75.6	53.2	39.9	120.6	64.4	33.7	23.5	14.3	17.4
19	20.4	56.2	68.5	79.7	52.1	59.3	126.8	60.3	33.7	22.5	14.3	19.4
20	243.3	56.2	99.2	73.6	57.2	149.2	358.8	72.6	34.8	22.5	14.3	18.4
21	127.8	56.2	105.3	79.7	54.2	133.9	127.8	64.4	38.8	21.5	14.3	17.4
22	58.3	121.6	120.6	71.6	48.0	69.5	253.5	70.5	33.7	20.4	14.3	16.4
23	46.0	185.0	158.4	57.2	33.7	303.6	137.0	59.3	32.7	20.4	14.3	16.4
24	44.0	81.8	317.9	64.4	30.7	995.7	335.3	57.2	31.7	19.4	14.3	15.3
25	42.9	64.4	260.7	73.6	28.6	370.1	248.4	81.8	47.0	18.4	13.3	15.3
26	31.7	68.5	144.1	78.7	36.8	201.4	314.8	55.2	62.4	17.4	13.3	15.3
27	27.6	66.4	107.3	73.6	72.6	125.7	156.4	61.3	35.8	17.4	13.3	15.3
28	26.6	65.4	115.5	67.5	66.4	101.2	103.2	52.1	51.1	17.4	13.3	15.3
29	26.6		98.1	64.4	59.3	93.0	100.2	48.0	41.9	16.4	13.3	15.3
30	25.6		107.3	61.3	54.2	82.8	94.0	57.2	68.5	16.4	13.3	15.3
31	25.6		100.2		53.2		196.3	57.2		16.4		15.3
Average	35.7	75.2	103.6	78.0	54.0	121.9	161.1	113.7	46.3	26.2	14.9	17.2
Maximum	243.3	352.7	317.9	124.7	72.6	995.7	358.8	431.4	82.8	68.5	16.4	34.8
Minimum	16.4	25.6	59.3	57.2	28.6	34.8	73.6	48.0	31.7	16.4	13.3	13.3

Average annual discharge = 71 (m^3/sec)

Annual inflow volume = 2,228 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1975

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	15.3	61.3	110.4	148.2	97.1	99.2	88.9	110.4	344.5	99.2	36.8	24.5
2	15.3	35.8	86.9	155.4	93.0	94.0	97.1	379.3	483.5	98.1	35.8	23.5
3	14.3	27.6	81.8	186.0	97.1	101.2	77.7	272.9	327.1	71.6	35.8	22.5
4	14.3	25.6	188.1	171.7	139.0	92.0	95.1	283.2	242.3	73.6	35.8	22.5
5	14.3	23.5	158.4	152.3	139.0	90.0	100.2	599.0	309.7	71.6	35.8	21.5
6	14.3	27.6	100.2	142.1	102.2	87.9	84.8	306.7	198.3	71.6	34.8	21.5
7	14.3	25.6	85.9	137.0	93.0	91.0	96.1	272.9	364.9	68.5	33.7	21.5
8	14.3	54.2	80.8	131.9	92.0	114.5	99.2	212.6	194.2	66.4	33.7	21.5
9	14.3	75.6	77.7	110.4	69.5	108.4	92.0	189.1	210.6	64.4	34.8	21.5
10	13.3	52.1	123.7	97.1	102.2	96.1	92.0	141.1	217.7	61.3	33.7	20.4
11	14.3	40.9	300.5	99.2	97.1	79.7	86.9	167.6	815.7	59.3	30.7	20.4
12	14.3	39.9	132.9	97.1	100.2	80.8	146.2	916.9	349.6	58.3	27.6	20.4
13	14.3	373.1	106.3	96.1	108.4	82.8	116.5	306.7	279.1	57.2	29.6	20.4
14	14.3	156.4	108.4	83.8	109.4	97.1	175.8	192.2	251.5	56.2	27.6	20.4
15	14.3	88.9	111.4	74.6	101.2	97.1	711.5	166.6	303.6	54.2	26.6	20.4
16	13.3	69.5	104.3	75.6	142.1	97.1	1,438.3	225.9	147.2	52.1	27.6	19.4
17	13.3	64.4	105.3	96.1	306.7	105.3	379.3	239.2	317.9	51.1	27.6	19.4
18	13.3	62.4	105.3	103.2	160.5	99.2	185.0	752.4	231.0	50.1	27.6	19.4
19	13.3	60.3	106.3	110.4	108.4	106.3	257.6	899.6	257.6	49.1	28.6	19.4
20	12.3	61.3	104.3	98.1	106.3	137.0	202.4	2,053.7	246.4	49.1	28.6	19.4
21	12.3	58.3	99.2	97.1	106.3	108.4	404.8	546.9	247.4	46.0	28.6	19.4
22	15.3	54.2	147.2	117.6	92.0	88.9	186.0	804.5	252.5	44.0	29.6	19.4
23	20.4	58.3	502.9	215.7	85.9	91.0	156.4	870.9	140.0	44.0	28.6	19.4
24	16.4	56.2	239.2	131.9	92.0	85.9	205.5	396.6	116.5	42.9	28.6	19.4
25	16.4	63.4	166.6	149.2	93.0	74.6	180.9	289.3	98.1	40.9	28.6	19.4
26	16.4	71.6	147.2	300.5	98.1	77.7	161.5	202.4	91.0	39.9	27.6	19.4
27	16.4	73.6	141.1	314.8	94.0	83.8	146.2	176.8	71.6	40.9	27.6	19.4
28	16.4	126.8	140.0	148.2	100.2	178.9	183.0	2,068.0	72.6	40.9	27.6	19.4
29	16.4		141.1	110.4	120.6	166.6	263.7	633.8	80.8	38.8	27.6	19.4
30	29.6		142.1	100.2	116.5	85.9	137.0	450.8	80.8	38.8	26.6	19.4
31	84.8		142.1		94.0		116.5	382.3		37.8		19.4
Average	17.5	71.0	141.5	135.1	111.5	99.9	218.2	500.3	244.8	56.1	30.5	20.4
Maximum	84.8	373.1	502.9	314.8	306.7	178.9	1,438.3	2,068.0	815.7	99.2	36.8	24.5
Minimum	12.3	23.5	77.7	74.6	69.5	74.6	77.7	110.4	71.6	37.8	26.6	19.4

Average annual discharge = 138 (m^3/sec)

Annual inflow volume = 4,348 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1976

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	18.4	96.1	178.9	143.1	150.3	144.1	105.3	3,789.4	261.7	185.0	39.9	26.6
2	17.4	80.8	201.4	141.1	152.3	144.1	134.9	3,963.2	428.3	97.1	38.8	27.6
3	17.4	60.3	195.2	139.0	152.3	144.1	153.3	891.4	610.3	81.8	37.8	34.8
4	17.4	54.2	200.4	116.5	150.3	138.0	121.6	755.4	488.6	74.6	36.8	31.7
5	17.4	49.1	198.3	259.6	137.0	140.0	93.0	1,013.0	330.2	72.6	35.8	29.6
6	17.4	46.0	167.6	215.7	131.9	143.1	108.4	1,013.0	240.2	65.4	35.8	29.6
7	16.4	44.0	152.3	160.5	141.1	120.6	113.5	2,254.0	213.6	93.0	35.8	28.6
8	16.4	44.0	141.1	164.6	147.2	125.7	127.8	821.9	261.7	82.8	34.8	27.6
9	16.4	44.0	250.4	199.3	137.0	125.7	199.3	561.2	177.9	68.5	34.8	27.6
10	16.4	44.0	166.6	261.7	155.4	162.5	567.3	431.4	162.5	62.4	33.7	26.6
11	16.4	45.0	128.8	236.1	167.6	137.0	268.8	335.3	156.4	58.3	33.7	26.6
12	16.4	61.3	115.5	187.1	160.5	168.7	257.6	387.4	153.3	56.2	33.7	25.6
13	25.6	103.2	139.0	168.7	178.9	248.4	306.7	257.6	168.7	55.2	32.7	25.6
14	189.1	150.3	132.9	166.6	163.6	198.3	373.1	502.9	141.1	53.2	31.7	24.5
15	45.0	1,064.2	154.4	169.7	146.2	274.0	422.2	300.5	128.8	52.1	31.7	24.5
16	29.6	341.4	532.6	171.7	154.4	211.6	972.1	367.0	121.6	52.1	30.7	24.5
17	26.6	237.2	537.7	203.4	240.2	261.7	324.0	268.8	120.6	50.1	29.6	23.5
18	24.5	445.7	349.6	196.3	189.1	212.6	1,478.2	295.4	146.2	48.0	30.7	23.5
19	22.5	401.7	287.2	194.2	201.4	176.8	502.9	341.4	104.3	47.0	30.7	23.5
20	21.5	268.8	370.1	226.9	161.5	117.6	532.6	352.7	97.1	44.0	29.6	23.5
21	20.4	210.6	300.5	244.3	141.1	137.0	488.6	248.4	93.0	42.9	29.6	23.5
22	20.4	173.8	246.4	242.3	134.9	145.2	344.5	201.4	88.9	40.9	28.6	22.5
23	20.4	153.3	211.6	228.0	129.8	130.8	382.3	176.8	84.8	38.8	28.6	22.5
24	21.5	137.0	185.0	279.1	186.0	100.2	500.9	185.0	82.8	37.8	28.6	22.5
25	23.5	349.6	175.8	264.8	177.9	96.1	317.9	216.7	79.7	77.7	29.6	22.5
26	31.7	338.4	178.9	225.9	144.1	97.1	755.4	171.7	76.7	53.2	28.6	23.5
27	546.9	225.9	230.0	216.7	123.7	97.1	434.5	300.5	75.6	46.0	27.6	24.5
28	191.2	193.2	244.3	231.0	126.8	103.2	240.2	191.2	74.6	45.0	28.6	23.5
29	79.7	178.9	190.1	207.5	127.8	106.3	225.9	177.9	73.6	45.0	27.6	22.5
30	62.4		163.6	169.7	131.9	109.4	219.8	171.7	185.0	42.9	26.6	22.5
31	56.2		163.6		146.2		183.0	111.4		41.9		22.5
Average	53.6	194.5	222.3	201.0	154.5	150.6	363.1	679.2	180.9	61.7	32.1	25.4
Maximum	546.9	1,064.2	537.7	279.1	240.2	274.0	1,478.2	3,963.2	610.3	185.0	39.9	34.8
Minimum	16.4	44.0	115.5	116.5	123.7	96.1	93.0	111.4	73.6	37.8	26.6	22.5

Average annual discharge = 194 (m^3/sec)

Annual inflow volume = 6,129 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1977

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.5	75.6	51.1	63.4	94.0	97.1	127.8	106.3	155.4	76.7	47.0	65.4
2	24.5	79.7	49.1	61.3	97.1	97.1	289.3	338.4	152.3	79.7	42.9	41.9
3	23.5	74.6	49.1	60.3	370.1	94.0	382.3	268.8	234.1	88.9	271.9	38.8
4	22.5	66.4	51.1	63.4	218.8	96.1	207.5	1,553.8	116.5	68.5	104.3	37.8
5	22.5	64.4	51.1	85.9	131.9	91.0	203.4	651.2	206.5	68.5	59.3	37.8
6	22.5	58.3	60.3	167.6	104.3	73.6	1,377.0	382.3	309.7	80.8	50.1	36.8
7	21.5	54.2	65.4	116.5	88.9	68.5	213.6	288.3	108.4	64.4	45.0	35.8
8	21.5	51.1	75.6	80.8	80.8	63.4	238.2	300.5	297.5	61.3	42.9	35.8
9	22.5	53.2	74.6	72.6	162.5	64.4	168.7	221.8	97.1	58.3	42.9	33.7
10	35.8	61.3	74.6	102.2	175.8	69.5	148.2	209.6	160.5	95.1	42.9	34.8
11	120.6	63.4	68.5	81.8	163.6	63.4	607.2	221.8	146.2	56.2	40.9	36.8
12	29.6	61.3	62.4	100.2	100.2	73.6	259.6	286.2	108.4	53.2	41.9	61.3
13	22.5	60.3	63.4	87.9	117.6	91.0	364.9	203.4	147.2	51.1	41.9	39.9
14	20.4	61.3	86.9	92.0	119.6	128.8	738.1	213.6	113.5	50.1	42.9	38.8
15	20.4	60.3	63.4	84.8	106.3	86.9	1,365.7	155.4	104.3	50.1	40.9	36.8
16	21.5	59.3	72.6	72.6	87.9	68.5	1,142.9	404.8	92.0	127.8	40.9	35.8
17	21.5	59.3	58.3	81.8	82.8	72.6	613.3	189.1	111.4	72.6	38.8	34.8
18	22.5	61.3	53.2	99.2	85.9	76.7	306.7	229.0	332.2	54.2	38.8	33.7
19	24.5	63.4	50.1	289.3	91.0	68.5	292.4	317.9	202.4	50.1	37.8	35.8
20	25.6	62.4	45.0	215.7	101.2	73.6	300.5	260.7	115.5	49.1	38.8	36.8
21	24.5	57.2	45.0	120.6	94.0	80.8	358.8	204.4	112.4	50.1	38.8	37.8
22	24.5	37.8	54.2	100.2	94.0	87.9	494.8	218.8	114.5	49.1	36.8	37.8
23	27.6	49.1	62.4	101.2	91.0	103.2	376.2	228.0	113.5	49.1	39.9	35.8
24	261.7	48.0	66.4	103.2	82.8	268.8	553.0	229.0	104.3	44.0	38.8	37.8
25	502.9	45.0	71.6	93.0	151.3	133.9	515.2	191.2	94.0	592.9	37.8	327.1
26	244.3	45.0	68.5	90.0	101.2	460.0	376.2	141.1	84.8	183.0	40.9	442.6
27	167.6	54.2	72.6	84.8	105.3	174.8	297.5	108.4	83.8	90.0	40.9	169.7
28	107.3	56.2	64.4	116.5	112.4	159.5	208.5	151.3	81.8	70.5	35.8	85.9
29	81.8		64.4	108.4	113.5	387.4	131.9	123.7	87.9	58.3	32.7	55.2
30	72.6		66.4	109.4	145.2	161.5	180.9	297.5	142.1	55.2	80.8	34.8
31	76.7		66.4		109.4		107.3	196.3		50.1		31.7
Average	69.7	58.7	62.2	103.6	121.9	121.2	417.7	286.9	144.3	85.4	52.5	67.3
Maximum	502.9	79.7	86.9	289.3	370.1	460.0	1,377.0	1,553.8	332.2	592.9	271.9	442.6
Minimum	20.4	37.8	45.0	60.3	80.8	63.4	107.3	106.3	81.8	44.0	32.7	31.7

Average annual discharge = 134 (m^3/sec)

Annual inflow volume = 4,211 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1978

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	59.3	103.2	224.9	171.7	173.8	112.4	182.0	425.3	169.7	121.6	48.0	49.1
2	58.3	94.0	180.9	170.7	173.8	125.7	173.8	410.9	157.4	110.4	46.0	49.1
3	57.2	85.9	154.4	171.7	180.9	143.1	419.1	1,267.6	165.6	104.3	44.0	48.0
4	55.2	79.7	196.3	174.8	191.2	138.0	229.0	295.4	153.3	95.1	73.6	47.0
5	52.1	74.6	312.8	168.7	187.1	155.4	390.5	256.6	132.9	88.9	64.4	46.0
6	52.1	94.0	240.2	166.6	189.1	150.3	1,591.6	232.0	139.0	82.8	203.4	50.1
7	51.1	114.5	182.0	176.8	190.1	145.2	867.9	165.6	143.1	77.7	192.2	47.0
8	50.1	83.8	160.5	191.2	164.6	145.2	379.3	216.7	132.9	76.7	124.7	48.0
9	46.0	68.5	151.3	200.4	173.8	142.1	256.6	1,680.6	138.0	75.6	134.9	50.1
10	44.0	74.6	232.0	212.6	172.8	119.6	297.5	969.1	160.5	74.6	90.0	52.1
11	40.9	73.6	300.5	211.6	171.7	115.5	192.2	833.1	155.4	73.6	79.7	53.2
12	40.9	78.7	230.0	231.0	154.4	100.2	172.8	648.1	164.6	73.6	71.6	54.2
13	51.1	88.9	187.1	233.1	143.1	145.2	352.7	795.3	133.9	72.6	137.0	55.2
14	110.4	93.0	180.9	250.4	139.0	158.4	332.2	463.1	238.2	70.5	150.3	55.2
15	64.4	112.4	172.8	252.5	143.1	114.5	240.2	358.8	195.2	68.5	79.7	52.1
16	52.1	111.4	830.1	243.3	161.5	111.4	252.5	586.8	164.6	62.4	57.2	48.0
17	50.1	110.4	3,356.0	285.2	164.6	104.3	321.0	390.5	164.6	57.2	53.2	42.9
18	48.0	112.4	720.7	468.2	169.7	103.2	288.3	379.3	137.0	54.2	51.1	38.8
19	48.0	102.2	474.3	234.1	147.2	102.2	407.9	738.1	147.2	51.1	45.0	34.8
20	48.0	98.1	373.1	187.1	154.4	100.2	312.8	445.7	128.8	51.1	46.0	31.7
21	50.1	94.0	324.0	171.7	138.0	139.0	839.3	393.6	119.6	53.2	46.0	27.6
22	49.1	95.1	285.2	162.5	142.1	156.4	546.9	526.5	133.9	53.2	58.3	24.5
23	57.2	99.2	260.7	191.2	143.1	143.1	613.3	264.8	232.0	54.2	56.2	20.4
24	56.2	97.1	250.4	189.1	170.7	138.0	572.5	246.4	172.8	53.2	49.1	16.4
25	53.2	113.5	235.1	174.8	276.0	127.8	564.3	218.8	118.6	55.2	48.0	12.3
26	53.2	123.7	218.8	172.8	204.4	123.7	529.5	204.4	102.2	53.2	48.0	11.2
27	56.2	110.4	213.6	168.7	188.1	187.1	561.2	196.3	252.5	52.1	49.1	11.2
28	255.6	117.6	234.1	174.8	148.2	152.3	439.6	249.4	206.5	54.2	49.1	11.2
29	268.8		214.7	178.9	147.2	254.5	376.2	201.4	152.3	56.2	48.0	11.2
30	142.1		200.4	173.8	152.3	1,142.9	1,090.7	183.0	134.9	54.2	49.1	11.2
31	116.5		182.0		123.7		520.3	193.2		51.1		11.2
Average	72.2	96.6	370.3	205.3	167.1	169.9	461.7	465.7	158.2	68.8	76.4	36.2
Maximum	268.8	123.7	3,356.0	468.2	276.0	1,142.9	1,591.6	1,680.6	252.5	121.6	203.4	55.2
Minimum	40.9	68.5	151.3	162.5	123.7	100.2	172.8	165.6	102.2	51.1	44.0	11.2

Average annual discharge = 197 (m^3/sec)

Annual inflow volume = 6,212 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1979

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	9.2	34.8	65.4	178.9	97.1	60.3	104.3	62.4	102.2	96.1	56.2	48.0
2	9.2	42.9	105.3	152.3	109.4	185.0	92.0	665.5	102.2	86.9	47.0	45.0
3	9.2	35.8	235.1	194.2	104.3	81.8	104.3	74.6	103.2	81.8	47.0	45.0
4	9.2	38.8	450.8	292.4	98.1	68.5	105.3	809.6	119.6	71.6	46.0	47.0
5	9.2	38.8	812.7	217.7	86.9	66.4	120.6	209.6	124.7	67.5	46.0	47.0
6	9.2	35.8	723.7	182.0	80.8	74.6	78.7	163.6	145.2	72.6	41.9	46.0
7	9.2	34.8	463.1	191.2	71.6	72.6	78.7	156.4	132.9	67.5	40.9	45.0
8	9.2	33.7	422.2	203.4	72.6	108.4	68.5	352.7	195.2	66.4	53.2	42.9
9	9.2	34.8	321.0	195.2	100.2	128.8	113.5	317.9	82.8	65.4	96.1	42.9
10	9.2	35.8	289.3	183.0	134.9	108.4	110.4	330.2	80.8	64.4	64.4	42.9
11	9.2	34.8	218.8	177.9	106.3	103.2	77.7	321.0	216.7	64.4	54.2	42.9
12	10.2	31.7	194.2	176.8	70.5	100.2	161.5	300.5	173.8	64.4	47.0	42.9
13	12.3	29.6	195.2	168.7	79.7	373.1	675.7	278.0	83.8	80.8	44.0	42.9
14	32.7	28.6	182.0	147.2	79.7	154.4	231.0	237.2	157.4	84.8	41.9	41.9
15	62.4	25.6	168.7	144.1	91.0	86.9	93.0	289.3	128.8	76.7	42.9	41.9
16	38.8	24.5	155.4	125.7	107.3	61.3	91.0	255.6	121.6	64.4	47.0	44.0
17	26.6	28.6	896.5	126.8	78.7	61.3	79.7	146.2	94.0	61.3	52.1	41.9
18	22.5	23.5	245.3	120.6	61.3	59.3	62.4	119.6	195.2	58.3	48.0	41.9
19	23.5	275.0	202.4	112.4	59.3	88.9	57.2	175.8	243.3	54.2	48.0	41.9
20	24.5	474.3	198.3	125.7	64.4	93.0	173.8	157.4	193.2	53.2	46.0	41.9
21	29.6	98.1	209.6	103.2	92.0	107.3	116.5	94.0	208.5	54.2	44.0	40.9
22	29.6	67.5	213.6	95.1	112.4	129.8	295.4	86.9	122.7	57.2	41.9	39.9
23	27.6	58.3	211.6	90.0	92.0	126.8	99.2	197.3	127.8	56.2	41.9	39.9
24	26.6	58.3	207.5	97.1	78.7	129.8	178.9	269.9	118.6	51.1	50.1	35.8
25	26.6	81.8	209.6	100.2	108.4	129.8	73.6	190.1	226.9	50.1	137.0	32.7
26	27.6	81.8	195.2	99.2	196.3	114.5	50.1	134.9	163.6	49.1	71.6	66.4
27	26.6	80.8	202.4	100.2	160.5	108.4	47.0	108.4	129.8	49.1	59.3	64.4
28	25.6	72.6	215.7	108.4	100.2	102.2	71.6	98.1	118.6	49.1	54.2	42.9
29	28.6		193.2	105.3	75.6	96.1	50.1	124.7	95.1	49.1	49.1	39.9
30	109.4		231.0	103.2	59.3	96.1	47.0	109.4	101.2	47.0	50.1	47.0
31	36.8		246.4		50.1		96.1	100.2		48.0		65.4
Average	24.2	69.3	286.5	147.3	92.9	109.2	122.7	223.8	140.3	63.3	53.6	44.9
Maximum	109.4	474.3	896.5	292.4	196.3	373.1	675.7	809.6	243.3	96.1	137.0	66.4
Minimum	9.2	23.5	65.4	90.0	50.1	59.3	47.0	62.4	80.8	47.0	40.9	32.7

Average annual discharge = 115 (m^3/sec)

Annual inflow volume = 3,634 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1980

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	112.4	50.1	99.2	123.7	111.4	124.7	69.5	146.2	225.9	40.9	46.0	45.0
2	105.3	48.0	87.9	127.8	111.4	121.6	77.7	198.3	48.0	40.9	45.0	42.9
3	66.4	158.4	76.7	141.1	110.4	116.5	100.2	989.5	27.6	40.9	42.9	40.9
4	55.2	115.5	68.5	103.2	108.4	99.2	200.4	373.1	31.7	37.8	40.9	38.8
5	54.2	96.1	572.5	110.4	104.3	87.9	186.0	288.3	58.3	35.8	38.8	37.8
6	57.2	80.8	651.2	121.6	107.3	80.8	146.2	165.6	81.8	37.8	38.8	34.8
7	58.3	74.6	215.7	125.7	113.5	75.6	83.8	182.0	82.8	35.8	36.8	33.7
8	56.2	68.5	207.5	110.4	113.5	75.6	66.4	153.3	75.6	150.3	35.8	33.7
9	54.2	63.4	150.3	116.5	112.4	85.9	83.8	540.8	86.9	85.9	34.8	33.7
10	53.2	58.3	115.5	123.7	106.3	87.9	60.3	66.4	264.8	48.0	34.8	32.7
11	52.1	55.2	105.3	118.6	93.0	104.3	367.0	35.8	91.0	56.2	33.7	31.7
12	51.1	51.1	130.8	97.1	93.0	110.4	133.9	40.9	113.5	45.0	33.7	32.7
13	50.1	55.2	96.1	86.9	91.0	226.9	107.3	59.3	188.1	39.9	32.7	32.7
14	49.1	63.4	83.8	93.0	103.2	213.6	180.9	81.8	121.6	37.8	32.7	31.7
15	47.0	203.4	172.8	86.9	109.4	128.8	189.1	94.0	85.9	35.8	31.7	31.7
16	51.1	154.4	158.4	88.9	108.4	106.3	88.9	77.7	68.5	37.8	31.7	31.7
17	51.1	106.3	124.7	111.4	98.1	93.0	96.1	158.4	59.3	35.8	30.7	29.6
18	47.0	95.1	238.2	124.7	87.9	98.1	75.6	96.1	49.1	40.9	29.6	29.6
19	51.1	85.9	148.2	123.7	92.0	100.2	85.9	73.6	50.1	49.1	29.6	29.6
20	52.1	114.5	120.6	129.8	102.2	106.3	144.1	68.5	57.2	41.9	28.6	28.6
21	53.2	101.2	116.5	130.8	86.9	176.8	112.4	60.3	50.1	40.9	28.6	28.6
22	50.1	110.4	286.2	114.5	78.7	122.7	72.6	53.2	40.9	36.8	28.6	28.6
23	49.1	124.7	171.7	98.1	72.6	110.4	99.2	48.0	37.8	33.7	27.6	29.6
24	49.1	104.3	165.6	99.2	72.6	975.2	71.6	85.9	34.8	31.7	27.6	35.8
25	49.1	86.9	157.4	110.4	77.7	243.3	74.6	84.8	68.5	31.7	26.6	32.7
26	61.3	76.7	184.0	111.4	80.8	252.5	184.0	84.8	45.0	34.8	29.6	41.9
27	80.8	149.2	126.8	106.3	90.0	120.6	276.0	85.9	38.8	33.7	300.5	53.2
28	86.9	236.1	133.9	112.4	112.4	91.0	229.0	70.5	38.8	33.7	94.0	36.8
29	79.7	120.6	128.8	111.4	115.5	71.6	222.8	66.4	35.8	34.8	57.2	31.7
30	68.5		120.6	107.3	103.2	99.2	187.1	71.6	37.8	41.9	47.0	29.6
31	62.4		119.6		116.5		128.8	148.2		54.2		28.6
Average	60.1	100.3	172.1	112.2	99.5	150.2	135.5	153.2	76.5	44.6	45.9	34.2
Maximum	112.4	236.1	651.2	141.1	116.5	975.2	367.0	989.5	264.8	150.3	300.5	53.2
Minimum	47.0	48.0	68.5	86.9	72.6	71.6	60.3	35.8	27.6	31.7	26.6	28.6

Average annual discharge = 99 (m^3/sec)

Annual inflow volume = 3,122 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1981

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.6	93.0	255.6	312.8	126.8	168.7	146.2	281.1	61.3	58.3	27.6	21.5
2	29.6	79.7	169.7	275.0	146.2	124.7	177.9	243.3	60.3	81.8	26.6	21.5
3	31.7	79.7	132.9	361.9	175.8	94.0	86.9	222.8	68.5	56.2	27.6	22.5
4	68.5	119.6	122.7	324.0	155.4	81.8	103.2	233.1	65.4	49.1	27.6	22.5
5	121.6	419.1	121.6	239.2	243.3	71.6	217.7	480.5	63.4	46.0	27.6	22.5
6	83.8	219.8	584.7	191.2	171.7	72.6	166.6	417.1	57.2	40.9	27.6	21.5
7	53.2	163.6	515.2	196.3	128.8	86.9	78.7	474.3	51.1	39.9	27.6	21.5
8	35.8	144.1	297.5	165.6	119.6	115.5	119.6	370.1	50.1	38.8	27.6	21.5
9	38.8	137.0	235.1	184.0	124.7	133.9	396.6	529.5	50.1	37.8	27.6	20.4
10	37.8	132.9	332.2	187.1	104.3	106.3	213.6	309.7	48.0	36.8	26.6	20.4
11	35.8	124.7	254.5	182.0	94.0	91.0	151.3	270.9	47.0	35.8	26.6	20.4
12	34.8	139.0	196.3	208.5	110.4	69.5	133.9	208.5	48.0	34.8	29.6	19.4
13	33.7	168.7	190.1	218.8	116.5	57.2	370.1	228.0	48.0	33.7	31.7	18.4
14	33.7	694.1	272.9	209.6	138.0	54.2	920.0	186.0	50.1	32.7	29.6	19.4
15	33.7	324.0	259.6	233.1	131.9	54.2	146.2	268.8	46.0	31.7	28.6	19.4
16	33.7	228.0	217.7	445.7	109.4	57.2	240.2	192.2	42.9	35.8	27.6	20.4
17	33.7	184.0	199.3	266.8	112.4	50.1	83.8	138.0	44.0	37.8	27.6	21.5
18	32.7	167.6	208.5	198.3	129.8	58.3	399.7	125.7	60.3	35.8	27.6	21.5
19	32.7	183.0	212.6	172.8	143.1	68.5	222.8	111.4	60.3	34.8	27.6	20.4
20	31.7	155.4	488.6	194.2	129.8	63.4	110.4	106.3	51.1	32.7	25.6	20.4
21	31.7	148.2	738.1	370.1	125.7	70.5	72.6	97.1	49.1	31.7	25.6	20.4
22	31.7	141.1	414.0	244.3	94.0	61.3	173.8	116.5	47.0	30.7	24.5	20.4
23	64.4	121.6	306.7	159.5	86.9	59.3	209.6	103.2	47.0	29.6	24.5	20.4
24	270.9	143.1	269.9	161.5	127.8	58.3	951.7	80.8	45.0	29.6	23.5	20.4
25	274.0	226.9	262.7	177.9	141.1	79.7	804.5	69.5	45.0	29.6	22.5	20.4
26	126.8	137.0	228.0	193.2	128.8	56.2	341.4	68.5	44.0	28.6	22.5	19.4
27	86.9	116.5	212.6	161.5	103.2	71.6	250.4	120.6	52.1	27.6	22.5	19.4
28	153.3	182.0	220.8	143.1	103.2	71.6	619.5	72.6	45.0	25.6	21.5	20.4
29	129.8		286.2	126.8	96.1	82.8	463.1	142.1	58.3	29.6	21.5	20.4
30	173.8		1,269.6	134.9	94.0	164.6	535.7	72.6	86.9	30.7	21.5	20.4
31	130.8		491.7		312.8		390.5	63.4		28.6		20.4
Average	75.5	184.8	321.5	221.3	133.1	81.8	299.9	206.6	53.1	37.2	26.2	20.6
Maximum	274.0	694.1	1,269.6	445.7	312.8	168.7	951.7	529.5	86.9	81.8	31.7	22.5
Minimum	29.6	79.7	121.6	126.8	86.9	50.1	72.6	63.4	42.9	25.6	21.5	18.4

Average annual discharge = 139 (m^3/sec)

Annual inflow volume = 4,370 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1982

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.4	31.7	240.2	289.3	277.0	153.3	373.1	989.5	68.5	37.8	36.8	32.7
2	19.4	29.6	219.8	271.9	330.2	108.4	154.4	448.8	67.5	35.8	35.8	38.8
3	19.4	28.6	125.7	259.6	261.7	93.0	125.7	248.4	63.4	31.7	34.8	42.9
4	21.5	48.0	99.2	256.6	224.9	98.1	92.0	195.2	62.4	28.6	33.7	37.8
5	29.6	37.8	254.5	239.2	230.0	105.3	91.0	876.1	59.3	26.6	33.7	35.8
6	23.5	33.7	215.7	219.8	222.8	124.7	86.9	300.5	57.2	23.5	33.7	35.8
7	21.5	30.7	145.2	204.4	292.4	133.9	112.4	1,362.6	55.2	21.5	33.7	34.8
8	20.4	32.7	127.8	133.9	233.1	132.9	130.8	396.6	56.2	20.4	33.7	37.8
9	19.4	27.6	107.3	132.9	193.2	124.7	87.9	584.7	54.2	20.4	33.7	81.8
10	19.4	31.7	384.4	147.2	185.0	127.8	80.8	804.5	51.1	23.5	34.8	90.0
11	19.4	71.6	201.4	139.0	361.9	122.7	66.4	480.5	49.1	21.5	34.8	46.0
12	19.4	54.2	160.5	132.9	257.6	121.6	81.8	367.0	48.0	129.8	33.7	41.9
13	19.4	29.6	129.8	133.9	184.0	139.0	140.0	428.3	51.1	56.2	32.7	48.0
14	19.4	32.7	137.0	138.0	152.3	126.8	97.1	295.4	53.2	41.9	31.7	51.1
15	19.4	30.7	141.1	139.0	157.4	215.7	80.8	303.6	49.1	31.7	87.9	44.0
16	19.4	31.7	226.9	419.1	133.9	186.0	95.1	306.7	44.0	33.7	361.9	40.9
17	19.4	36.8	235.1	812.7	126.8	156.4	104.3	193.2	41.9	31.7	77.7	37.8
18	18.4	31.7	174.8	483.5	115.5	128.8	110.4	144.1	39.9	24.5	81.8	35.8
19	18.4	38.8	160.5	314.8	130.8	106.3	237.2	179.9	42.9	31.7	71.6	35.8
20	18.4	223.9	149.2	250.4	104.3	105.3	347.6	132.9	38.8	31.7	59.3	34.8
21	17.4	131.9	149.2	208.5	99.2	126.8	263.7	116.5	69.5	30.7	61.3	33.7
22	29.6	75.6	436.5	201.4	100.2	99.2	146.2	113.5	238.2	35.8	48.0	33.7
23	49.1	61.3	529.5	187.1	284.2	93.0	453.9	110.4	96.1	38.8	40.9	35.8
24	25.6	57.2	920.0	224.9	216.7	81.8	923.1	222.8	71.6	42.9	38.8	38.8
25	22.5	50.1	874.0	205.5	139.0	64.4	169.7	127.8	55.2	34.8	36.8	34.8
26	25.6	45.0	436.5	217.7	143.1	58.3	244.3	113.5	50.1	31.7	35.8	33.7
27	27.6	44.0	338.4	347.6	172.8	127.8	112.4	92.0	45.0	35.8	35.8	32.7
28	30.7	142.1	314.8	604.1	174.8	124.7	197.3	83.8	41.9	178.9	34.8	38.8
29	27.6		289.3	494.8	150.3	90.0	190.1	80.8	41.9	68.5	34.8	64.4
30	27.6		306.7	312.8	184.0	194.2	287.2	93.0	40.9	45.0	33.7	47.0
31	33.7		309.7		174.8		550.0	80.8		38.8		41.9
Average	23.3	54.3	275.5	270.8	194.0	122.4	201.1	331.4	60.1	41.5	53.9	42.6
Maximum	49.1	223.9	920.0	812.7	361.9	215.7	923.1	1,362.6	238.2	178.9	361.9	90.0
Minimum	17.4	27.6	99.2	132.9	99.2	58.3	66.4	80.8	38.8	20.4	31.7	32.7

Average annual discharge = 140 (m^3/sec)

Annual inflow volume = 4,417 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1983

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	37.8	93.0	297.5	228.0	287.2	172.8	425.3	295.4	226.9	57.2	45.0	29.6
2	33.7	83.8	774.9	240.2	221.8	185.0	285.2	321.0	1,198.1	56.2	44.0	29.6
3	32.7	76.7	373.1	211.6	216.7	187.1	352.7	217.7	448.8	57.2	45.0	29.6
4	31.7	66.4	259.6	335.3	231.0	156.4	468.2	425.3	417.1	57.2	44.0	27.6
5	31.7	62.4	210.6	283.2	231.0	134.9	292.4	256.6	295.4	56.2	44.0	27.6
6	31.7	60.3	162.5	215.7	228.0	119.6	277.0	330.2	270.9	56.2	42.9	27.6
7	35.8	57.2	146.2	289.3	242.3	116.5	141.1	491.7	244.3	57.2	41.9	26.6
8	42.9	54.2	141.1	450.8	247.4	161.5	137.0	312.8	221.8	57.2	44.0	26.6
9	37.8	50.1	146.2	297.5	245.3	172.8	116.5	344.5	201.4	58.3	42.9	26.6
10	34.8	48.0	174.8	270.9	269.9	154.4	150.3	264.8	247.4	58.3	37.8	25.6
11	32.7	46.0	317.9	270.9	297.5	208.5	120.6	207.5	158.4	57.2	37.8	25.6
12	31.7	45.0	220.8	434.5	248.4	162.5	97.1	280.1	143.1	51.1	37.8	25.6
13	29.6	44.0	171.7	1,174.6	212.6	144.1	106.3	213.6	127.8	104.3	36.8	25.6
14	28.6	48.0	147.2	602.1	246.4	124.7	133.9	182.0	116.5	163.6	36.8	25.6
15	29.6	236.1	159.5	980.3	230.0	165.6	96.1	178.9	232.0	73.6	36.8	25.6
16	31.7	112.4	155.4	995.7	192.2	212.6	129.8	145.2	234.1	57.2	36.8	25.6
17	29.6	81.8	138.0	586.8	159.5	183.0	146.2	174.8	137.0	52.1	36.8	25.6
18	27.6	69.5	117.6	500.9	253.5	125.7	121.6	685.9	108.4	49.1	35.8	25.6
19	26.6	64.4	937.4	390.5	265.8	118.6	121.6	352.7	99.2	49.1	34.8	24.5
20	25.6	61.3	624.6	347.6	282.1	107.3	105.3	281.1	83.8	57.2	35.8	24.5
21	25.6	61.3	292.4	317.9	287.2	98.1	107.3	281.1	78.7	66.4	35.8	24.5
22	28.6	56.2	229.0	297.5	253.5	97.1	157.4	245.3	75.6	54.2	35.8	24.5
23	27.6	55.2	172.8	309.7	266.8	118.6	567.3	275.0	73.6	49.1	34.8	26.6
24	26.6	288.3	161.5	287.2	164.6	110.4	252.5	352.7	92.0	50.1	34.8	24.5
25	26.6	159.5	468.2	264.8	148.2	103.2	288.3	691.0	82.8	49.1	34.8	25.6
26	26.6	105.3	633.8	295.4	199.3	116.5	453.9	636.9	69.5	47.0	33.7	25.6
27	193.2	93.0	410.9	358.8	187.1	152.3	642.0	358.8	66.4	47.0	31.7	24.5
28	448.8	84.8	264.8	317.9	174.8	136.0	281.1	265.8	63.4	45.0	31.7	24.5
29	306.7		235.1	286.2	175.8	159.5	183.0	165.6	63.4	44.0	31.7	24.5
30	202.4		216.7	303.6	174.8	173.8	196.3	155.4	58.3	42.9	30.7	24.5
31	117.6		210.6		154.4		196.3	210.6		40.9		24.5
Average	66.9	84.4	289.4	404.8	225.7	146.0	230.6	309.7	197.9	58.8	37.8	26.0
Maximum	448.8	288.3	937.4	1,174.6	297.5	212.6	642.0	691.0	1,198.1	163.6	45.0	29.6
Minimum	25.6	44.0	117.6	211.6	148.2	97.1	96.1	145.2	58.3	40.9	30.7	24.5

Average annual discharge = 174 (m^3/sec)

Annual inflow volume = 5,476 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1984

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.5	20.4	42.9	306.7	49.1	68.5	99.2	201.4	575.7	91.0	41.9	35.8
2	24.5	19.4	42.9	332.2	60.3	70.5	100.2	119.6	543.9	88.9	39.9	35.8
3	23.5	20.4	44.0	275.0	69.5	62.4	77.7	94.0	622.0	84.8	37.8	34.8
4	23.5	20.4	44.0	159.5	72.6	79.7	94.0	82.8	451.3	82.8	36.8	33.7
5	22.5	20.4	39.9	154.4	69.5	58.3	97.1	538.1	341.4	79.7	35.8	32.7
6	22.5	20.4	36.8	97.1	76.7	79.7	115.5	186.0	341.4	76.7	34.8	31.7
7	23.5	20.4	36.8	98.1	80.8	69.5	97.1	156.4	405.0	75.6	33.7	31.7
8	23.5	21.5	35.8	80.8	80.8	56.2	175.8	711.7	324.0	73.6	33.7	30.7
9	23.5	20.4	35.8	80.8	84.8	40.9	150.3	436.5	270.9	70.5	35.8	30.7
10	23.5	20.4	35.8	76.7	76.7	60.3	103.2	250.4	244.3	70.5	39.9	29.6
11	23.5	19.4	36.8	69.5	81.8	111.4	117.6	529.5	220.8	68.5	35.8	29.6
12	23.5	19.4	34.8	72.6	84.8	79.7	103.2	355.7	205.5	67.5	34.8	28.6
13	21.5	19.4	37.8	75.6	91.0	64.4	84.8	471.5	167.6	66.4	34.8	62.4
14	21.5	18.4	35.8	91.0	73.6	56.2	66.4	630.7	239.2	64.4	34.8	54.2
15	20.4	18.4	35.8	106.3	75.6	58.3	140.0	355.8	190.1	59.3	34.8	42.9
16	20.4	18.4	39.9	91.0	61.3	53.2	116.5	746.4	152.3	61.3	34.8	38.8
17	20.4	18.4	29.6	90.0	55.2	58.3	125.7	335.3	147.2	60.3	34.8	36.8
18	20.4	42.9	157.4	74.6	58.3	390.5	150.3	259.6	160.5	60.3	34.8	36.8
19	19.4	63.4	109.4	78.7	66.4	223.9	167.6	671.6	147.2	58.3	35.8	34.8
20	19.4	114.5	59.3	77.7	58.3	134.9	194.2	393.6	125.7	58.3	35.8	34.8
21	19.4	54.2	54.2	74.6	50.1	109.4	125.7	355.7	137.0	57.2	35.8	33.7
22	18.4	40.9	54.2	64.4	57.2	88.9	190.1	642.0	156.4	55.2	59.3	33.7
23	18.4	35.8	58.3	58.3	64.4	83.8	119.6	349.6	117.6	54.2	99.2	32.7
24	18.4	34.8	63.4	60.3	61.3	88.9	102.2	535.7	165.6	52.1	60.3	32.7
25	18.4	36.8	127.8	70.5	69.5	137.0	99.2	471.3	119.6	54.2	50.1	31.7
26	18.4	35.8	95.1	71.6	77.7	153.3	81.8	324.0	107.3	54.2	40.9	31.7
27	18.4	34.8	71.6	76.7	62.4	139.0	111.4	431.4	105.3	51.1	39.9	31.7
28	17.4	33.7	71.6	82.8	81.8	137.0	326.9	335.3	103.2	49.1	37.8	31.7
29	18.4	34.8	76.7	78.7	86.9	114.5	203.4	306.7	104.3	48.0	36.8	31.7
30	18.4		76.7	59.3	65.4	113.5	220.8	259.6	95.1	47.0	36.8	32.7
31	18.4		100.2		63.4		157.4	352.9		42.9		54.2
Average	20.9	31.0	58.7	106.2	69.9	101.4	132.8	383.6	236.3	64.0	40.6	35.6
Maximum	24.5	114.5	157.4	332.2	91.0	390.5	326.9	746.4	622.0	91.0	99.2	62.4
Minimum	17.4	18.4	29.6	58.3	49.1	40.9	66.4	82.8	95.1	42.9	33.7	28.6

Average annual discharge = 107 (m^3/sec)

Annual inflow volume = 3,384 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1985

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	70.5	50.1	64.4	59.3	73.6	59.3	70.5	207.5	64.4	52.1	47.0	46.0
2	49.1	48.0	62.4	57.2	196.3	61.3	55.2	207.5	62.4	52.1	47.0	46.0
3	40.9	48.0	65.4	57.2	80.8	66.4	44.0	283.2	60.3	53.2	47.0	46.0
4	39.9	49.1	61.3	71.6	65.4	62.4	40.9	462.9	58.3	52.1	47.0	45.0
5	55.2	93.0	59.3	60.3	59.3	66.4	41.9	422.2	74.6	82.8	47.0	45.0
6	53.2	63.4	64.4	70.5	58.3	67.5	49.1	330.2	62.4	75.6	46.0	45.0
7	45.0	58.3	66.4	117.6	63.4	66.4	168.7	1,536.4	58.3	72.6	45.0	45.0
8	42.9	57.2	54.2	166.6	72.6	102.2	233.1	417.1	62.4	63.4	45.0	74.6
9	40.9	55.2	53.2	193.2	97.1	64.4	86.9	278.0	60.3	161.5	45.0	70.5
10	38.8	53.2	49.1	157.4	157.4	83.8	113.5	250.4	59.3	134.9	46.0	50.1
11	37.8	53.2	49.1	117.6	94.0	145.2	75.6	223.9	60.3	81.8	47.0	47.0
12	37.8	52.1	48.0	96.1	88.9	56.2	139.0	222.8	64.4	71.6	47.0	45.0
13	37.8	53.2	47.0	82.8	78.7	60.3	246.4	165.6	64.4	66.4	47.0	46.0
14	37.8	53.2	45.0	80.8	75.6	62.4	180.9	146.2	66.4	63.4	46.0	45.0
15	37.8	53.2	44.0	72.6	62.4	69.5	179.9	138.0	68.5	64.4	46.0	48.0
16	37.8	53.2	44.0	69.5	58.3	63.4	407.9	123.7	59.3	67.5	46.0	95.1
17	37.8	53.2	41.9	70.5	54.2	60.3	330.2	114.5	68.5	61.3	46.0	95.1
18	36.8	53.2	48.0	78.7	53.2	57.2	198.3	107.3	106.3	60.3	45.0	64.4
19	45.0	53.2	45.0	74.6	51.1	59.3	192.2	98.1	69.5	57.2	45.0	55.2
20	45.0	53.2	41.9	71.6	70.5	60.3	260.7	101.2	58.3	56.2	45.0	51.1
21	68.5	54.2	44.0	75.6	83.8	62.4	141.1	95.1	57.2	54.2	45.0	47.0
22	53.2	51.1	44.0	73.6	76.7	56.2	297.5	88.9	77.7	53.2	46.0	47.0
23	47.0	51.1	48.0	68.5	74.6	63.4	120.6	279.1	73.6	52.1	46.0	46.0
24	45.0	54.2	56.2	61.3	84.8	60.3	189.1	91.0	82.8	52.1	47.0	46.0
25	44.0	58.3	51.1	56.2	120.6	54.2	1,102.0	97.1	63.4	52.1	47.0	327.1
26	92.0	56.2	56.2	51.1	84.8	57.2	570.4	81.8	57.2	51.1	47.0	905.7
27	96.1	56.2	94.0	53.2	66.4	100.2	344.5	77.7	55.2	50.1	47.0	222.8
28	68.5	58.3	99.2	57.2	66.4	106.3	269.9	69.5	54.2	49.1	47.0	108.4
29	62.4		88.9	56.2	66.4	81.8	287.2	66.4	54.2	48.0	47.0	91.0
30	56.2		70.5	62.4	65.4	72.6	471.3	74.6	54.2	47.0	47.0	82.8
31	53.2		62.4		62.4		417.1	70.5		47.0		73.6
Average	50.1	55.2	57.0	81.4	79.5	70.3	236.3	223.5	64.6	64.7	46.3	100.1
Maximum	96.1	93.0	99.2	193.2	196.3	145.2	1,102.0	1,536.4	106.3	161.5	47.0	905.7
Minimum	36.8	48.0	41.9	51.1	51.1	54.2	40.9	66.4	54.2	47.0	45.0	45.0

Average annual discharge = 95 (m^3/sec)

Annual inflow volume = 2,987 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1986

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	66.4	38.8	101.2	231.0	188.1	154.4	168.7	842.3	106.3	69.5	56.2	108.4
2	62.4	38.8	100.2	194.2	171.7	124.7	104.3	396.6	101.2	65.4	56.2	108.4
3	58.3	38.8	100.2	188.1	167.6	129.8	98.1	384.8	100.2	62.4	55.2	109.4
4	56.2	38.8	99.2	178.9	154.4	129.8	116.5	1,770.5	97.1	62.4	56.2	112.4
5	54.2	37.8	100.2	192.2	154.4	127.8	119.6	818.8	93.0	66.4	55.2	112.4
6	53.2	37.8	101.2	214.7	164.6	119.6	111.4	486.0	91.0	59.3	55.2	106.3
7	53.2	37.8	102.2	230.0	174.8	115.5	379.3	500.5	85.9	55.2	55.2	103.2
8	53.2	36.8	100.2	236.1	182.0	120.6	163.6	361.9	83.8	56.2	56.2	99.2
9	51.1	37.8	99.2	231.0	312.8	130.8	163.6	361.9	90.0	93.0	56.2	95.1
10	51.1	40.9	101.2	239.2	268.8	140.0	143.1	312.8	113.5	54.2	56.2	91.0
11	50.1	49.1	177.9	253.5	170.7	150.3	142.1	263.7	98.1	77.7	56.2	244.3
12	49.1	53.2	586.8	261.7	188.1	132.9	161.5	231.0	84.8	75.6	57.2	1,136.7
13	47.0	292.2	774.9	240.2	196.3	161.5	103.2	240.2	99.2	64.4	57.2	540.8
14	44.0	144.6	1,536.4	255.6	196.3	157.4	100.2	199.3	86.9	63.4	57.2	257.6
15	40.9	132.5	621.5	226.9	186.0	137.0	111.4	324.0	77.7	92.0	627.7	187.1
16	38.8	117.6	445.7	200.4	179.9	133.9	233.1	213.6	74.6	81.8	317.9	174.8
17	38.8	115.5	404.8	175.8	164.6	120.6	217.7	171.7	71.6	223.9	127.8	161.5
18	37.8	231.0	567.3	174.8	156.4	131.9	502.9	282.1	69.5	117.6	107.3	157.4
19	40.9	130.8	422.2	177.9	167.6	137.0	338.4	203.4	69.5	88.9	95.1	143.1
20	40.9	114.5	335.3	184.0	185.0	124.7	183.0	157.4	68.5	77.7	88.9	132.9
21	39.9	170.7	321.0	185.0	200.4	139.0	154.4	140.0	67.5	72.6	86.9	128.8
22	40.9	180.9	335.3	189.1	170.7	159.5	234.1	133.9	69.5	69.5	84.8	125.7
23	60.3	137.0	265.8	164.9	137.0	172.8	203.4	128.8	67.5	66.4	83.8	121.6
24	47.0	127.8	226.9	225.4	127.8	187.1	176.8	125.7	84.8	62.4	80.8	119.6
25	45.0	120.6	200.4	483.1	126.8	289.3	170.7	167.6	63.4	60.3	79.7	117.6
26	44.0	115.5	186.0	760.8	126.8	210.6	169.7	167.6	79.7	57.2	196.3	116.5
27	42.9	110.4	229.0	755.4	121.6	202.8	728.9	233.1	71.6	55.2	330.2	111.4
28	40.9	105.3	300.5	347.6	139.0	128.8	463.1	130.8	125.7	56.2	152.3	108.4
29	39.9		249.4	249.4	174.8	159.5	224.9	116.5	128.8	56.2	127.8	104.3
30	39.9		219.8	219.8	150.3	216.7	399.7	116.5	106.3	55.2	115.5	102.2
31	38.8		206.5		165.6		500.5	114.5		56.2		95.1
Average	47.3	101.2	310.3	262.2	173.2	151.5	228.6	325.7	87.6	73.4	116.3	175.3
Maximum	66.4	292.2	1,536.4	760.8	312.8	289.3	728.9	1,770.5	128.8	223.9	627.7	1,136.7
Minimum	37.8	36.8	99.2	164.9	121.6	115.5	98.1	114.5	63.4	54.2	55.2	91.0

Average annual discharge = 172 (m^3/sec)

Annual inflow volume = 5,418 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1987

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	80.8	61.3	105.3	179.9	155.4	196.3	102.2	97.1	123.7	34.7	42.9	34.8
2	77.7	60.3	101.2	222.8	129.8	195.2	104.3	91.0	66.4	37.9	41.9	34.8
3	77.7	60.3	95.1	261.7	112.4	268.8	100.2	78.7	57.2	50.9	42.9	35.8
4	77.7	58.3	99.2	234.1	102.2	278.0	99.2	208.5	56.2	41.9	41.9	35.8
5	82.8	56.2	104.3	178.9	106.3	208.5	104.3	199.3	71.6	37.0	41.9	35.8
6	80.8	56.2	82.8	166.6	147.2	206.5	123.7	100.2	57.2	35.0	41.9	34.8
7	77.7	56.2	139.0	163.6	116.5	191.2	123.7	114.5	65.4	34.1	40.9	34.8
8	76.7	57.2	169.7	164.6	300.5	206.5	106.3	95.1	59.3	34.1	41.9	34.8
9	75.6	60.3	134.9	344.5	263.7	414.0	104.3	105.3	127.8	33.8	41.9	34.8
10	75.6	57.2	116.5	211.6	396.6	338.4	103.2	98.1	112.4	244.7	40.9	34.8
11	74.6	54.2	106.3	165.6	247.4	207.5	112.4	104.3	83.8	173.6	40.9	34.8
12	74.6	54.2	110.4	152.3	201.4	171.7	112.4	147.2	61.3	214.1	39.9	34.8
13	74.6	55.2	116.5	134.9	180.9	147.2	101.2	158.4	56.2	151.3	38.8	34.8
14	73.6	55.2	105.3	121.6	169.7	147.2	91.0	108.4	55.2	146.1	38.8	33.7
15	72.6	56.2	107.3	121.6	157.4	155.4	88.9	95.1	54.2	102.1	37.8	33.7
16	71.6	56.2	200.4	119.6	154.4	144.1	145.2	90.0	56.2	80.4	37.8	33.7
17	74.6	159.5	154.4	121.6	145.2	124.7	102.2	93.0	50.1	66.8	37.8	33.7
18	72.6	123.7	124.7	134.9	144.1	114.5	111.4	167.6	48.0	140.3	36.8	33.7
19	68.5	134.9	121.6	132.9	152.3	112.4	97.1	90.0	47.0	141.2	36.8	32.7
20	68.5	68.5	120.6	134.9	172.8	119.6	100.2	124.7	47.0	100.7	35.8	32.7
21	66.4	65.4	199.3	147.2	213.2	126.8	92.0	238.2	47.0	81.3	35.8	32.7
22	66.4	68.5	373.1	155.4	283.5	107.3	99.2	167.6	56.2	72.6	35.8	32.7
23	64.4	71.6	414.0	161.5	821.6	104.3	110.4	140.0	51.1	64.2	35.8	32.7
24	64.4	379.3	275.0	158.4	402.1	106.3	138.0	215.7	46.0	62.5	35.8	32.7
25	64.4	314.8	230.0	124.7	256.0	104.3	154.4	122.7	42.9	58.1	35.8	31.7
26	64.4	137.0	445.7	123.7	239.8	103.2	244.3	79.7	40.9	55.0	35.8	31.7
27	64.4	133.9	288.3	123.7	218.8	104.3	124.7	72.6	38.8	52.7	34.8	31.7
28	64.4	114.5	147.2	130.8	215.7	104.3	101.2	90.0	37.8	48.3	34.8	31.7
29	64.4		207.5	146.2	198.3	105.3	92.0	97.1	36.8	47.4	34.8	31.7
30	64.4		185.0	161.5	193.2	103.2	92.0	72.6	35.8	46.0	34.8	31.7
31	63.4		171.7		192.2		117.6	107.3		45.1		32.7
Average	71.6	95.9	172.7	163.4	219.1	167.2	112.9	121.6	59.7	81.7	38.5	33.6
Maximum	82.8	379.3	445.7	344.5	821.6	414.0	244.3	238.2	127.8	244.7	42.9	35.8
Minimum	63.4	54.2	82.8	119.6	102.2	103.2	88.9	72.6	35.8	33.8	34.8	31.7

Average annual discharge = 112 (m^3/sec)

Annual inflow volume = 3,522 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1988

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	32.7	35.0	84.4	196.7	118.6	83.9	114.0	1,356.8	105.3	85.4	46.0	43.1
2	32.7	34.8	80.1	177.7	101.0	79.2	112.2	720.3	93.1	80.8	78.1	43.1
3	32.4	34.4	86.0	145.5	82.2	55.8	198.7	598.8	95.2	77.0	45.7	42.8
4	32.4	34.8	91.4	127.3	78.7	52.3	267.6	497.6	92.3	95.5	45.7	42.8
5	32.1	35.0	102.7	114.0	76.7	49.5	184.3	419.5	86.2	80.8	45.7	42.8
6	32.1	35.0	108.2	106.4	80.1	44.6	157.6	373.2	84.4	74.6	45.7	42.5
7	31.8	35.0	203.6	114.0	75.2	44.0	100.1	335.6	83.9	73.2	45.7	41.9
8	31.8	34.8	145.5	119.2	63.4	35.6	62.2	529.4	97.5	71.1	46.0	41.4
9	31.5	44.6	103.6	126.8	59.0	35.6	49.2	596.0	119.5	70.3	45.7	40.8
10	31.3	38.2	89.3	122.7	70.3	39.4	53.8	335.6	92.3	71.1	46.0	40.2
11	31.3	36.5	1,119.6	116.8	77.5	39.4	115.7	361.7	87.1	70.6	45.7	40.2
12	31.8	36.5	1,067.5	130.7	81.3	38.7	71.8	274.3	83.9	68.6	45.7	39.9
13	32.1	34.8	318.2	134.8	79.2	39.1	740.6	422.4	82.5	67.2	45.7	39.6
14	33.0	34.4	205.4	142.6	82.2	39.6	714.5	280.3	80.5	66.2	45.4	38.8
15	31.8	34.8	167.7	143.2	69.1	44.0	1,649.0	526.5	118.1	65.4	45.1	38.2
16	31.5	33.5	233.2	141.8	70.0	46.9	3,500.5	289.3	142.1	64.2	44.9	37.6
17	31.0	33.2	220.2	127.3	70.6	47.2	943.1	303.8	97.5	64.2	44.9	37.3
18	30.7	32.4	221.0	141.2	63.7	68.6	569.9	306.7	81.0	63.1	44.9	38.2
19	30.1	32.4	181.1	167.7	57.6	54.4	564.2	283.8	75.2	61.6	44.6	40.2
20	29.7	33.0	170.1	172.1	59.0	59.0	1,249.8	244.5	74.9	60.2	44.3	45.7
21	31.0	70.6	162.8	122.7	63.7	62.8	685.6	256.6	72.4	95.2	44.3	45.1
22	51.5	58.5	166.3	114.6	66.5	79.6	1,044.3	229.7	81.0	56.7	44.6	117.5
23	40.5	45.7	173.0	112.2	63.9	73.5	792.6	215.3	69.7	55.3	44.3	215.2
24	35.0	37.9	177.7	101.0	62.2	71.2	729.1	200.8	235.5	54.1	44.3	89.4
25	34.1	42.5	173.6	96.1	62.2	68.9	480.2	309.5	480.2	53.0	44.3	67.7
26	33.5	41.7	419.5	103.6	64.2	74.9	381.9	187.5	188.0	52.0	44.3	60.2
27	33.2	48.0	249.1	105.9	70.6	131.3	451.3	191.0	129.6	50.6	44.3	50.3
28	33.8	309.5	208.0	115.1	68.6	96.6	509.2	159.7	107.3	49.8	44.3	41.9
29	37.3	119.8	216.7	126.1	70.0	500.5	1,669.2	140.0	99.3	48.6	44.3	37.3
30	35.6		232.3	116.8	69.1	151.6	564.1	130.1	96.3	47.7	44.0	35.0
31	35.9		229.7		67.7		1,342.3	118.6		46.6		35.0
Average	33.4	50.9	239.0	129.4	72.4	76.9	647.4	361.1	114.4	65.8	46.1	52.0
Maximum	51.5	309.5	1,119.6	196.7	118.6	500.5	3,500.5	1,356.8	480.2	95.5	78.1	215.2
Minimum	29.7	32.4	80.1	96.1	57.6	35.6	49.2	118.6	69.7	46.6	44.0	35.0

Average annual discharge = 159 (m^3/sec)

Annual inflow volume = 5,019 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1989

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	33.9	46.0	62.4	605.0	90.2	98.0	117.3	662.8	107.3	55.1	41.1	37.6
2	39.4	41.2	62.6	306.7	132.4	100.8	140.1	487.6	108.2	53.4	40.6	36.1
3	42.7	41.6	61.2	235.3	197.1	107.0	91.1	311.6	102.4	51.8	40.1	34.8
4	38.4	43.5	58.5	198.8	174.7	107.8	84.0	217.9	91.1	51.3	46.3	33.8
5	48.2	49.7	61.2	171.4	122.4	163.7	117.3	254.9	88.4	51.5	109.6	32.9
6	407.8	55.3	62.5	152.4	104.4	117.0	118.4	198.9	90.6	50.9	61.0	32.0
7	158.3	48.4	63.2	151.0	94.7	100.4	89.4	160.6	86.0	50.4	47.7	31.2
8	116.3	45.5	68.6	149.0	95.7	87.5	71.7	151.1	78.3	48.4	44.6	30.3
9	102.8	44.9	74.8	274.9	94.9	92.4	84.0	226.0	76.0	46.5	43.0	30.9
10	88.1	44.4	86.7	285.4	103.8	87.5	59.9	127.9	75.3	44.8	42.5	31.6
11	79.8	43.9	76.9	179.4	106.4	101.1	84.0	142.7	74.3	43.0	42.1	35.6
12	75.5	43.8	77.1	157.6	108.2	96.6	51.9	165.9	95.6	114.6	41.9	36.0
13	72.2	44.4	76.2	143.8	113.8	101.8	130.3	165.5	80.3	177.5	41.1	34.6
14	70.2	44.3	80.6	142.0	120.2	101.3	163.5	140.6	87.6	79.3	40.3	34.2
15	68.8	44.5	104.0	139.1	122.2	87.7	347.9	124.5	79.3	55.8	40.0	34.2
16	67.4	45.5	82.6	128.7	119.5	94.9	176.5	134.8	81.7	50.3	40.0	34.7
17	65.4	48.9	81.6	135.3	119.9	88.9	102.0	131.6	77.1	48.4	39.9	35.1
18	65.4	55.0	119.6	132.9	120.4	80.9	92.2	142.4	76.2	48.0	40.2	35.4
19	63.7	50.7	140.5	129.6	119.6	79.1	92.2	164.2	88.7	47.7	40.7	36.5
20	62.4	47.9	160.0	125.5	121.6	72.4	104.5	361.0	101.3	46.8	40.4	44.9
21	61.3	45.7	128.0	124.3	124.2	70.7	69.8	189.2	97.2	46.2	39.8	69.2
22	60.3	44.1	482.2	113.4	121.4	68.7	54.1	146.7	111.3	45.6	39.4	53.2
23	59.5	41.8	471.3	113.9	107.3	65.4	82.7	174.3	129.0	45.0	39.2	77.7
24	58.7	39.8	249.0	117.9	100.9	69.1	190.7	137.8	114.4	44.6	49.8	74.9
25	56.5	45.9	212.8	165.7	89.2	70.2	162.2	160.1	78.9	44.2	60.1	61.0
26	56.0	48.7	190.7	153.7	79.9	82.5	118.6	119.8	63.8	43.6	47.2	56.6
27	55.8	53.6	230.4	122.3	87.2	89.9	103.1	251.5	60.4	42.8	40.8	52.1
28	55.7	61.2	229.8	104.9	97.5	96.1	99.7	229.8	57.0	42.2	40.0	50.9
29	54.0		211.6	108.8	107.7	88.7	1,493.4	148.9	57.6	41.9	39.5	51.1
30	52.3		185.8	105.6	100.3	116.9	1,782.1	126.3	56.9	41.7	38.8	51.8
31	51.1		259.3		86.5		2,120.5	113.5		41.4		52.0
Average	77.0	46.8	145.5	172.5	112.4	92.8	277.3	202.3	85.7	54.7	45.2	43.3
Maximum	407.8	61.2	482.2	605.0	197.1	163.7	2,120.5	662.8	129.0	177.5	109.6	77.7
Minimum	33.9	39.8	58.5	104.9	79.9	65.4	51.9	113.5	56.9	41.4	38.8	30.3

Average annual discharge = 114 (m^3/sec)

Annual inflow volume = 3,584 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1990

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	51.5	56.2	146.2	215.1	126.3	110.8	195.5	101.8	168.3	72.6	38.7	24.0
2	50.9	49.4	118.3	202.9	129.3	102.9	116.5	782.8	145.5	61.1	40.4	25.0
3	50.9	43.3	102.0	193.2	128.7	103.8	145.0	144.9	137.0	58.5	38.2	25.8
4	51.7	40.1	93.2	190.2	127.2	102.7	481.8	282.9	176.5	55.5	36.6	25.8
5	52.8	38.3	86.1	194.9	141.0	95.0	163.9	315.2	256.1	51.7	35.3	25.8
6	53.3	40.3	82.6	262.3	122.9	85.8	191.9	281.0	190.4	49.6	33.9	25.8
7	57.0	81.8	77.5	453.2	128.9	77.7	349.2	249.6	149.5	48.6	32.5	25.7
8	54.9	306.0	76.6	320.3	136.3	79.0	147.3	444.7	162.5	47.0	31.3	25.6
9	53.0	227.2	78.9	218.0	145.9	84.4	358.5	1,133.7	100.7	46.3	30.3	25.5
10	51.7	125.2	115.6	184.8	154.7	75.5	184.5	541.9	103.5	45.3	29.2	25.6
11	50.5	94.4	317.4	161.9	139.3	75.2	118.5	359.1	94.1	44.0	28.3	25.5
12	49.7	80.9	143.9	148.6	157.9	112.9	97.2	271.2	89.0	43.1	28.0	25.5
13	48.6	177.9	109.3	157.8	149.6	133.3	94.4	318.2	123.4	49.7	27.5	25.2
14	48.6	212.5	121.9	167.7	150.7	81.4	83.4	377.9	149.7	43.8	27.3	25.9
15	47.5	115.0	131.6	145.7	171.8	88.6	107.8	239.4	110.2	42.0	27.0	55.9
16	46.0	97.9	147.6	144.9	190.0	71.0	137.3	206.6	108.2	40.9	26.7	145.2
17	46.0	86.0	463.1	176.5	161.4	71.3	154.9	189.8	89.3	51.1	26.5	118.2
18	54.9	73.2	427.4	183.7	168.6	72.8	115.7	174.3	84.0	131.6	26.3	61.6
19	49.1	66.1	434.3	170.2	176.3	82.0	125.0	159.6	187.5	55.8	26.1	44.6
20	43.9	62.5	787.9	148.9	141.3	98.1	223.6	124.9	99.9	45.9	25.9	40.5
21	44.2	61.1	1,301.3	148.2	125.3	92.3	154.4	115.5	84.9	43.6	25.6	38.2
22	47.4	56.0	2,004.6	134.4	115.2	92.8	117.4	114.8	90.2	42.8	36.1	38.2
23	46.4	53.1	768.7	138.6	122.5	104.2	83.3	144.0	84.2	42.5	28.9	37.3
24	46.3	88.2	471.5	151.2	139.6	147.0	95.6	117.0	98.4	42.7	27.6	43.8
25	43.4	157.9	392.9	161.3	150.8	370.8	80.2	104.8	87.8	42.4	26.7	43.4
26	41.3	234.0	330.0	168.5	150.8	127.2	284.7	102.2	70.7	41.9	25.6	39.5
27	137.5	217.2	294.0	164.1	154.1	107.0	271.2	98.6	68.7	41.6	24.7	40.9
28	122.4	181.8	270.3	149.8	149.3	138.1	127.7	178.4	63.5	41.2	24.0	946.7
29	66.2		272.0	141.0	150.1	104.4	78.9	379.4	75.4	41.0	23.8	2,330.7
30	57.1		309.7	133.0	139.5	157.4	110.5	313.7	72.2	40.5	23.1	541.0
31	53.2		238.9		138.4		120.3	242.8		40.2		265.6
Average	55.4	111.6	345.7	184.4	144.6	108.2	165.0	277.8	117.4	49.8	29.4	167.3
Maximum	137.5	306.0	2,004.6	453.2	190.0	370.8	481.8	1,133.7	256.1	131.6	40.4	2,330.7
Minimum	41.3	38.3	76.6	133.0	115.2	71.0	78.9	98.6	63.5	40.2	23.1	24.0

Average annual discharge = 147 (m^3/sec)

Annual inflow volume = 4,638 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1991

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	188.0	87.8	131.3	292.3	179.8	72.6	74.7	110.0	235.3	65.6	37.0	25.1
2	165.0	94.3	157.5	417.0	182.8	82.9	74.5	89.6	197.5	64.1	36.2	25.1
3	148.9	103.6	162.5	452.6	168.0	97.2	91.6	84.0	157.5	62.2	35.6	25.1
4	137.7	115.4	754.4	309.0	150.6	92.6	83.9	108.9	147.9	61.4	35.0	25.1
5	127.6	117.6	412.2	287.7	147.4	95.7	78.9	163.0	213.5	59.9	34.4	25.0
6	123.0	129.1	277.6	294.2	147.5	101.6	149.9	96.6	191.9	58.8	33.9	24.9
7	118.2	136.8	241.9	274.7	161.0	99.4	103.0	88.4	98.2	57.8	33.9	24.8
8	115.3	129.6	324.3	489.5	153.2	100.9	96.4	111.9	86.1	56.2	33.9	24.7
9	110.0	140.0	294.2	883.7	129.2	104.3	105.8	93.9	78.1	54.5	33.8	24.6
10	104.3	398.7	215.6	549.6	121.4	134.1	124.3	112.7	75.7	53.5	33.7	24.6
11	97.7	671.7	201.0	343.4	93.1	150.3	183.6	98.1	123.7	50.0	33.6	24.4
12	97.0	706.3	213.5	305.5	77.4	112.9	222.1	77.8	113.7	51.8	33.3	24.4
13	87.1	272.1	223.0	406.7	75.5	113.8	253.1	72.4	109.8	51.0	32.7	24.2
14	77.5	217.7	210.3	1,217.4	85.7	114.6	463.2	69.1	336.6	47.2	32.0	24.1
15	70.6	249.6	202.9	674.6	95.1	156.7	271.8	67.0	445.8	47.5	31.3	24.0
16	65.2	166.1	202.4	368.2	106.0	153.8	172.4	63.4	469.6	48.8	30.5	23.8
17	61.1	146.2	200.3	300.3	108.9	150.1	121.0	98.7	404.7	48.8	29.7	23.7
18	57.6	134.0	267.3	257.8	114.0	166.9	130.3	94.7	199.2	48.8	28.9	23.6
19	54.8	126.3	385.3	236.0	119.1	215.8	148.8	91.9	159.7	48.7	28.4	24.0
20	52.4	121.0	235.2	217.5	144.1	156.7	266.4	102.6	139.1	48.7	27.1	24.4
21	49.9	114.8	232.6	206.6	191.0	142.8	425.4	99.9	114.8	48.6	26.7	37.5
22	48.7	113.2	261.2	194.1	170.0	110.2	284.8	84.4	127.2	46.2	26.3	108.7
23	45.8	114.1	345.6	212.4	137.0	123.4	188.6	182.6	105.7	48.1	25.8	46.8
24	43.0	124.4	250.8	180.4	125.5	103.0	129.8	104.6	81.6	47.5	25.6	41.4
25	40.7	250.2	210.8	176.2	129.7	101.5	225.0	99.4	76.3	45.4	25.6	39.0
26	58.9	203.3	210.3	174.0	112.1	94.1	114.7	97.8	132.9	41.8	25.5	39.2
27	124.2	177.4	222.5	171.3	85.6	87.7	104.4	102.2	92.1	40.5	25.3	39.7
28	126.4	174.2	237.7	155.2	83.3	85.2	94.2	282.4	79.3	39.8	25.2	42.0
29	128.6		256.3	168.1	78.7	81.1	113.1	408.5	74.3	39.0	25.1	41.9
30	84.7		274.6	167.9	71.7	74.8	155.5	308.6	68.0	38.4	25.1	37.6
31	83.9		284.8		64.9		118.0	272.6		37.6		31.5
Average	93.4	197.7	261.3	346.1	122.9	115.9	166.7	127.0	164.5	50.3	30.4	32.1
Maximum	188.0	706.3	754.4	1,217.4	191.0	215.8	463.2	408.5	469.6	65.6	37.0	108.7
Minimum	40.7	87.8	131.3	155.2	64.9	72.6	74.5	63.4	68.0	37.6	25.1	23.6

Average annual discharge = 142 (m^3/sec)

Annual inflow volume = 4,467 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1992

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	35.8	225.0	109.4	284.1	259.4	141.7	155.2	149.4	365.7	260.5	196.9	143.0
2	28.0	152.5	89.0	273.2	247.2	156.0	150.4	200.4	517.2	256.1	192.7	143.5
3	27.1	130.6	82.3	268.0	363.4	186.9	161.8	944.5	461.3	250.2	188.6	143.5
4	26.0	115.0	70.7	263.6	297.1	161.2	162.6	321.0	325.8	240.8	184.5	143.2
5	25.3	103.7	63.6	277.7	249.2	148.3	140.2	336.3	312.7	231.8	180.5	142.5
6	26.1	137.8	60.5	431.9	219.9	163.0	132.7	408.1	365.1	233.1	177.5	142.4
7	33.1	239.9	46.7	852.4	220.0	157.6	134.8	223.2	356.3	234.6	173.1	142.7
8	44.5	139.8	56.3	300.9	228.9	158.4	151.0	237.3	310.6	225.7	169.4	142.9
9	34.6	125.6	57.7	288.0	227.3	149.9	153.3	548.0	5,469.4	220.9	166.6	142.9
10	31.9	115.5	57.3	751.6	215.1	149.2	150.6	324.2	6,696.7	216.7	163.9	143.1
11	46.2	108.9	59.6	274.8	214.9	186.4	206.4	253.1	1,391.0	216.6	160.6	143.5
12	43.2	104.6	64.8	258.9	224.7	172.3	161.5	232.7	887.4	212.4	157.1	148.6
13	37.6	509.1	131.1	258.7	244.5	165.0	149.0	212.8	770.4	210.6	154.4	153.8
14	34.4	245.2	133.8	250.5	247.7	149.9	192.4	267.3	718.4	210.2	152.3	149.5
15	31.4	181.3	86.2	248.5	246.9	157.1	166.2	277.6	674.3	209.9	150.1	147.9
16	35.1	157.5	75.2	248.2	242.3	152.7	157.4	861.3	565.9	209.2	148.1	146.9
17	27.0	144.5	72.1	246.6	238.9	154.9	195.9	830.2	581.9	207.0	145.9	146.9
18	25.7	137.9	83.4	312.3	208.2	140.1	230.7	478.4	492.3	205.8	143.6	147.3
19	26.0	129.9	93.9	236.3	183.7	143.3	185.4	423.7	457.9	407.4	176.2	147.8
20	25.6	118.1	104.7	255.6	170.2	148.4	219.8	377.7	428.6	250.7	304.6	148.3
21	25.6	105.4	119.1	688.8	169.5	168.2	214.3	384.7	407.7	219.4	185.7	148.8
22	25.4	95.9	173.5	408.8	161.4	137.7	217.8	400.2	385.8	211.8	153.8	149.2
23	27.6	90.8	1,190.6	265.6	180.3	131.7	162.0	285.7	367.1	207.5	149.9	149.0
24	31.6	84.7	654.6	266.5	191.2	138.7	279.6	280.5	349.1	204.1	149.0	148.3
25	42.6	79.1	932.6	274.7	193.7	125.4	360.1	335.8	329.6	202.2	145.7	147.8
26	57.0	77.2	1,537.1	274.5	245.8	123.2	271.5	333.2	314.6	201.5	145.1	147.3
27	160.1	77.4	994.3	273.5	266.2	130.8	154.0	270.3	302.3	201.2	145.5	146.9
28	262.0	78.0	451.8	277.7	210.5	139.8	153.4	259.6	289.9	200.5	145.3	146.4
29	586.7	134.0	517.6	354.6	177.2	178.8	246.2	248.6	276.4	200.1	143.8	145.9
30	1,350.2		328.6	306.5	167.4	144.3	204.9	363.0	266.2	200.3	142.8	145.2
31	357.5		291.6		153.8		180.1	479.3		200.9		187.0
Average	115.2	142.9	283.5	332.4	221.5	152.0	187.1	372.5	847.9	224.5	166.4	147.5
Maximum	1,350.2	509.1	1,537.1	852.4	363.4	186.9	360.1	944.5	6,696.7	407.4	304.6	187.0
Minimum	25.3	77.2	46.7	236.3	153.8	123.2	132.7	149.4	266.2	200.1	142.8	142.4

Average annual discharge = 266 (m^3/sec)

Annual inflow volume = 8,400 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1993

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	249.8	83.3	117.0	159.0	205.1	205.2	199.7	199.3	246.5	47.4	31.2	28.4
2	186.7	82.2	106.6	153.8	220.6	141.5	169.1	155.0	176.7	46.5	30.7	28.4
3	187.6	80.2	104.3	147.3	202.0	193.5	124.6	242.7	214.7	45.6	30.2	28.3
4	180.6	80.4	99.7	146.3	188.2	154.6	129.1	183.4	131.1	44.6	29.6	27.8
5	144.3	75.7	100.4	153.4	189.4	138.0	226.5	147.7	102.7	43.7	27.9	27.5
6	180.4	74.3	101.7	165.0	188.8	139.7	172.1	162.9	121.4	42.2	211.1	27.2
7	187.9	79.1	100.0	175.6	192.9	142.1	172.6	209.4	124.5	40.4	137.7	26.9
8	187.9	89.8	99.0	172.9	184.9	148.5	368.0	123.0	182.0	39.3	48.9	26.7
9	176.3	85.7	102.3	175.2	199.3	151.7	434.5	116.7	182.7	38.5	90.8	26.3
10	144.5	80.8	109.2	194.3	234.2	147.2	826.6	162.6	145.7	38.1	39.9	25.9
11	143.9	76.5	302.4	211.2	199.8	157.7	592.4	142.9	197.4	38.0	33.7	26.1
12	140.4	76.1	600.1	226.8	155.1	162.4	427.1	147.6	120.2	38.1	33.4	26.1
13	141.3	73.4	372.7	219.6	140.4	163.6	242.8	120.4	149.2	38.2	33.0	26.0
14	132.7	67.1	254.4	226.9	139.1	171.4	192.1	111.9	83.5	38.4	31.0	26.1
15	125.0	65.7	217.9	238.2	139.5	175.7	263.8	198.2	70.4	38.7	29.7	26.2
16	154.7	73.0	183.4	188.0	178.7	183.1	322.5	124.7	63.6	37.8	30.4	26.1
17	272.2	146.7	164.6	189.9	156.8	202.6	161.2	137.6	61.0	36.8	31.0	26.1
18	179.2	109.9	162.1	192.9	147.5	200.5	300.6	110.3	59.4	35.9	31.5	26.0
19	149.1	92.7	145.2	193.3	126.3	195.9	184.6	92.6	56.3	35.1	46.2	25.9
20	131.8	91.6	133.7	193.1	116.8	142.7	144.0	197.0	53.5	34.1	35.4	25.7
21	124.6	76.3	132.3	195.1	114.4	140.3	150.1	111.9	52.8	33.1	32.3	25.9
22	116.7	71.0	126.2	198.7	133.2	156.4	317.0	75.5	54.1	32.1	31.3	26.1
23	112.8	69.5	480.9	197.2	147.8	199.0	645.7	68.0	106.2	31.1	30.8	26.3
24	107.7	66.5	1,769.5	198.6	143.5	491.4	633.3	88.2	112.7	30.2	30.4	26.4
25	104.8	147.6	502.9	204.1	149.7	358.3	1,126.5	84.7	62.1	29.3	30.0	26.5
26	101.9	259.8	246.3	215.4	153.5	234.0	447.6	76.2	57.3	29.9	29.7	26.6
27	97.8	159.6	176.1	203.2	151.6	182.4	315.1	89.7	54.9	30.5	29.5	26.6
28	95.8	137.4	207.4	217.8	147.0	145.4	266.0	74.4	52.6	31.1	29.1	26.7
29	93.8		197.6	211.0	173.6	129.5	225.8	65.7	51.9	31.7	28.9	26.6
30	91.6		188.2	216.4	170.8	117.6	247.4	63.8	49.6	32.4	28.6	26.5
31	88.8		175.8		144.1		219.9	165.1		31.9		26.6
Average	146.2	95.4	251.0	192.7	165.6	182.4	330.6	130.6	106.5	36.8	43.8	26.6
Maximum	272.2	259.8	1,769.5	238.2	234.2	491.4	1,126.5	242.7	246.5	47.4	211.1	28.4
Minimum	88.8	65.7	99.0	146.3	114.4	117.6	124.6	63.8	49.6	29.3	27.9	25.7

Average annual discharge = 143 (m^3/sec)

Annual inflow volume = 4,505 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1994

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.5	34.6	66.3	121.3	136.9	116.0	533.4	327.5	465.5	79.8	51.8	41.4
2	26.3	31.3	64.0	82.3	173.1	100.2	175.6	282.1	445.5	47.7	49.0	42.8
3	26.1	27.8	64.6	72.6	151.4	90.1	834.4	243.2	215.2	48.2	48.3	44.4
4	25.9	25.8	85.4	264.6	136.2	82.4	337.6	388.5	290.6	82.4	47.8	51.9
5	25.8	24.6	79.8	965.1	124.1	73.9	176.6	325.4	373.9	85.8	47.5	60.2
6	25.7	37.1	77.9	1,010.7	127.1	70.8	145.1	339.0	336.9	90.4	47.0	120.3
7	25.7	45.8	79.2	348.2	128.5	75.1	893.9	1,213.4	261.5	85.1	46.6	153.3
8	25.5	37.2	82.6	202.3	207.8	94.5	286.5	404.0	209.1	79.1	46.5	577.5
9	25.3	41.2	83.7	184.0	283.5	104.3	244.9	279.2	206.2	75.8	45.9	205.4
10	25.0	37.2	84.0	160.6	162.5	166.9	674.5	624.9	209.7	72.7	45.4	121.2
11	26.0	36.4	79.8	143.4	203.9	137.1	353.7	298.7	240.6	69.6	44.9	84.0
12	27.9	35.0	75.9	130.9	142.0	170.8	241.9	259.4	215.6	66.4	44.3	78.7
13	47.6	33.2	65.4	126.0	126.0	167.7	212.7	223.2	219.0	63.4	43.7	73.7
14	44.4	33.8	75.1	106.8	144.9	112.1	387.7	653.3	210.1	60.7	43.1	68.9
15	44.6	34.7	101.1	144.1	195.3	96.5	247.4	313.2	204.9	57.5	42.5	71.3
16	43.2	35.9	72.1	108.7	134.8	84.8	168.6	323.6	188.6	54.2	41.8	64.0
17	42.7	37.0	55.7	105.3	121.5	91.0	211.8	1,230.7	179.9	52.7	41.3	59.7
18	42.1	38.3	52.8	102.4	119.5	93.6	697.1	516.4	171.8	51.8	40.1	61.4
19	41.4	40.0	59.1	103.4	125.1	97.1	187.8	365.7	159.5	51.0	38.8	62.4
20	41.9	45.3	188.9	95.7	128.7	123.3	1,320.3	348.9	145.5	49.8	38.1	63.3
21	37.4	542.5	105.0	83.0	123.8	124.9	361.5	475.3	123.8	48.6	37.5	64.5
22	33.6	178.6	83.6	87.1	125.2	116.4	1,183.9	602.6	105.4	47.6	37.0	70.2
23	29.1	110.5	72.2	88.8	147.3	148.3	698.2	582.3	93.4	46.6	36.4	82.1
24	26.4	97.0	68.1	82.9	127.0	140.5	1,245.1	359.8	81.0	44.3	35.9	100.2
25	25.4	93.3	75.4	69.5	126.5	234.8	251.0	328.7	80.8	70.6	34.5	108.9
26	28.6	85.1	83.6	82.2	122.7	418.5	216.9	652.5	80.9	152.9	34.9	94.7
27	99.7	74.0	84.6	90.8	127.2	175.5	226.6	371.2	79.5	122.8	34.2	156.2
28	79.1	67.5	83.8	93.7	126.3	156.4	868.4	327.6	78.5	103.1	35.5	329.7
29	50.9		76.9	127.0	128.9	134.9	388.2	301.1	78.6	86.6	38.7	174.7
30	44.0		77.4	148.9	126.2	282.7	1,115.0	293.7	79.3	75.6	40.0	106.6
31	38.7		150.5		116.9		471.4	287.1		64.0		98.2
Average	37.2	70.0	82.4	184.4	144.2	136.0	495.4	436.9	194.4	70.5	42.0	112.6
Maximum	99.7	542.5	188.9	1,010.7	283.5	418.5	1,320.3	1,230.7	465.5	152.9	51.8	577.5
Minimum	25.0	24.6	52.8	69.5	116.9	70.8	145.1	223.2	78.5	44.3	34.2	41.4

Average annual discharge = 168 (m^3/sec)

Annual inflow volume = 5,307 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1995

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	87.9	65.6	149.2	224.7	166.9	111.2	120.7	721.2	247.0	62.5	35.6	46.5
2	92.3	65.7	147.3	196.1	153.3	113.5	95.2	735.2	200.7	61.9	35.3	40.7
3	87.2	66.3	142.6	184.3	149.6	111.5	115.5	586.3	174.1	69.8	35.0	38.3
4	83.5	67.7	143.9	162.7	141.1	113.5	116.8	701.1	140.8	66.4	33.9	37.1
5	82.4	67.4	149.1	153.2	147.7	117.6	130.0	572.7	125.4	53.7	32.8	35.3
6	81.1	66.8	148.2	145.9	138.5	123.3	144.7	486.5	120.9	52.3	32.4	33.4
7	78.1	66.5	147.4	149.0	147.7	138.4	130.9	421.0	120.8	51.4	32.3	31.1
8	76.0	66.2	137.7	145.3	148.9	134.0	189.7	339.8	121.6	50.5	32.1	32.9
9	73.3	66.0	127.0	186.0	154.4	132.9	206.1	288.4	156.1	50.0	31.8	46.0
10	80.0	66.6	125.1	261.4	163.0	136.2	156.6	334.7	129.2	49.7	31.7	45.8
11	78.0	271.6	123.6	194.4	165.8	122.3	165.6	243.1	125.6	45.3	31.5	38.5
12	73.4	435.4	116.6	251.0	167.2	125.1	129.2	223.0	124.2	34.3	31.4	37.4
13	66.2	141.5	106.2	210.7	166.1	124.1	120.6	252.4	116.0	34.0	31.2	37.9
14	66.8	184.9	112.3	207.5	165.1	123.1	130.2	305.4	100.7	34.2	31.0	38.0
15	71.2	251.4	106.5	242.3	162.0	122.1	143.6	278.3	98.6	43.1	30.5	37.4
16	72.9	166.9	106.4	299.9	149.5	131.2	168.6	241.5	92.0	68.1	30.3	37.5
17	70.0	147.7	106.4	248.8	137.1	139.1	215.0	252.8	74.3	51.7	29.6	37.4
18	66.6	185.3	106.5	231.2	148.9	145.7	203.7	227.6	72.5	54.7	29.1	36.6
19	67.5	138.2	120.1	231.3	136.5	205.2	459.3	222.1	68.7	43.7	28.8	36.0
20	70.9	138.5	134.5	217.9	123.5	210.7	450.6	578.3	67.2	43.1	28.6	35.5
21	71.3	134.1	154.7	220.6	119.5	281.0	338.7	430.2	65.8	42.6	28.6	34.7
22	67.8	112.3	160.3	225.1	129.9	210.3	479.6	367.1	65.1	42.2	28.2	34.0
23	67.8	99.4	223.1	233.5	131.4	157.4	661.7	250.8	64.4	41.8	27.8	33.4
24	68.7	97.7	243.1	252.8	118.1	136.9	598.0	305.6	90.9	41.3	27.4	32.9
25	66.9	100.0	205.4	241.0	111.5	108.6	1,094.8	202.8	72.6	40.8	28.7	32.3
26	65.8	100.1	411.9	243.0	113.5	104.9	1,575.3	190.7	63.8	40.1	30.1	31.8
27	65.0	216.6	249.5	243.9	111.6	98.0	1,789.9	248.5	63.9	39.0	31.5	31.3
28	65.3	186.9	445.0	217.1	111.9	109.2	2,468.7	228.1	63.8	38.0	37.3	31.8
29	64.0		463.7	201.9	113.2	106.9	1,235.9	253.5	63.8	37.1	70.7	30.2
30	64.4		313.3	180.8	109.7	116.2	804.4	271.4	63.1	36.4	54.8	29.7
31	65.8		260.3		109.2		701.3	393.4		35.8		27.6
Average	72.8	134.8	183.5	213.5	139.1	137.0	494.9	359.8	105.1	46.9	33.3	35.8
Maximum	92.3	435.4	463.7	299.9	167.2	281.0	2,468.7	735.2	247.0	69.8	70.7	46.5
Minimum	64.0	65.6	106.2	145.3	109.2	98.0	95.2	190.7	63.1	34.0	27.4	27.6

Average annual discharge = 164 (m^3/sec)

Annual inflow volume = 5,163 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1996

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	28.4	47.0	171.8	329.0	217.6	164.8	369.9	233.2	163.1	93.6	40.9	28.7
2	27.8	46.7	125.6	276.5	182.3	153.2	242.8	193.9	166.1	94.9	40.0	27.9
3	27.4	62.2	135.9	236.4	160.6	134.6	196.2	293.9	189.9	281.4	38.8	27.2
4	27.0	73.1	103.1	198.0	156.4	133.4	347.0	265.8	159.9	310.8	38.0	32.3
5	26.8	66.4	110.4	207.5	151.8	129.4	288.6	284.8	164.1	138.3	37.0	33.2
6	26.5	61.1	131.6	223.6	146.7	121.1	245.6	401.9	166.9	65.1	36.7	29.5
7	26.3	64.0	177.0	261.3	132.1	128.6	175.6	268.1	172.5	61.7	37.4	27.3
8	25.9	70.3	194.1	355.2	135.8	138.0	155.6	258.7	140.3	69.0	38.4	27.2
9	24.9	132.0	159.4	207.2	132.7	161.1	153.3	246.8	138.2	77.9	39.5	26.9
10	24.0	131.8	155.8	190.1	130.2	136.7	156.2	252.8	133.5	74.7	40.6	26.9
11	36.7	75.8	164.2	186.8	125.3	136.8	182.7	264.2	117.1	71.1	41.6	26.5
12	50.9	82.4	307.5	185.1	125.6	142.0	185.0	456.8	106.6	64.6	42.7	26.3
13	66.4	90.0	287.9	180.3	121.0	232.6	194.1	941.4	98.3	55.0	39.3	26.1
14	84.1	134.3	286.0	178.4	114.8	193.4	242.4	976.8	156.6	47.8	33.9	25.8
15	597.4	577.7	435.7	190.4	142.9	232.0	177.6	652.0	116.9	40.5	30.7	25.4
16	328.7	238.4	616.2	189.1	150.6	323.3	152.9	538.0	91.9	33.2	29.7	25.2
17	156.3	179.3	934.7	216.1	134.1	251.2	136.9	461.1	79.1	27.1	29.4	25.0
18	111.7	130.3	1,226.2	213.9	101.7	200.1	120.8	377.2	78.8	22.8	28.9	24.9
19	77.5	142.2	798.3	213.8	95.2	315.2	122.7	328.1	75.1	21.8	27.4	24.6
20	66.1	168.4	535.5	199.1	87.1	634.9	242.9	237.1	70.4	28.3	26.3	24.5
21	55.1	195.3	461.9	190.0	172.8	1,108.8	250.1	186.3	66.7	44.9	31.5	24.3
22	45.8	223.1	375.4	181.4	265.0	469.8	163.8	227.0	123.3	66.3	37.0	24.0
23	68.3	252.4	308.9	173.4	277.8	353.7	178.7	1,007.2	109.6	58.5	35.0	23.5
24	66.0	693.2	271.2	161.9	229.8	338.4	165.7	671.0	96.7	51.4	31.0	23.1
25	51.7	451.4	222.6	181.7	430.0	266.6	138.6	505.1	94.5	48.3	28.5	22.9
26	49.6	331.3	251.8	166.3	318.7	235.8	126.9	348.4	91.8	47.0	28.4	22.9
27	50.2	317.1	306.8	165.4	252.5	252.9	106.6	278.0	90.2	45.8	28.4	22.9
28	50.5	259.2	404.5	167.8	231.7	235.5	201.4	230.8	87.9	44.6	28.6	23.0
29	49.5	222.6	785.3	171.9	212.2	300.8	268.2	199.0	87.1	43.5	29.0	23.0
30	48.4		504.7	205.5	199.6	433.7	167.5	220.2	89.0	42.6	29.7	22.9
31	47.3		375.8		158.6		262.9	181.8		42.0		22.8
Average	78.2	190.3	365.3	206.8	177.2	268.6	197.4	386.7	117.4	71.4	34.1	25.7
Maximum	597.4	693.2	1,226.2	355.2	430.0	1,108.8	369.9	1,007.2	189.9	310.8	42.7	33.2
Minimum	24.0	46.7	103.1	161.9	87.1	121.1	106.6	181.8	66.7	21.8	26.3	22.8

Average annual discharge = 177 (m^3/sec)

Annual inflow volume = 5,589 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1997

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.6	23.6	33.4	347.6	100.3	101.4	134.9	198.1	356.4	105.1	90.7	99.0
2	22.6	23.3	82.3	466.9	92.1	105.4	110.7	236.1	349.5	130.1	86.6	94.1
3	22.7	27.0	97.3	397.8	113.3	107.9	97.2	169.5	313.2	119.7	83.2	90.4
4	22.5	26.6	75.2	566.2	106.3	115.0	138.7	118.1	217.8	119.5	78.7	86.8
5	22.5	38.6	60.4	303.2	104.9	101.0	124.8	114.9	227.6	164.8	75.3	83.1
6	22.3	32.6	57.9	212.2	92.4	107.8	118.8	122.8	289.6	127.3	71.5	79.5
7	22.2	30.9	53.7	143.3	196.6	123.0	149.9	150.5	339.5	116.4	68.0	76.0
8	21.9	29.9	47.5	133.3	195.3	140.0	165.9	150.1	577.9	119.9	63.2	81.5
9	21.6	28.6	55.8	133.5	167.2	171.1	334.1	158.9	338.6	112.9	104.8	247.0
10	21.4	27.9	56.8	134.2	119.5	122.8	212.9	168.9	266.5	101.7	148.5	148.2
11	21.2	37.2	49.2	132.9	110.6	109.7	172.2	230.7	210.1	125.2	92.3	124.4
12	21.0	32.4	45.1	150.7	113.6	105.3	130.8	623.1	185.0	101.8	91.5	115.8
13	20.9	24.8	37.2	136.0	105.0	113.3	129.0	356.7	214.0	104.9	94.5	112.1
14	20.7	22.9	25.6	161.5	99.8	114.1	162.3	308.8	197.0	103.1	98.5	110.3
15	20.6	20.7	25.5	239.3	94.2	116.4	147.8	242.4	170.0	94.3	91.9	109.5
16	20.4	19.6	114.9	163.9	89.7	111.4	184.6	226.2	153.7	112.5	86.0	109.1
17	20.3	18.6	87.5	136.7	88.7	111.0	161.6	197.7	137.7	99.3	80.1	101.4
18	19.5	18.4	78.1	123.5	85.1	118.4	170.7	181.3	127.5	93.0	73.8	92.8
19	19.9	18.3	304.3	110.4	82.5	109.8	448.3	163.4	121.5	87.7	67.6	86.5
20	52.3	18.4	149.5	95.1	81.1	114.0	184.1	230.6	119.4	135.2	60.8	79.3
21	63.7	18.4	115.2	93.2	93.5	124.6	191.2	189.6	145.2	195.0	54.9	72.1
22	52.0	18.5	101.7	95.3	92.5	110.3	242.5	389.4	141.9	123.0	52.4	65.0
23	27.3	17.4	71.8	84.3	81.6	122.3	191.9	273.3	119.8	99.4	53.5	57.8
24	23.4	16.4	58.6	89.8	75.3	122.0	191.6	226.5	116.9	95.1	56.1	56.2
25	22.4	32.6	50.3	106.1	75.2	124.3	193.5	249.6	109.7	88.1	72.7	54.1
26	20.9	69.7	43.0	107.7	71.1	117.8	361.7	441.0	97.5	110.0	162.2	52.7
27	20.9	39.9	65.6	109.5	83.2	183.1	752.7	5,816.5	94.6	131.4	171.1	51.8
28	25.8	30.7	146.2	101.6	96.3	202.2	268.8	1,587.5	97.1	100.0	130.7	49.9
29	23.6		532.4	96.6	91.8	240.5	342.7	775.1	129.3	113.0	112.0	56.4
30	24.9		302.4	97.6	86.4	169.3	292.0	535.3	109.3	116.8	104.9	55.6
31	24.9		280.4		82.0		251.6	448.4		101.9		52.9
Average	25.4	27.3	106.6	175.7	102.2	127.8	218.0	492.9	202.5	114.5	89.3	88.8
Maximum	63.7	69.7	532.4	566.2	196.6	240.5	752.7	5,816.5	577.9	195.0	171.1	247.0
Minimum	19.5	16.4	25.5	84.3	71.1	101.0	97.2	114.9	94.6	87.7	52.4	49.9

Average annual discharge = 149 (m^3/sec)

Annual inflow volume = 4,685 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1998

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	52.7	54.3	372.2	213.0	297.7	118.4	264.9	99.1	103.8	47.3	29.0	19.9
2	50.0	65.1	413.0	241.4	293.8	113.9	200.1	81.3	88.0	46.7	28.7	20.6
3	49.7	64.0	481.3	288.3	286.1	96.6	146.5	78.0	101.7	46.1	28.8	21.3
4	48.4	61.5	2,310.3	293.2	273.2	106.1	205.3	72.5	107.0	48.5	28.7	22.0
5	49.5	60.6	1,085.6	289.8	262.2	93.5	133.7	95.2	106.0	46.1	28.2	22.8
6	48.1	63.1	621.8	290.1	229.6	89.3	218.4	144.5	81.1	45.5	29.0	23.6
7	46.7	65.5	484.8	276.2	164.5	94.3	134.0	100.9	73.2	43.3	27.8	24.4
8	52.3	69.9	458.1	1,198.1	227.6	88.5	108.2	75.7	70.6	35.4	26.6	24.4
9	54.0	72.7	403.1	678.3	195.1	76.9	106.0	70.1	105.0	35.2	25.6	23.8
10	57.1	78.6	346.7	387.4	139.6	77.9	222.8	89.8	85.8	35.2	24.8	23.8
11	61.4	85.8	309.9	358.7	127.9	95.5	202.6	100.6	92.0	35.6	25.7	24.7
12	65.6	94.9	330.1	304.4	117.1	254.6	389.6	109.1	106.1	36.3	25.0	23.8
13	79.9	104.9	323.4	263.2	112.0	135.2	376.7	122.2	82.4	35.4	25.9	23.6
14	99.0	160.4	266.3	248.3	130.6	95.3	393.4	171.9	71.5	35.1	25.3	23.4
15	218.8	781.1	231.9	245.5	127.2	74.8	442.6	209.3	71.1	34.8	26.2	23.3
16	137.4	371.8	232.4	243.2	133.0	64.7	547.1	105.9	68.1	33.3	25.5	23.8
17	97.5	546.4	236.5	236.5	148.7	64.5	337.2	96.2	64.3	35.8	25.6	23.7
18	84.7	933.0	228.1	229.8	137.3	75.0	210.2	85.4	65.2	35.7	24.2	23.5
19	77.5	429.5	243.7	244.0	131.9	75.8	159.7	83.6	64.0	34.9	23.5	22.7
20	71.7	345.6	250.4	255.8	132.8	64.2	114.7	101.2	62.4	35.9	22.8	22.5
21	67.6	296.6	226.9	276.7	132.5	71.2	115.5	85.3	62.0	34.1	21.5	22.0
22	63.7	325.4	280.4	290.4	130.2	83.1	115.0	84.8	61.7	32.4	21.4	21.0
23	60.0	336.7	259.1	304.8	126.8	84.3	116.2	88.5	58.8	31.3	20.6	21.1
24	56.4	708.8	224.9	320.5	118.6	86.6	106.7	88.3	56.1	30.2	20.5	20.5
25	53.1	644.5	220.4	345.1	121.2	87.7	102.2	83.7	54.1	30.7	20.4	20.6
26	49.9	462.1	200.3	737.3	116.4	85.3	152.6	98.8	54.2	30.0	20.9	20.7
27	50.6	405.9	191.6	406.2	125.9	90.2	98.9	89.3	50.8	30.1	20.8	20.1
28	52.7	382.8	195.5	332.8	142.6	95.4	88.5	80.4	49.1	28.3	20.1	20.2
29	52.1		218.9	322.3	179.8	119.1	84.3	79.9	47.0	28.2	20.0	21.0
30	51.4		204.3	310.8	126.0	127.5	115.1	116.6	46.8	28.2	19.9	21.1
31	52.1		199.6		119.1		148.7	125.7		28.8		22.3
Average	68.1	288.3	388.8	347.7	164.7	96.2	198.6	100.4	73.7	35.9	24.4	22.3
Maximum	218.8	933.0	2,310.3	1,198.1	297.7	254.6	547.1	209.3	107.0	48.5	29.0	24.7
Minimum	46.7	54.3	191.6	213.0	112.0	64.2	84.3	70.1	46.8	28.2	19.9	19.9

Average annual discharge = 150 (m^3/sec)

Annual inflow volume = 4,724 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 1999

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.5	59.8	60.9	105.4	87.7	37.4	119.2	304.2	122.0	122.0	27.0	26.8
2	21.9	56.4	63.0	102.6	72.6	39.3	107.3	213.4	186.6	98.2	28.6	26.9
3	22.2	53.2	67.3	77.8	71.9	40.0	105.4	201.5	105.3	78.0	30.1	27.3
4	21.6	50.0	77.1	80.3	64.7	39.7	61.8	176.4	88.4	72.1	38.1	27.7
5	21.8	47.0	95.8	86.8	65.6	56.2	51.9	196.2	99.5	78.9	63.3	26.7
6	23.1	45.3	85.3	80.5	66.3	38.8	52.0	259.3	170.8	68.4	57.6	26.3
7	38.7	42.5	238.6	87.8	67.9	40.4	46.5	593.9	103.2	65.1	63.8	25.9
8	36.3	39.3	306.5	89.5	63.6	50.4	40.4	280.1	94.1	63.1	52.0	26.9
9	35.3	42.2	282.3	95.0	62.6	53.1	40.1	213.9	159.9	61.6	46.1	26.4
10	33.5	46.0	186.7	79.8	58.4	58.1	40.1	286.9	89.7	62.2	45.1	26.3
11	31.3	51.6	137.9	99.3	48.8	51.2	115.0	210.8	93.7	61.8	44.8	26.2
12	29.1	60.1	117.7	111.6	55.2	62.7	106.1	217.8	81.8	61.7	40.6	26.5
13	25.9	61.5	98.0	123.7	59.1	56.1	97.8	266.0	77.1	59.2	40.6	25.9
14	22.5	68.7	85.7	99.0	48.5	49.8	72.9	172.5	76.9	57.6	39.9	25.5
15	20.6	63.1	76.5	84.8	41.2	48.9	52.6	135.1	167.1	55.3	39.6	25.3
16	19.1	55.7	67.5	77.0	37.9	48.5	52.6	109.7	137.9	55.4	39.6	25.3
17	20.3	54.5	60.5	77.7	47.3	47.4	204.1	91.3	148.6	54.5	39.6	25.2
18	21.7	78.1	53.9	88.3	59.3	69.4	366.2	82.0	103.8	51.2	39.6	24.5
19	23.1	130.5	48.9	82.5	58.1	77.5	305.1	80.1	245.4	48.5	39.6	24.2
20	28.3	107.0	59.4	78.4	57.5	117.9	221.3	108.9	173.7	46.2	37.3	24.2
21	127.4	65.0	68.6	74.1	74.4	113.8	159.1	85.0	97.8	44.9	36.8	24.1
22	128.6	63.1	44.9	68.3	78.9	67.1	128.9	76.7	74.7	39.9	35.9	24.2
23	91.3	62.3	39.9	75.1	66.5	57.9	93.4	111.7	107.7	36.2	35.3	24.3
24	262.4	64.9	41.1	74.3	64.7	55.6	79.0	71.7	152.9	33.4	34.9	24.1
25	174.5	70.1	48.6	76.6	71.6	90.3	101.9	85.4	122.0	32.7	34.4	24.4
26	102.5	66.7	57.5	75.0	55.6	60.8	63.0	134.8	93.1	32.4	38.4	24.3
27	75.3	67.6	59.5	87.1	60.2	63.5	52.5	154.7	81.2	25.4	32.3	24.3
28	63.6	61.7	63.5	76.1	51.3	56.8	51.2	114.0	99.7	24.5	28.1	24.4
29	60.1		68.3	75.1	52.3	65.6	135.1	77.2	143.3	23.7	27.2	24.5
30	58.2		75.3	88.4	49.1	68.2	141.9	86.2	239.0	25.6	27.1	23.7
31	60.8		91.4		43.5		169.9	111.6		25.7		23.9
Average	55.6	61.9	94.5	85.9	60.1	59.4	110.8	171.3	124.6	53.7	39.4	25.4
Maximum	262.4	130.5	306.5	123.7	87.7	117.9	366.2	593.9	245.4	122.0	63.8	27.7
Minimum	19.1	39.3	39.9	68.3	37.9	37.4	40.1	71.7	74.7	23.7	27.0	23.7

Average annual discharge = 79 (m^3/sec)

Annual inflow volume = 2,482 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2000

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.5	216.3	51.1	95.9	61.4	48.5	156.9	1,760.3	155.4	59.3	43.4	27.9
2	22.4	164.2	49.9	95.0	73.4	46.8	195.8	884.4	152.5	57.2	42.3	29.1
3	21.5	102.3	46.4	102.4	79.7	44.6	179.9	458.8	114.1	58.1	43.3	28.7
4	19.9	84.5	49.0	95.7	78.5	47.5	141.3	347.5	120.9	57.2	42.3	27.5
5	18.2	75.3	102.0	74.6	65.6	49.5	69.5	285.2	106.0	56.1	39.5	28.6
6	18.1	70.8	68.4	75.6	65.2	39.5	59.7	268.0	111.1	52.6	37.0	27.0
7	18.1	63.0	64.2	78.2	61.6	52.2	65.2	265.2	137.4	51.7	36.3	28.3
8	17.6	54.6	65.1	63.3	66.0	54.0	134.9	239.3	105.2	50.7	35.8	26.6
9	18.1	52.4	67.1	61.5	73.8	111.3	169.7	372.1	151.5	50.7	35.2	28.9
10	17.8	124.9	72.3	72.3	77.6	65.4	102.2	326.1	112.5	50.8	34.0	28.6
11	18.2	120.0	69.1	80.2	84.3	70.7	107.5	283.0	115.2	48.9	30.9	31.1
12	172.5	109.0	63.7	87.2	86.8	53.5	89.9	250.7	82.5	47.0	31.1	30.6
13	243.8	81.9	61.3	94.9	156.3	39.8	106.4	211.2	67.5	48.5	27.7	33.0
14	174.2	67.3	56.8	82.8	102.2	34.5	136.1	223.3	57.8	46.5	27.9	31.2
15	82.3	65.7	55.8	89.9	94.5	83.6	142.7	233.7	57.1	44.3	27.9	33.5
16	61.2	63.6	56.0	71.2	116.8	67.2	83.7	242.7	54.9	44.0	27.8	34.5
17	47.2	60.0	55.6	74.2	89.1	58.8	153.2	190.1	51.3	45.5	26.4	37.1
18	44.2	58.3	51.3	76.5	88.1	70.8	80.0	183.0	43.2	42.9	27.6	48.5
19	47.2	56.7	46.3	74.2	108.4	73.2	67.9	145.8	53.2	40.2	26.0	47.9
20	57.9	52.2	42.9	73.6	82.5	123.0	135.5	148.0	209.4	38.2	27.6	38.5
21	51.9	52.2	40.1	76.5	73.2	87.4	131.8	148.3	137.7	38.4	26.3	33.1
22	46.6	51.7	41.7	88.3	74.1	64.5	630.3	129.1	123.9	38.7	25.4	28.9
23	43.1	50.5	41.8	69.5	77.9	91.6	744.6	128.4	88.6	37.2	26.6	26.9
24	40.7	45.3	43.9	68.3	67.9	69.2	370.4	117.9	80.4	35.7	28.0	23.6
25	38.4	43.2	46.7	81.7	64.2	67.1	269.0	110.4	88.6	35.8	27.0	24.3
26	39.8	45.1	75.9	81.5	58.8	74.6	267.2	104.1	200.5	36.1	27.0	23.2
27	38.9	46.1	115.0	80.0	53.2	125.1	186.9	101.6	114.0	35.1	28.8	24.7
28	36.9	45.6	99.7	62.3	47.5	213.3	197.7	116.5	89.0	35.7	27.4	24.2
29	35.8	45.6	119.9	58.7	45.4	97.9	191.3	173.0	73.4	38.5	27.8	23.0
30	35.3		114.6	58.8	51.4	323.1	164.7	187.8	64.9	43.3	29.6	23.5
31	36.3		90.6		63.6		653.3	141.8		44.3		22.4
Average	51.2	74.8	65.3	78.2	77.1	81.6	199.5	283.1	104.0	45.5	31.5	29.8
Maximum	243.8	216.3	119.9	102.4	156.3	323.1	744.6	1,760.3	209.4	59.3	43.4	48.5
Minimum	17.6	43.2	40.1	58.7	45.4	34.5	59.7	101.6	43.2	35.1	25.4	22.4

Average annual discharge = 94 (m^3/sec)

Annual inflow volume = 2,965 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2001

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.8	20.2	24.7	47.3	51.6	50.4	105.6	296.8	120.5	45.2	25.8	19.2
2	23.6	21.8	24.3	38.2	51.7	123.0	73.0	262.8	133.1	47.1	28.2	20.3
3	26.2	21.0	23.5	39.8	51.5	169.6	86.8	271.5	118.0	52.2	34.8	19.3
4	26.4	20.1	23.1	49.3	50.8	115.5	74.2	463.3	129.1	66.2	45.6	18.4
5	25.9	21.3	22.7	42.5	52.2	138.7	77.8	323.4	97.2	55.9	38.1	19.4
6	25.4	20.1	22.6	41.1	61.0	125.4	52.9	335.7	106.0	50.3	42.3	18.4
7	24.0	19.0	21.5	43.4	68.9	137.7	60.9	398.4	86.2	47.5	42.3	19.6
8	22.2	19.2	21.3	47.2	70.7	125.1	105.5	257.1	104.2	44.3	37.5	18.7
9	22.2	19.3	21.2	51.2	66.9	137.0	88.4	228.8	82.8	44.6	34.1	19.5
10	21.3	19.1	21.0	51.5	69.5	143.5	80.1	238.2	80.3	44.8	33.1	18.5
11	22.7	20.0	19.4	48.5	72.3	83.6	641.8	197.8	82.9	44.6	34.0	17.5
12	21.8	21.3	19.3	51.2	75.4	73.3	158.4	164.8	157.6	45.7	31.7	17.8
13	21.5	20.3	21.6	53.2	73.3	66.6	216.2	151.3	116.4	43.7	31.1	18.4
14	23.3	19.3	23.6	49.4	70.1	119.3	136.9	374.4	207.9	44.9	29.9	18.4
15	22.5	20.5	22.8	53.0	79.5	118.9	145.8	345.7	191.0	42.0	28.9	17.7
16	23.1	21.8	25.2	61.0	63.9	181.9	386.9	288.0	114.6	40.9	29.2	19.6
17	21.8	20.9	24.3	110.9	85.5	453.2	272.0	191.6	100.9	41.6	28.1	20.7
18	21.0	21.0	21.2	155.2	62.1	175.9	171.7	167.1	90.6	38.3	25.7	21.6
19	21.6	20.6	20.1	86.7	62.5	109.6	142.4	164.3	82.9	37.6	23.9	25.5
20	22.0	21.4	24.3	90.6	147.7	87.6	133.9	167.3	77.2	36.0	25.2	23.7
21	21.6	22.7	47.4	64.6	108.9	141.2	132.9	188.6	72.5	35.0	25.7	23.2
22	22.4	21.5	38.7	54.9	78.1	183.1	415.1	180.0	65.9	34.1	23.6	22.2
23	22.1	21.4	30.6	44.8	75.3	152.7	649.4	219.1	62.1	32.4	22.1	21.6
24	21.2	23.7	26.9	46.6	61.8	163.8	532.5	164.7	59.0	32.3	23.0	21.5
25	22.2	27.5	25.6	48.6	54.2	104.9	306.7	140.8	56.3	29.8	21.6	20.5
26	22.2	27.4	25.8	45.7	49.5	123.8	200.2	134.3	60.0	29.9	20.7	20.3
27	22.1	27.7	24.3	46.2	44.6	110.1	189.0	126.1	55.8	28.4	21.3	20.2
28	20.9	27.0	27.5	43.4	46.2	65.9	158.8	129.3	51.2	26.6	20.4	20.0
29	20.9		47.3	52.4	64.0	58.0	617.5	119.5	48.1	25.0	19.3	18.6
30	21.1		60.7	47.4	49.5	238.2	539.3	114.3	45.7	24.8	20.2	19.6
31	20.0		45.6		55.3		366.6	146.5		25.1		18.9
Average	22.5	21.7	27.3	56.9	66.9	135.9	236.1	224.2	95.2	39.9	28.9	20.0
Maximum	26.4	27.7	60.7	155.2	147.7	453.2	649.4	463.3	207.9	66.2	45.6	25.5
Minimum	20.0	19.0	19.3	38.2	44.6	50.4	52.9	114.3	45.7	24.8	19.3	17.5

Average annual discharge = 82 (m^3/sec)

Annual inflow volume = 2,580 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2002

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.1	27.3	44.1	93.2	47.8	57.3	82.5	84.2	193.7	43.7	29.2	21.6
2	19.3	28.5	46.0	91.1	48.9	49.8	67.7	103.1	247.7	43.4	28.5	21.5
3	19.8	26.8	51.7	84.2	50.5	73.3	59.4	79.1	167.7	43.0	28.3	21.3
4	19.0	26.4	41.7	83.7	60.6	56.3	63.7	102.3	319.9	42.4	27.2	21.9
5	18.1	25.6	39.9	83.6	88.2	52.9	57.8	125.1	222.7	42.9	27.8	20.9
6	17.4	26.3	38.6	83.1	92.7	59.6	52.0	238.2	159.2	44.4	29.0	20.8
7	17.8	29.4	39.7	123.7	86.6	53.4	42.5	178.9	133.1	44.5	28.2	19.8
8	18.0	34.2	39.0	110.8	78.5	51.3	40.4	138.9	161.7	43.6	27.8	19.7
9	17.6	30.8	53.3	94.0	82.7	57.3	35.2	116.8	120.8	42.9	26.6	19.9
10	18.2	27.8	218.9	85.3	84.2	81.4	43.4	94.4	106.6	42.3	26.6	20.5
11	17.3	26.2	147.3	81.1	94.1	80.3	44.3	102.3	93.2	41.4	26.9	20.3
12	17.2	26.0	111.1	82.2	96.4	76.5	36.2	586.7	107.4	41.6	27.1	19.4
13	16.1	26.0	103.8	87.0	91.5	82.7	35.2	886.7	98.5	46.8	25.8	20.4
14	19.7	25.8	97.2	93.4	88.8	182.5	33.8	530.3	157.3	47.3	25.0	21.5
15	54.9	25.9	91.5	88.8	97.9	129.5	38.8	413.7	159.9	43.3	24.9	21.1
16	123.3	27.2	86.7	86.8	107.4	119.8	41.4	240.4	134.3	41.1	25.3	20.8
17	89.3	30.9	92.4	82.3	96.5	197.2	66.7	177.7	197.9	39.4	23.9	19.9
18	60.2	35.4	89.9	81.8	96.2	161.6	85.0	141.6	157.8	38.2	24.1	20.8
19	49.3	37.9	93.7	84.0	89.8	124.9	82.8	122.1	123.5	37.7	23.7	20.3
20	41.5	34.3	101.1	86.4	77.6	99.9	151.2	134.4	99.2	42.3	23.3	23.2
21	38.5	52.3	99.7	84.8	72.3	116.5	274.6	117.5	85.6	39.3	23.0	23.9
22	38.6	82.2	109.4	76.2	70.7	83.7	126.6	158.9	71.1	38.3	22.7	23.6
23	36.0	548.2	87.7	73.8	72.0	92.2	187.6	143.6	59.5	37.2	22.8	22.2
24	36.2	204.0	103.5	74.2	68.5	246.0	107.2	183.8	73.9	36.3	23.7	22.0
25	33.9	139.1	223.4	74.7	67.2	192.3	116.4	240.0	59.6	34.6	22.9	22.7
26	34.1	91.6	153.1	73.7	61.3	111.2	94.1	220.3	56.6	33.3	22.6	22.5
27	31.8	63.3	124.2	61.5	66.0	90.5	115.5	214.3	51.9	32.3	23.5	21.4
28	30.3	45.8	108.1	54.6	70.2	113.9	95.9	155.4	48.3	31.7	22.7	21.8
29	30.9		105.6	48.2	97.4	158.1	93.3	130.3	45.1	30.4	21.4	21.9
30	28.7		102.6	44.1	74.1	102.5	115.3	289.8	44.7	29.0	21.8	21.5
31	28.4		96.8		56.8		75.3	198.8		28.5		20.6
Average	33.6	64.5	94.9	81.7	78.5	105.2	82.6	214.5	125.3	39.5	25.2	21.3
Maximum	123.3	548.2	223.4	123.7	107.4	246.0	274.6	886.7	319.9	47.3	29.2	23.9
Minimum	16.1	25.6	38.6	44.1	47.8	49.8	33.8	79.1	44.7	28.5	21.4	19.4

Average annual discharge = 81 (m^3/sec)

Annual inflow volume = 2,543 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2003

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.4	26.6	460.9	172.0	302.0	28.5	77.7	200.8	78.1	74.2	28.2	18.8
2	19.3	27.1	1,182.7	166.8	155.7	34.8	69.2	290.5	82.9	61.5	26.9	21.0
3	19.5	23.9	599.4	159.3	100.4	30.5	69.2	211.5	109.7	56.4	26.5	19.7
4	19.6	21.2	428.1	167.2	89.1	26.4	75.4	129.3	179.5	48.7	27.9	21.7
5	19.0	22.0	341.2	146.1	76.5	26.4	147.6	92.4	134.6	44.7	26.8	23.8
6	18.6	21.3	309.6	129.3	64.3	26.8	161.0	74.5	114.6	44.5	26.7	21.8
7	18.1	22.1	289.0	143.3	66.2	95.4	176.1	69.3	90.5	43.1	24.2	23.7
8	19.1	22.4	252.7	158.4	62.5	97.1	94.0	82.3	104.0	39.9	25.1	21.9
9	20.4	21.7	227.9	169.6	60.4	112.7	177.1	63.3	128.6	44.7	24.8	22.2
10	19.1	20.7	206.3	179.0	56.6	106.2	115.3	56.9	95.6	42.4	23.4	24.7
11	17.9	20.2	181.7	186.0	53.7	86.3	129.6	56.6	87.3	39.0	24.6	26.0
12	17.3	20.0	166.3	192.3	53.1	79.0	106.9	56.4	83.6	40.1	23.1	25.0
13	16.0	19.1	170.9	194.0	49.9	70.1	107.9	52.5	114.5	36.1	25.3	28.9
14	15.9	18.7	181.4	197.9	50.8	69.8	86.8	47.1	92.1	34.5	23.9	57.7
15	15.4	19.5	181.5	191.7	51.4	71.0	113.9	44.6	95.6	34.3	26.3	75.2
16	16.0	24.2	205.7	283.6	52.4	72.1	168.1	43.1	76.6	33.4	24.8	55.9
17	15.4	355.5	194.4	229.4	53.5	74.0	87.5	54.8	70.6	31.2	38.2	45.8
18	16.2	3,568.6	178.5	204.4	57.3	70.3	84.2	131.4	68.6	30.1	49.6	38.5
19	15.8	1,658.1	179.1	209.3	49.5	71.0	73.0	208.7	63.1	30.2	32.8	35.3
20	15.9	423.0	184.9	231.8	57.5	92.5	116.7	238.1	61.7	30.1	28.0	31.3
21	15.5	286.3	202.5	177.5	57.2	128.1	143.5	193.9	58.4	29.8	26.0	33.2
22	15.9	245.0	220.5	161.6	55.1	97.5	132.1	123.3	55.3	27.6	25.6	31.3
23	15.4	261.4	197.8	173.5	50.1	87.6	123.9	117.0	65.5	27.8	23.2	32.3
24	16.0	243.8	199.1	187.8	41.4	84.2	247.1	91.0	189.3	27.3	25.0	30.2
25	15.0	218.5	215.2	180.4	38.8	97.8	142.5	76.1	375.1	25.0	22.9	27.8
26	14.2	214.1	202.2	179.1	37.6	95.1	146.1	76.4	279.5	26.2	20.8	29.6
27	14.6	211.8	206.6	181.4	40.0	88.7	163.5	78.1	161.1	25.8	18.7	27.4
28	13.8	351.9	206.4	149.8	38.6	81.8	128.0	76.3	118.6	24.6	20.7	29.3
29	21.4		287.4	142.2	28.7	75.7	121.7	87.2	95.1	24.4	22.8	27.4
30	22.6		238.0	158.1	27.2	67.7	160.2	133.1	81.0	26.2	20.7	28.1
31	28.2		188.7		27.9		114.2	85.3		26.7		25.5
Average	17.6	299.6	273.8	180.1	64.7	74.8	124.5	107.8	113.7	36.5	26.1	31.0
Maximum	28.2	3,568.6	1,182.7	283.6	302.0	128.1	247.1	290.5	375.1	74.2	49.6	75.2
Minimum	13.8	18.7	166.3	129.3	27.2	26.4	69.2	43.1	55.3	24.4	18.7	18.8

Average annual discharge = 111 (m^3/sec)

Annual inflow volume = 3,505 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2004

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.6	127.9	75.6	37.2	342.6	45.7	58.3	173.5	58.6	36.7	36.2	88.1
2	29.4	98.2	64.8	35.9	186.6	53.2	71.6	99.6	89.8	37.6	34.6	65.8
3	29.2	95.6	57.2	34.6	127.4	47.6	61.5	203.2	61.0	39.1	34.6	53.5
4	29.2	81.8	54.2	35.9	115.7	42.1	82.7	132.5	52.4	40.8	33.6	46.2
5	29.3	70.6	51.7	39.4	102.4	41.8	68.7	87.5	47.2	39.9	30.4	43.3
6	29.0	62.8	53.5	44.5	89.9	40.7	65.7	106.4	53.1	38.2	30.3	42.0
7	29.0	55.2	51.8	45.0	88.3	86.2	62.5	308.9	45.8	38.4	32.3	37.6
8	28.3	53.0	52.8	40.3	84.1	65.4	94.1	236.9	46.4	42.4	30.6	37.0
9	27.4	77.9	67.5	51.1	81.9	84.8	207.4	157.0	45.3	46.5	33.0	34.5
10	26.0	106.0	72.4	49.5	77.6	68.0	107.1	116.6	43.9	52.0	30.4	34.4
11	27.0	87.2	68.1	43.6	74.5	52.3	89.2	136.5	41.3	123.3	33.3	34.0
12	28.1	80.2	62.6	42.4	74.2	52.8	151.3	89.7	43.1	99.8	30.7	33.0
13	29.8	84.3	58.9	40.3	70.8	50.3	88.0	64.4	47.9	80.8	28.5	33.1
14	31.1	79.7	59.1	37.4	71.9	52.8	154.1	59.7	51.6	70.8	31.0	32.5
15	32.3	85.6	59.5	39.4	72.6	78.9	86.7	74.4	97.8	60.5	28.8	31.2
16	33.0	79.3	66.6	41.9	74.0	63.0	82.4	81.7	150.7	57.4	31.2	28.3
17	65.2	77.4	68.5	38.9	74.4	60.5	50.3	225.6	91.4	50.4	28.8	29.0
18	115.9	124.2	67.4	37.4	78.2	99.0	89.7	163.4	69.4	49.3	31.2	28.3
19	61.9	108.8	66.2	37.6	68.6	70.9	59.8	110.7	59.0	48.5	28.8	28.5
20	48.8	87.6	59.8	41.8	76.7	80.8	49.3	102.2	57.1	47.9	29.5	107.0
21	47.1	85.6	59.0	38.6	75.5	91.2	53.5	79.0	98.8	49.1	30.1	61.3
22	196.3	77.8	49.2	35.0	72.1	108.5	46.2	74.1	68.6	50.4	28.8	43.9
23	243.1	77.7	46.1	42.9	66.4	78.0	41.9	85.7	54.5	53.9	27.1	38.5
24	159.1	82.4	44.4	41.5	56.3	109.3	35.7	85.4	49.7	51.3	28.9	40.3
25	107.4	82.4	37.5	42.1	53.9	158.5	30.0	97.5	51.8	52.7	32.9	39.8
26	90.9	81.4	38.5	44.6	53.2	99.7	27.7	93.8	55.0	55.6	32.5	37.6
27	78.9	80.3	36.1	51.0	57.1	92.8	47.9	62.6	58.5	64.6	32.0	39.0
28	71.9	89.7	34.4	75.0	56.0	64.5	65.9	73.9	50.2	55.7	36.7	36.7
29	73.0	80.6	33.7	91.7	44.9	55.6	80.1	58.4	43.5	48.0	40.4	37.6
30	117.7		33.3	344.9	43.6	48.4	159.9	65.2	37.8	41.0	188.8	38.1
31	176.4		34.5		45.2		151.2	59.6		39.7		44.5
Average	68.3	84.9	54.4	54.0	85.7	71.4	81.3	115.0	60.7	53.6	36.9	42.7
Maximum	243.1	127.9	75.6	344.9	342.6	158.5	207.4	308.9	150.7	123.3	188.8	107.0
Minimum	25.6	53.0	33.3	34.6	43.6	40.7	27.7	58.4	37.8	36.7	27.1	28.3

Average annual discharge = 67 (m^3/sec)

Annual inflow volume = 2,133 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2005

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	353.3	66.4	195.6	199.1	166.9	84.7	233.0	101.2	47.9	40.0	52.2	39.0
2	149.5	65.2	197.1	211.1	162.8	78.0	238.1	97.8	44.7	40.2	49.9	41.2
3	99.8	64.4	199.5	215.8	193.5	76.0	196.6	104.5	44.5	41.4	47.0	37.9
4	85.8	58.7	210.3	220.8	181.1	75.3	160.4	97.3	43.0	41.5	50.5	40.1
5	74.3	71.2	230.5	230.0	191.0	79.6	170.7	118.8	48.4	42.7	47.5	36.8
6	65.0	72.6	233.7	221.2	186.6	76.3	166.1	95.0	57.3	42.3	45.0	33.5
7	55.7	174.4	227.0	226.6	176.2	81.1	122.0	97.4	132.4	43.5	48.0	35.6
8	47.3	160.7	213.9	230.5	181.0	84.7	158.8	99.9	99.0	42.6	45.6	32.4
9	44.7	620.3	222.3	217.6	180.0	80.8	185.2	107.7	108.3	49.4	48.2	34.9
10	42.8	383.6	207.7	181.3	161.8	81.0	190.9	109.3	72.9	50.8	45.4	32.7
11	40.1	658.2	214.5	159.2	141.2	88.4	306.3	107.0	68.7	57.7	42.4	32.9
12	41.0	711.2	209.9	159.6	130.7	90.0	426.0	101.8	80.3	102.9	45.1	31.6
13	40.7	410.5	220.6	160.5	130.9	89.1	409.0	157.7	69.8	64.6	42.2	34.2
14	41.9	329.1	214.1	167.9	120.1	76.3	300.8	99.8	54.4	56.4	44.8	31.4
15	39.5	307.9	235.1	172.8	106.3	75.4	283.5	88.2	54.9	51.9	41.9	33.9
16	40.3	309.8	273.3	179.5	111.9	87.7	336.8	127.2	49.9	62.4	44.6	31.4
17	37.0	254.1	311.7	168.8	107.1	90.4	220.1	122.2	72.4	77.8	41.7	29.7
18	39.3	273.4	359.9	175.1	103.2	104.0	182.2	102.3	308.5	65.3	38.8	31.6
19	36.1	375.2	618.3	192.2	106.9	112.2	173.1	84.0	162.0	60.7	41.3	29.6
20	38.4	264.9	492.7	196.4	96.6	124.5	178.8	85.9	95.9	60.0	38.5	30.2
21	35.2	217.6	442.0	184.5	99.1	129.6	204.3	75.6	71.9	55.8	41.1	30.0
22	51.6	220.0	568.5	199.1	87.6	141.2	197.4	71.0	58.2	56.4	38.3	32.4
23	87.0	223.6	428.9	228.5	87.8	155.4	158.9	66.9	79.5	52.3	40.9	31.2
24	62.0	213.9	385.7	207.3	95.5	167.7	154.3	61.6	54.9	53.3	38.1	29.9
25	46.1	200.7	318.8	211.9	89.1	169.1	142.8	78.4	51.0	49.7	41.0	32.7
26	40.5	194.3	290.3	239.6	83.2	184.2	138.9	66.3	46.9	50.4	38.6	29.8
27	36.4	193.9	300.8	208.1	83.5	184.6	191.2	93.4	51.6	50.2	41.5	32.5
28	68.0	189.7	293.3	195.1	79.4	171.4	122.1	73.6	46.4	50.3	41.1	30.2
29	68.9		255.3	167.0	86.3	188.8	115.4	62.1	40.8	52.2	42.1	30.2
30	61.0		225.6	157.6	98.0	193.7	149.0	52.9	40.1	49.6	42.4	30.9
31	56.5		210.5		98.2		100.9	46.8		50.8		28.1
Average	65.3	260.2	290.6	196.2	126.6	114.0	203.7	92.1	75.2	53.7	43.5	32.9
Maximum	353.3	711.2	618.3	239.6	193.5	193.7	426.0	157.7	308.5	102.9	52.2	41.2
Minimum	35.2	58.7	195.6	157.6	79.4	75.3	100.9	46.8	40.1	40.0	38.1	28.1

Average annual discharge = 129 (m^3/sec)

Annual inflow volume = 4,058 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2006

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.2	51.3	142.6	126.5	110.0	67.4	88.7	254.7	277.1	63.6	31.5	57.9
2	60.5	52.3	124.0	128.8	106.7	64.0	54.7	228.2	384.0	59.0	30.3	49.9
3	79.1	52.2	106.5	127.4	101.6	62.6	85.1	275.4	488.9	55.5	31.6	44.8
4	70.3	53.3	92.2	105.8	104.7	101.3	64.7	1,141.8	415.5	52.8	29.2	76.8
5	54.6	53.0	79.2	118.2	125.0	89.6	78.4	982.3	292.2	48.0	28.0	1,425.0
6	46.7	52.6	65.0	122.4	123.6	90.3	77.0	713.6	231.4	48.8	28.6	626.8
7	43.3	52.1	64.1	126.9	133.4	64.0	147.3	523.4	199.8	47.0	28.1	305.2
8	44.6	55.7	63.4	121.9	133.2	51.5	146.4	700.4	177.1	44.9	28.3	242.2
9	40.4	56.9	63.6	120.2	144.4	52.8	145.0	490.3	172.1	44.8	30.6	217.1
10	36.1	56.1	64.0	243.3	132.4	54.8	189.0	409.7	158.3	45.3	33.1	216.4
11	37.3	53.7	65.2	133.6	129.4	57.5	166.5	301.6	163.9	43.8	33.3	216.0
12	34.0	54.7	68.2	106.9	126.2	59.7	283.7	255.0	167.7	43.5	50.4	193.1
13	34.5	53.4	90.9	88.3	129.9	62.1	474.0	252.9	161.7	46.8	147.0	177.4
14	30.2	65.6	126.8	85.8	130.3	61.3	243.4	273.4	131.9	45.3	93.7	165.7
15	33.6	175.1	128.7	80.7	111.9	68.0	172.7	304.5	119.7	45.8	70.3	157.7
16	163.9	149.8	144.1	75.2	128.4	156.1	122.4	259.4	125.9	41.9	73.5	146.5
17	260.9	104.5	99.4	73.0	169.3	171.2	91.5	248.0	117.4	38.2	92.2	136.4
18	200.1	78.7	90.4	76.7	121.0	117.0	72.7	224.3	111.7	38.6	204.1	136.9
19	98.5	88.9	89.9	72.6	109.1	90.0	65.6	196.3	101.9	46.5	174.1	128.0
20	70.2	66.2	160.5	73.8	105.1	71.3	74.6	348.7	127.0	77.5	118.5	125.0
21	64.0	66.3	212.8	75.8	131.6	64.5	82.2	269.4	101.5	54.6	92.2	124.5
22	57.7	63.6	140.5	83.5	114.8	63.9	120.1	227.4	94.6	47.0	87.6	144.9
23	53.9	65.6	134.5	103.6	127.0	60.8	322.9	249.3	86.5	43.4	99.5	111.9
24	49.2	65.8	123.6	92.2	122.7	66.2	502.9	207.0	84.7	40.7	81.0	98.2
25	47.6	84.5	130.9	99.3	125.4	75.6	242.6	212.0	79.0	37.8	66.8	87.7
26	44.4	356.0	153.7	111.7	113.1	105.0	312.9	204.3	75.0	35.9	63.4	89.1
27	45.0	260.2	134.6	124.6	114.1	132.7	518.4	240.4	76.2	38.4	64.6	100.1
28	47.3	170.0	126.7	125.3	106.0	194.2	623.9	276.6	74.5	34.9	62.2	91.5
29	48.1		117.7	114.7	93.4	163.8	397.8	228.4	71.3	33.9	63.5	83.2
30	48.1		115.8	118.5	83.6	182.0	324.7	245.0	65.2	32.0	60.8	78.2
31	49.5		116.7		76.8		250.4	212.4		29.3		74.7
Average	65.2	91.4	110.9	108.6	118.8	90.7	211.0	353.4	164.5	45.3	69.9	191.2
Maximum	260.9	356.0	212.8	243.3	169.3	194.2	623.9	1,141.8	488.9	77.5	204.1	1,425.0
Minimum	29.2	51.3	63.4	72.6	76.8	51.5	54.7	196.3	65.2	29.3	28.0	44.8

Average annual discharge = 136 (m^3/sec)

Annual inflow volume = 4,281 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2007

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	69.2	37.3	209.8	419.5	166.5	108.7	226.7	120.3	86.0	48.0	23.3	21.4
2	66.0	36.4	173.0	374.0	164.1	116.6	300.5	112.8	81.5	47.2	26.9	21.5
3	61.8	35.6	150.0	339.1	161.8	129.5	209.5	95.1	75.2	46.7	23.6	21.5
4	64.1	36.2	152.9	296.9	165.1	149.2	168.7	99.2	67.3	44.2	25.8	21.1
5	68.1	38.9	172.6	274.3	167.1	158.4	126.8	96.4	85.5	43.7	23.7	19.2
6	65.7	35.7	160.6	261.6	160.8	129.6	147.7	126.3	75.8	40.3	24.2	19.1
7	63.8	35.7	160.0	254.5	152.6	132.1	148.2	105.5	75.0	40.2	24.3	19.3
8	64.7	37.0	162.4	240.2	173.0	135.2	411.7	89.1	84.8	38.1	24.4	19.7
9	60.8	36.1	163.8	237.9	179.3	147.3	219.9	78.5	88.2	36.7	26.7	19.2
10	63.0	40.5	155.5	230.8	172.3	151.0	155.0	71.8	79.1	36.2	23.9	19.4
11	57.7	130.0	150.9	226.9	159.2	154.6	126.9	68.6	89.2	36.6	22.0	19.7
12	55.8	194.3	503.6	226.3	145.4	161.3	186.7	69.0	75.7	32.2	23.5	19.6
13	53.1	124.3	640.8	225.7	155.5	171.6	137.2	109.4	63.6	33.4	21.9	21.4
14	47.8	101.7	392.4	224.1	164.2	207.8	90.8	486.0	64.3	31.9	22.1	23.5
15	47.0	97.3	307.5	229.6	179.1	207.7	169.1	293.3	69.0	28.7	23.1	20.0
16	43.0	82.7	276.7	228.6	199.3	171.3	118.8	168.1	70.7	31.8	22.3	20.3
17	42.6	81.3	258.5	227.9	196.1	174.8	87.1	144.0	83.8	29.9	21.5	20.1
18	40.9	76.6	258.9	249.1	189.7	170.0	89.3	129.6	78.1	30.9	20.7	19.8
19	40.4	66.6	280.1	232.5	262.3	133.3	91.7	91.4	66.0	27.9	21.4	20.2
20	40.2	61.7	2,356.3	233.3	239.3	129.9	190.5	138.2	92.5	26.9	20.8	18.9
21	39.1	58.5	1,305.4	222.8	198.2	118.4	236.3	116.5	120.1	27.1	19.8	21.2
22	40.5	98.2	677.1	207.8	168.1	120.0	213.1	129.5	95.7	26.9	20.5	18.9
23	41.1	75.5	474.3	205.4	160.1	156.0	196.5	137.4	85.9	23.8	19.6	21.1
24	41.5	61.1	422.8	210.8	149.8	132.8	234.9	221.0	84.5	25.6	21.4	19.9
25	38.4	60.7	399.6	185.3	134.1	152.8	160.4	120.6	62.7	25.6	19.3	18.7
26	41.7	59.1	387.3	170.1	124.8	165.7	130.6	144.6	59.7	24.3	19.8	19.8
27	41.8	175.7	384.1	185.3	124.1	138.8	134.0	109.3	58.0	25.3	20.2	20.1
28	37.8	305.3	386.1	185.3	128.5	220.0	113.8	90.0	57.9	24.1	19.4	17.9
29	38.9		398.0	178.0	128.9	317.1	205.6	100.3	57.2	25.5	20.0	17.4
30	36.0		408.9	178.2	113.3	229.9	151.8	90.8	49.7	25.5	21.0	17.5
31	37.4		412.2		116.7		122.8	85.3		25.4		17.3
Average	50.0	81.4	411.0	238.7	164.5	159.7	171.0	130.3	76.1	32.6	22.2	19.8
Maximum	69.2	305.3	2,356.3	419.5	262.3	317.1	411.7	486.0	120.1	48.0	26.9	23.5
Minimum	36.0	35.6	150.0	170.1	113.3	108.7	87.1	68.6	49.7	23.8	19.3	17.3

Average annual discharge = 130 (m^3/sec)

Annual inflow volume = 4,107 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2008

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.9	35.8	131.1	80.2	85.5	84.2	202.1	290.0	142.2	44.8	37.8	29.4
2	17.3	35.8	134.6	86.5	94.1	119.3	163.0	302.9	139.3	41.9	36.1	32.1
3	18.2	39.5	125.1	102.6	98.2	115.7	132.2	927.4	152.4	43.0	34.2	32.3
4	15.6	48.0	104.7	125.1	111.9	112.4	144.1	557.8	169.8	38.1	33.9	29.4
5	17.1	71.8	108.2	200.9	99.2	110.9	129.5	512.9	152.3	37.7	34.8	30.3
6	15.7	70.2	105.9	406.7	96.3	142.2	314.4	408.0	141.7	64.0	29.4	30.2
7	18.3	55.0	120.1	164.1	91.7	186.1	256.8	337.0	176.0	52.1	34.0	32.2
8	31.0	84.0	106.5	130.3	85.8	172.7	197.2	332.6	151.8	64.5	36.6	35.0
9	133.1	67.7	108.8	123.9	86.7	192.1	159.3	382.9	148.6	49.3	31.9	258.8
10	183.9	58.1	107.6	132.7	80.1	151.4	138.9	295.8	124.6	48.5	33.1	104.5
11	116.8	51.6	100.4	216.3	85.6	185.1	169.4	337.5	118.4	43.4	28.8	71.6
12	61.9	52.2	99.6	241.5	78.6	267.2	203.0	333.7	120.7	40.1	28.3	59.1
13	50.3	54.5	100.2	178.4	89.7	188.9	193.9	300.6	122.2	39.4	34.3	47.7
14	41.1	56.5	98.4	137.5	85.6	262.0	214.2	294.0	110.9	37.7	41.3	44.4
15	33.0	57.8	94.7	163.0	92.5	649.4	170.8	306.2	83.4	105.8	48.5	43.3
16	28.6	59.0	102.2	285.8	114.8	394.6	153.7	302.9	80.4	95.3	39.8	45.0
17	215.5	66.6	106.6	192.2	128.4	248.8	143.2	255.5	101.3	74.1	32.8	46.6
18	619.6	63.2	104.3	152.4	100.9	205.4	200.2	211.7	92.4	56.5	32.1	49.6
19	154.3	66.9	96.9	136.4	99.7	245.4	161.6	203.6	84.1	43.6	31.7	51.1
20	101.4	71.7	89.8	124.3	118.3	225.9	262.8	213.2	83.4	49.7	34.7	352.4
21	79.4	79.5	75.8	119.6	104.1	184.1	237.6	205.9	77.2	45.6	39.6	351.3
22	67.0	78.2	72.4	122.9	125.5	234.6	247.6	241.6	87.0	45.4	34.1	184.1
23	59.7	152.0	67.3	118.1	173.3	169.0	173.3	197.3	95.5	38.5	36.3	130.9
24	54.8	160.2	68.3	104.6	142.0	189.9	162.0	199.1	75.5	42.5	31.8	101.2
25	48.9	112.0	68.9	105.6	193.9	157.9	158.8	160.6	67.7	37.7	33.7	87.0
26	47.4	97.8	69.5	107.9	148.4	158.8	231.3	159.5	57.3	39.8	28.9	78.9
27	44.2	99.0	69.8	101.3	107.2	172.6	178.5	138.6	51.1	37.6	33.4	72.2
28	43.4	107.6	67.7	96.9	116.2	262.6	170.4	132.0	48.0	39.0	31.5	64.6
29	40.4	120.0	62.6	93.9	90.5	216.1	185.0	125.9	48.3	36.7	32.3	58.5
30	38.7		70.0	89.7	90.1	211.3	423.6	139.8	47.6	38.3	33.2	50.4
31	38.8		74.8		82.1		229.6	145.9		39.7		43.3
Average	79.1	74.9	94.0	148.0	106.3	207.2	197.0	288.8	105.0	48.7	34.3	85.4
Maximum	619.6	160.2	134.6	406.7	193.9	649.4	423.6	927.4	176.0	105.8	48.5	352.4
Minimum	15.6	35.8	62.6	80.2	78.6	84.2	129.5	125.9	47.6	36.7	28.3	29.4

Average annual discharge = 123 (m^3/sec)

Annual inflow volume = 3,879 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2009

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	42.7	70.1	105.5	76.6	123.4	93.7	82.7	112.1	165.1	45.2	26.5	23.2
2	42.2	66.3	98.0	110.9	128.7	89.3	90.3	117.8	174.0	48.0	26.9	25.2
3	42.2	66.8	99.6	189.9	119.9	95.2	89.7	147.5	219.1	45.3	26.1	23.3
4	45.5	66.0	195.9	165.1	143.6	93.9	88.1	105.0	217.9	70.9	23.9	25.3
5	49.5	71.1	142.4	150.2	148.8	93.4	79.8	116.0	143.7	55.3	26.2	23.8
6	43.9	156.2	136.6	177.2	130.5	84.8	75.5	123.2	117.7	50.5	26.2	25.3
7	39.0	123.1	120.4	351.5	105.3	61.5	56.6	167.0	102.2	46.7	26.3	26.2
8	39.0	99.0	104.5	292.2	106.2	62.2	55.0	119.5	94.3	44.8	26.5	22.5
9	41.9	95.6	90.0	313.5	106.1	52.5	60.5	101.3	90.7	44.5	32.3	22.0
10	42.0	102.4	79.6	226.8	105.5	52.7	80.4	145.5	91.1	44.1	89.8	23.8
11	42.7	130.9	80.9	197.5	104.0	55.4	79.4	115.0	115.0	41.5	47.2	24.3
12	40.1	125.6	73.8	174.9	96.8	56.8	94.5	106.9	111.7	40.7	33.2	24.9
13	40.3	121.1	75.9	161.6	92.4	57.5	192.4	135.1	90.9	39.3	29.9	24.8
14	40.4	425.5	76.6	152.8	101.1	57.8	122.4	135.5	86.6	38.6	30.2	24.2
15	41.0	221.2	80.1	138.5	109.8	56.0	93.9	351.8	81.6	37.2	31.0	22.4
16	44.5	183.4	81.2	133.0	104.7	126.0	81.1	334.6	95.5	34.7	28.7	22.4
17	51.1	161.0	77.6	140.0	107.6	118.4	76.6	270.5	82.8	34.2	29.3	22.3
18	75.2	159.2	81.2	138.5	126.2	86.0	185.2	174.8	62.1	32.5	30.8	22.4
19	153.0	141.6	81.5	139.7	136.1	70.2	114.2	136.3	60.4	31.9	28.7	20.7
20	107.6	162.1	79.1	134.8	129.7	57.6	96.7	148.9	57.8	32.1	30.8	20.1
21	76.9	139.5	79.7	136.7	137.1	52.4	125.2	108.2	56.2	31.7	26.8	21.4
22	68.7	125.8	72.8	146.4	108.6	52.8	221.3	121.6	54.9	32.6	26.5	21.6
23	62.2	132.4	70.9	125.9	98.3	54.9	203.1	101.3	51.1	32.2	26.4	20.9
24	64.0	191.1	72.2	114.7	94.6	56.5	194.4	117.1	50.5	31.5	26.4	21.8
25	69.2	149.6	104.7	105.4	95.4	63.0	125.8	100.0	47.0	31.5	26.5	21.4
26	91.4	134.9	118.8	103.1	92.3	56.9	98.8	186.6	46.6	29.6	26.6	21.5
27	124.5	122.8	81.9	107.2	87.4	66.0	118.1	126.2	45.4	28.5	27.4	22.2
28	103.0	111.5	115.4	107.3	90.2	72.0	255.0	92.3	47.9	28.3	25.3	20.0
29	79.2		104.9	119.6	88.1	77.8	261.4	88.9	47.4	28.6	27.4	20.2
30	69.0		130.2	116.3	85.2	93.9	220.8	82.5	50.7	27.4	25.4	18.9
31	69.2		91.0		87.0		122.6	130.5		27.3		19.6
Average	62.6	137.7	96.9	158.3	109.4	72.2	123.9	142.6	91.9	38.3	30.5	22.5
Maximum	153.0	425.5	195.9	351.5	148.8	126.0	261.4	351.8	219.1	70.9	89.8	26.2
Minimum	39.0	66.0	70.9	76.6	85.2	52.4	55.0	82.5	45.4	27.3	23.9	18.9

Average annual discharge = 90 (m^3/sec)

Annual inflow volume = 2,845 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2010

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.4	18.3	275.2	104.1	95.1	122.4	92.9	502.4	263.9	79.3	39.5	26.2
2	19.8	17.8	213.5	100.6	95.3	111.8	104.3	746.3	180.1	75.3	39.6	26.1
3	19.9	17.1	168.1	91.0	100.9	115.2	95.3	581.4	200.7	66.7	39.6	25.5
4	19.9	17.2	157.6	86.1	106.2	122.6	93.6	409.1	155.5	65.8	36.4	25.1
5	19.8	18.0	185.6	84.8	124.0	128.2	101.2	541.9	156.3	65.7	36.2	25.8
6	20.1	20.2	145.6	84.9	194.9	95.1	107.1	694.9	141.3	58.1	37.2	23.1
7	20.0	73.8	132.9	84.4	132.6	86.6	98.7	523.8	127.1	59.6	36.6	22.5
8	20.1	616.3	127.0	91.1	157.7	106.6	94.2	376.0	135.2	58.6	35.7	22.9
9	20.2	1,198.1	121.1	89.8	121.5	81.4	94.4	333.0	137.0	60.9	35.9	23.3
10	20.4	351.9	124.0	91.9	106.0	88.3	114.0	284.0	128.0	60.1	31.1	23.8
11	20.4	232.2	121.7	107.0	117.4	84.4	119.3	308.5	130.5	57.9	30.6	24.2
12	20.7	187.4	120.5	102.1	99.6	74.4	139.3	353.3	132.4	57.7	30.4	24.5
13	20.8	156.3	120.4	113.0	101.3	93.7	106.3	362.2	164.7	56.3	30.8	24.9
14	20.7	128.3	120.1	102.2	108.4	89.9	94.6	342.9	153.7	56.8	27.3	25.4
15	20.8	106.0	123.0	100.4	100.3	113.0	86.2	510.4	144.9	56.2	28.0	25.7
16	20.8	100.2	127.0	100.1	94.0	93.3	91.1	423.0	125.7	56.3	27.8	25.9
17	19.2	91.3	132.0	105.6	95.3	92.7	89.2	332.0	109.7	56.4	26.7	25.0
18	18.2	84.3	135.7	106.5	111.8	94.9	151.3	324.7	116.1	54.4	29.3	24.9
19	18.6	83.0	135.0	134.1	145.6	91.8	140.5	308.9	114.2	52.3	28.3	22.5
20	18.2	80.2	140.9	131.1	115.5	82.1	279.8	364.9	102.0	52.0	25.8	22.5
21	18.5	83.1	137.5	127.4	100.8	86.4	299.5	302.8	95.5	46.7	26.1	22.2
22	17.8	98.2	140.1	116.7	118.0	92.8	332.4	265.7	104.9	169.6	26.0	22.0
23	18.2	104.9	141.2	101.3	107.6	98.5	257.8	260.4	118.6	108.3	26.5	21.6
24	15.7	104.2	144.7	92.1	105.3	114.9	149.9	297.1	131.9	71.5	26.1	21.6
25	16.1	98.1	137.1	77.9	110.3	117.1	117.8	295.8	117.5	57.1	26.5	21.6
26	15.4	99.7	129.6	70.5	113.0	128.8	248.7	278.3	96.4	50.7	26.6	21.6
27	15.1	161.2	131.8	85.0	113.9	108.5	445.4	227.2	85.5	46.7	26.5	21.5
28	15.7	156.2	132.3	104.7	224.4	101.9	1,495.5	197.7	86.3	46.7	26.5	21.5
29	19.0		124.9	103.3	226.8	103.6	811.9	182.7	81.2	42.8	26.7	21.5
30	33.4		153.1	97.9	154.6	92.9	703.5	167.6	79.7	43.1	26.5	24.8
31	23.8		130.1		127.0		466.0	157.7		42.7		38.6
Average	19.6	160.8	142.9	99.6	123.4	100.5	245.9	363.1	130.5	62.3	30.6	24.1
Maximum	33.4	1,198.1	275.2	134.1	226.8	128.8	1,495.5	746.3	263.9	169.6	39.6	38.6
Minimum	15.1	17.1	120.1	70.5	94.0	74.4	86.2	157.7	79.7	42.7	25.8	21.5

Average annual discharge = 125 (m^3/sec)

Annual inflow volume = 3,954 (Mm^3)

River: Poonch **Station:** EFlow Site 3 **Year:** 2011

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	25.9	21.2	88.9	155.9	175.8	126.2	136.3	71.2	336.3	143.7	88.4	60.6
2	20.3	19.7	108.1	156.6	192.9	96.4	91.8	47.2	217.7	145.8	87.8	56.1
3	21.5	18.4	255.3	136.3	193.7	101.0	95.0	90.3	164.8	132.6	82.3	54.3
4	23.2	17.1	445.3	123.3	191.9	82.4	90.8	130.1	214.9	128.1	80.0	52.2
5	25.1	16.0	277.8	125.1	174.3	94.6	80.4	89.8	204.4	123.8	79.0	50.2
6	27.4	14.5	213.2	116.9	197.9	105.4	67.5	54.4	190.4	132.1	79.1	48.3
7	27.7	457.2	192.3	104.6	175.2	96.7	91.5	275.3	211.7	129.3	79.5	46.6
8	26.4	269.7	197.7	95.5	146.6	99.1	98.3	186.0	377.1	119.6	78.7	45.0
9	25.4	130.4	187.9	97.4	149.6	95.6	107.3	202.5	339.0	123.0	79.9	44.7
10	23.9	74.5	181.3	104.6	152.5	122.4	118.9	178.2	350.3	120.5	79.0	44.4
11	23.6	56.5	174.9	240.3	169.8	117.1	80.0	270.5	241.6	107.0	79.5	44.0
12	22.5	56.8	168.1	242.9	143.8	159.7	61.6	310.2	186.1	106.4	73.7	43.7
13	20.5	239.9	161.4	206.2	156.6	122.0	62.3	248.1	184.5	105.5	76.3	43.2
14	18.5	706.6	157.5	180.0	145.0	101.1	149.5	193.7	217.7	106.4	70.1	43.2
15	32.4	297.5	164.9	169.1	144.3	103.6	100.3	195.8	378.3	102.8	70.7	42.8
16	32.5	199.4	189.3	162.6	160.7	94.6	272.9	199.0	1,223.6	98.2	75.3	42.7
17	27.8	185.8	200.9	595.0	158.1	117.3	127.8	191.2	434.2	96.5	71.0	42.4
18	28.4	148.8	205.3	459.8	145.0	119.3	111.0	171.1	307.4	94.1	73.2	39.6
19	30.7	119.7	584.1	323.6	146.6	115.0	78.2	162.1	264.4	95.1	73.9	40.2
20	26.9	103.5	409.3	272.0	157.3	109.2	67.4	198.6	242.4	91.5	77.6	43.1
21	27.8	97.1	243.1	246.9	156.0	91.5	76.8	169.1	229.6	91.4	72.6	42.8
22	29.2	89.0	193.5	214.6	122.8	85.4	91.3	148.0	226.2	92.2	67.8	40.4
23	26.4	90.4	187.7	219.5	130.9	108.8	71.2	135.0	229.3	98.7	71.7	39.2
24	28.4	106.6	183.3	223.4	113.2	73.8	218.7	246.9	215.0	102.7	72.4	40.1
25	28.0	105.4	182.4	218.0	125.6	139.2	187.8	327.4	182.1	100.6	71.9	39.9
26	27.0	102.5	182.0	216.0	129.0	177.5	139.6	178.7	184.6	90.0	71.7	39.9
27	26.3	106.0	168.8	211.7	127.1	119.7	105.8	300.3	162.4	87.6	71.4	40.0
28	24.8	91.1	187.5	211.0	122.3	184.4	91.7	321.6	154.2	86.0	68.5	39.7
29	20.1		212.2	206.0	115.3	131.5	173.4	262.3	152.3	87.0	66.0	39.6
30	22.8		192.2	188.5	122.1	124.8	108.8	203.1	144.1	88.0	65.5	35.6
31	22.7		158.5		123.7		86.3	170.1		89.0		36.0
Average	25.6	140.8	214.7	207.4	150.5	113.8	111.0	191.2	272.2	106.9	75.2	43.9
Maximum	32.5	706.6	584.1	595.0	197.9	184.4	272.9	327.4	1,223.6	145.8	88.4	60.6
Minimum	18.5	14.5	88.9	95.5	113.2	73.8	61.6	47.2	144.1	86.0	65.5	35.6

Average annual discharge = 137 (m^3/sec)

Annual inflow volume = 4,334 (Mm^3)

APPENDIX E

SYNTHETIC MEAN DAILY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 4
(WITHOUT PROJECT)

River: Poonch **Station:** EFlow Site 4 **Year:** 1960

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	32.3	45.0	29.0	145.4	116.5	65.5	93.8	69.0	160.9	44.7	23.7	19.5
2	32.3	57.1	27.4	141.6	122.9	54.9	79.0	69.2	153.7	42.8	23.1	19.5
3	32.3	49.4	27.4	137.2	127.3	67.0	86.7	85.6	255.7	41.7	22.0	18.7
4	31.8	46.1	29.6	141.6	140.5	67.0	60.4	67.0	119.6	40.6	23.1	17.6
5	31.8	46.1	26.3	132.8	113.1	60.4	71.3	64.8	129.5	50.5	23.1	17.6
6	30.7	46.1	47.2	128.4	85.6	58.2	147.1	60.4	97.7	39.5	23.1	17.6
7	29.6	50.5	43.9	118.5	75.7	80.1	151.5	587.2	86.7	37.3	23.1	16.5
8	29.6	50.5	86.7	117.4	75.7	77.9	341.7	434.9	79.0	36.2	23.1	16.5
9	28.5	51.6	174.5	106.5	91.1	77.9	147.1	391.4	72.4	35.1	23.1	15.4
10	28.5	49.4	230.5	92.2	94.4	64.8	1,674.3	416.2	65.9	34.0	23.1	15.4
11	30.7	49.4	863.8	92.2	94.4	65.9	2,659.0	139.4	80.1	32.9	23.1	15.4
12	28.5	50.5	234.9	97.7	97.7	72.4	627.8	153.7	61.5	31.8	23.1	14.3
13	30.7	51.6	183.3	97.7	101.0	63.7	360.0	332.6	60.4	31.8	24.1	14.3
14	29.6	50.5	161.4	118.5	97.7	50.5	1,491.0	171.2	56.0	30.7	23.1	14.3
15	31.8	50.5	155.9	106.5	85.6	70.2	726.6	481.9	54.9	30.7	23.1	13.2
16	29.6	49.4	347.9	130.6	77.9	67.0	326.0	1,093.4	51.6	36.2	22.0	15.4
17	28.5	47.2	272.2	136.1	101.0	50.5	203.1	194.3	80.1	31.8	22.0	27.4
18	28.5	42.8	192.1	155.9	127.3	48.3	354.5	416.0	70.2	29.6	22.0	20.9
19	28.5	40.6	169.0	274.4	94.4	47.2	172.3	189.9	61.5	29.6	22.0	17.6
20	158.1	40.6	230.5	132.8	88.9	47.2	231.6	347.9	61.5	28.5	20.9	15.4
21	76.8	36.2	161.4	115.3	87.8	49.4	135.0	232.7	54.9	28.5	20.9	14.3
22	52.7	36.2	214.0	109.8	80.1	50.5	115.3	204.2	52.7	28.5	19.8	13.2
23	47.2	34.0	192.1	122.9	68.1	53.8	106.5	326.0	50.5	27.4	19.8	13.2
24	46.1	31.8	153.7	125.1	67.0	69.2	98.8	176.7	81.2	27.4	20.9	13.2
25	49.4	31.8	152.6	115.3	71.3	63.7	96.6	164.6	76.8	27.4	19.8	13.2
26	47.2	30.7	159.2	116.3	67.0	60.4	217.3	180.0	58.2	27.4	19.8	13.2
27	47.2	30.7	155.9	101.0	63.7	65.9	110.9	165.7	53.8	26.3	19.8	12.1
28	46.1	28.5	268.9	96.6	60.4	63.7	85.6	182.2	54.9	26.3	20.9	12.1
29	47.2	29.6	195.4	97.7	52.7	54.9	79.0	161.4	49.4	26.3	23.1	12.1
30	52.7		152.6	105.4	56.0	61.5	84.5	158.1	47.2	25.2	20.9	19.8
31	48.5		146.6		64.3		87.0	210.0		24.3		67.4
Average	41.7	43.3	177.0	123.6	88.6	61.6	362.0	255.7	81.3	32.6	22.0	17.6
Maximum	158.1	57.1	863.8	274.4	140.5	80.1	2,659.0	1,093.4	255.7	50.5	24.1	67.4
Minimum	28.5	28.5	26.3	92.2	52.7	47.2	60.4	60.4	47.2	24.3	19.8	12.1

Average annual discharge = 110 (m^3/sec)

Annual inflow volume = 3,468 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1961

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.0	158.1	87.8	96.6	105.4	65.9	183.3	313.9	429.2	195.4	75.7	52.7
2	20.9	299.7	83.4	99.9	104.3	72.4	112.0	534.5	580.6	113.1	60.4	35.1
3	18.7	187.7	77.9	107.6	108.7	76.8	135.0	297.5	174.5	102.1	54.9	48.3
4	12.1	189.9	69.2	97.7	110.9	82.3	140.5	185.5	180.0	97.7	50.5	47.2
5	9.9	155.9	70.2	138.3	104.3	83.4	237.1	167.9	124.0	93.3	49.4	46.1
6	8.8	136.1	64.8	107.6	96.6	147.1	259.0	133.9	237.1	90.0	49.4	46.1
7	7.7	130.6	59.3	85.6	91.1	236.0	219.5	118.5	593.8	86.7	48.3	45.0
8	7.7	106.5	59.3	80.1	84.5	288.7	369.9	125.1	1,376.4	84.5	47.2	43.9
9	7.7	88.9	54.9	81.2	91.1	206.4	242.6	854.0	1,031.8	107.6	47.2	42.8
10	7.7	82.3	53.8	232.7	90.0	171.2	161.4	683.8	587.2	96.6	46.1	41.7
11	7.7	79.0	65.9	1,034.0	88.9	142.7	149.3	293.1	378.7	79.0	45.0	40.6
12	7.7	72.4	95.5	553.2	88.9	130.6	108.7	209.6	310.6	79.0	42.8	40.6
13	6.6	64.8	90.0	994.5	87.8	107.6	94.4	173.4	329.3	64.8	41.7	40.6
14	6.6	62.6	96.6	394.0	86.7	104.3	96.6	161.4	277.7	64.8	41.7	39.5
15	6.6	60.4	106.5	293.1	220.6	91.1	225.0	185.5	543.3	61.5	42.8	38.4
16	6.6	61.5	113.1	228.3	124.0	73.5	621.3	270.0	373.2	60.4	73.5	41.7
17	6.6	82.3	122.9	203.1	75.7	69.2	373.2	211.8	283.2	57.1	61.5	92.2
18	6.6	103.2	107.6	184.4	61.5	70.2	146.0	207.5	238.2	57.1	47.2	62.6
19	6.6	99.9	142.7	173.4	60.4	77.9	107.6	118.5	206.4	58.2	45.0	49.4
20	6.6	101.0	127.3	253.6	60.4	87.8	122.9	391.9	184.4	60.4	43.9	47.2
21	6.6	93.3	108.7	267.8	63.7	74.6	161.4	152.6	178.9	62.6	42.8	45.0
22	6.6	88.9	82.3	193.2	80.1	116.3	1,276.5	114.2	187.7	60.4	41.7	43.9
23	6.6	80.1	76.8	140.5	93.3	106.5	950.5	169.0	208.5	57.1	39.5	41.7
24	6.6	82.3	139.4	112.0	68.1	96.6	391.9	279.9	299.7	53.8	37.3	40.6
25	7.7	71.3	138.3	104.3	40.6	104.3	419.3	373.2	400.6	52.7	36.2	40.6
26	37.3	72.4	93.3	99.9	38.4	180.0	562.0	194.3	388.6	48.3	58.2	40.6
27	26.3	83.4	87.8	117.4	31.8	159.2	329.3	177.8	191.0	46.1	160.3	39.5
28	20.9	88.9	121.8	115.3	31.8	97.7	251.4	137.2	124.0	43.9	113.1	38.4
29	580.6		96.6	124.0	43.9	129.5	466.5	115.3	116.3	79.0	64.8	36.2
30	484.1		101.0	127.3	57.1	204.2	717.8	221.7	117.4	151.5	56.0	34.0
31	268.9		109.8		58.2		459.9	540.0		132.8		31.8
Average	53.2	106.5	93.7	228.0	82.2	121.8	325.5	261.7	355.1	80.6	55.5	44.3
Maximum	580.6	299.7	142.7	1,034.0	220.6	288.7	1,276.5	854.0	1,376.4	195.4	160.3	92.2
Minimum	6.6	60.4	53.8	80.1	31.8	65.9	94.4	114.2	116.3	43.9	36.2	31.8

Average annual discharge = 151 (m^3/sec)

Annual inflow volume = 4,750 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1962

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.3	22.0	68.1	147.1	140.5	72.4	65.9	114.2	87.8	75.7	30.7	23.1
2	26.3	20.9	63.7	97.7	110.9	62.6	52.7	122.9	73.5	77.9	31.8	22.0
3	25.2	20.9	85.6	81.2	86.7	62.6	48.3	83.4	96.6	74.6	30.7	26.3
4	25.2	20.9	177.8	88.9	83.4	71.3	43.9	80.1	147.1	72.4	29.6	24.1
5	25.2	19.8	152.6	83.4	70.2	62.6	42.8	139.4	188.8	65.9	28.5	24.1
6	24.1	19.8	133.9	93.3	67.0	68.1	42.8	244.8	96.6	61.5	27.4	24.1
7	24.1	26.3	102.1	170.1	64.8	69.2	54.9	178.9	68.1	59.3	27.4	23.1
8	24.1	36.2	93.3	208.5	73.5	77.9	77.9	110.9	29.6	59.3	26.3	24.1
9	24.1	27.4	79.0	636.6	84.5	79.0	68.1	208.5	30.7	59.3	24.1	23.1
10	24.1	26.3	77.9	351.2	160.3	70.2	112.0	243.7	72.4	59.3	24.1	23.1
11	25.2	32.9	76.8	217.3	116.3	101.0	71.3	93.3	307.3	57.1	23.1	23.1
12	30.7	38.4	68.1	186.6	93.3	70.2	121.8	67.0	261.2	53.8	24.1	24.1
13	27.4	34.0	64.8	176.7	138.3	247.0	83.4	92.2	86.7	53.8	23.1	23.1
14	25.2	31.8	73.5	162.4	107.6	84.5	104.3	86.7	52.7	53.8	23.1	26.3
15	24.1	31.8	71.3	162.4	102.1	69.2	65.9	141.6	53.8	50.5	23.1	25.2
16	24.1	34.0	73.5	147.1	94.4	51.6	191.0	649.2	104.3	48.3	22.0	25.2
17	23.1	142.7	70.2	128.4	98.8	54.9	284.3	139.4	116.3	48.3	22.0	46.1
18	23.1	71.3	70.2	149.3	97.7	59.3	222.8	128.4	93.3	46.1	24.1	74.6
19	23.1	51.6	68.1	159.2	52.7	67.0	150.4	106.5	77.9	42.8	31.8	34.0
20	22.0	47.2	71.3	162.4	63.7	62.6	186.6	107.6	226.1	41.7	74.6	28.5
21	22.0	46.1	77.9	159.2	81.2	71.3	1,366.8	275.5	96.6	40.6	167.9	27.4
22	22.0	46.1	77.9	176.7	96.6	68.1	369.9	172.3	429.2	37.3	88.9	27.4
23	22.0	43.9	72.4	202.0	93.3	71.3	182.2	96.6	290.9	36.2	46.1	27.4
24	20.9	236.0	80.1	177.8	86.7	61.5	147.1	81.2	101.0	37.3	37.3	25.2
25	20.9	183.3	77.9	164.6	84.5	80.1	128.4	74.6	86.7	35.1	31.8	27.4
26	20.9	144.9	79.0	167.9	82.3	99.9	164.6	154.8	172.3	35.1	27.4	41.7
27	23.1	107.6	81.2	166.8	80.1	81.2	256.8	128.4	171.2	35.1	26.3	181.1
28	24.1	83.4	80.1	144.9	79.0	64.8	182.2	289.8	206.4	34.0	29.6	52.7
29	23.1		88.9	141.6	80.1	63.7	125.1	150.4	117.4	32.9	26.3	35.1
30	22.0		97.7	138.3	74.6	93.3	150.4	181.1	79.0	31.8	27.4	36.2
31	20.9		95.5		63.7		93.3	117.4		30.7		26.3
Average	23.8	58.8	85.5	175.0	90.6	77.3	169.6	156.8	134.1	49.9	36.0	34.7
Maximum	30.7	236.0	177.8	636.6	160.3	247.0	1,366.8	649.2	429.2	77.9	167.9	181.1
Minimum	20.9	19.8	63.7	81.2	52.7	51.6	42.8	67.0	29.6	30.7	22.0	22.0

Average annual discharge = 91 (m^3/sec)

Annual inflow volume = 2,874 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1963

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.1	23.1	35.1	91.1	65.9	264.5	237.1	963.0	441.2	37.3	15.4	25.2
2	23.1	22.0	34.0	84.5	178.9	124.0	212.9	292.0	149.3	31.8	16.5	23.1
3	24.1	22.0	37.3	205.3	147.1	109.8	153.7	142.7	95.5	27.4	19.8	24.1
4	26.3	22.0	73.5	206.4	125.1	116.3	124.0	149.3	115.3	25.2	17.6	23.1
5	27.4	20.9	221.7	56.0	198.7	117.4	81.2	375.4	133.9	23.1	16.5	22.0
6	28.5	20.9	271.1	76.8	225.0	121.8	76.8	249.2	165.7	25.2	14.3	20.9
7	27.4	20.9	136.1	105.4	141.6	109.8	93.3	212.9	99.9	29.6	16.5	20.9
8	27.4	20.9	150.4	113.1	138.3	106.5	122.9	341.4	61.5	29.6	17.6	17.6
9	27.4	20.9	154.8	118.5	228.3	96.6	82.3	293.1	147.1	29.6	14.3	18.7
10	27.4	20.9	263.4	92.2	236.0	69.2	92.2	146.0	139.4	28.5	12.1	18.7
11	26.3	20.9	128.4	99.9	159.2	102.1	186.6	302.9	77.9	27.4	11.0	18.7
12	25.2	19.8	98.8	108.7	149.3	103.2	286.5	344.7	49.4	26.3	11.0	18.7
13	29.6	20.9	83.4	116.3	181.1	99.9	199.8	231.6	36.2	24.1	11.0	173.4
14	30.7	20.9	71.3	119.6	347.9	98.8	230.5	142.7	58.2	23.1	11.0	121.8
15	29.6	40.6	82.3	116.3	203.1	99.9	113.1	140.5	61.5	23.1	18.7	35.1
16	28.5	161.4	199.8	114.2	220.6	108.7	62.6	127.3	49.4	24.1	34.0	31.8
17	25.2	110.9	217.3	176.7	206.4	109.8	63.7	300.8	83.4	19.8	35.1	31.8
18	24.1	73.5	150.4	142.7	164.6	118.5	416.0	490.6	68.1	18.7	37.3	29.6
19	25.2	58.2	106.5	127.3	131.7	253.6	221.7	215.1	50.5	17.6	32.9	30.7
20	23.1	42.8	81.2	120.7	166.8	139.4	206.4	429.2	93.3	16.5	31.8	28.5
21	23.1	34.0	72.4	105.4	133.9	119.6	540.0	614.7	76.8	16.5	29.6	29.6
22	23.1	39.5	101.0	128.4	117.4	118.5	245.9	524.7	54.9	17.6	27.4	27.4
23	23.1	42.8	255.7	147.1	109.8	125.1	140.5	347.9	42.8	15.4	26.3	26.3
24	23.1	38.4	391.9	204.2	102.1	120.7	76.8	329.3	41.7	13.2	24.1	26.3
25	23.1	37.3	125.1	131.7	106.5	115.3	64.8	219.5	42.8	12.1	24.1	27.4
26	23.1	36.2	99.9	116.3	109.8	122.9	70.2	265.6	64.8	12.1	23.1	27.4
27	23.1	36.2	103.2	252.5	107.6	109.8	65.9	229.4	93.3	13.2	24.1	24.1
28	24.1	35.1	106.5	512.6	106.5	247.0	225.0	174.5	90.0	13.2	30.7	23.1
29	24.1		106.5	323.8	108.7	250.3	317.2	141.6	68.1	14.3	27.4	23.1
30	24.1		108.7	245.9	106.5	210.7	1,429.1	86.7	54.9	13.2	29.6	24.1
31	22.0		108.7		110.9		773.8	268.9		14.3		29.6
Average	25.4	38.7	134.7	152.0	156.0	133.7	232.7	293.3	93.6	21.4	22.0	33.0
Maximum	30.7	161.4	391.9	512.6	347.9	264.5	1,429.1	963.0	441.2	37.3	37.3	173.4
Minimum	22.0	19.8	34.0	56.0	65.9	69.2	62.6	86.7	36.2	12.1	11.0	17.6

Average annual discharge = 112 (m^3/sec)

Annual inflow volume = 3,535 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1964

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	27.4	85.6	81.2	97.7	114.2	62.6	88.9	175.6	378.7	69.2	31.8	22.0
2	25.2	82.3	80.1	103.2	129.5	64.8	154.8	170.1	240.4	65.9	30.7	22.0
3	25.2	79.0	102.1	375.4	130.6	64.8	307.3	154.8	185.5	65.9	29.6	22.0
4	25.2	74.6	96.6	200.9	127.3	65.9	169.0	144.9	154.8	64.8	28.5	22.0
5	27.4	70.2	85.6	150.4	110.9	64.8	174.5	154.8	153.7	63.7	27.4	22.0
6	86.7	71.3	82.3	136.1	112.0	70.2	136.1	182.2	105.4	62.6	25.2	22.0
7	459.9	74.6	79.0	132.8	104.3	67.0	194.3	187.7	80.1	60.4	24.1	22.0
8	1,658.5	73.5	80.1	128.4	108.7	60.4	195.4	191.0	83.4	58.2	24.1	22.0
9	661.9	74.6	82.3	122.9	106.5	53.8	103.2	250.3	76.8	56.0	24.1	22.0
10	160.3	76.8	87.8	122.9	112.0	52.7	106.5	708.0	293.1	54.9	24.1	76.8
11	173.4	77.9	93.3	138.3	110.9	51.6	116.3	187.7	144.9	53.8	24.1	129.5
12	161.4	76.8	91.1	161.4	88.9	60.4	116.3	245.9	165.7	53.8	24.1	74.6
13	109.8	75.7	97.7	163.5	96.6	60.4	288.7	147.1	178.9	51.6	23.1	40.6
14	91.1	79.0	109.8	155.9	175.6	157.0	289.8	211.8	178.9	50.5	22.0	39.5
15	75.7	76.8	103.2	158.1	95.5	142.7	1,692.5	1,434.6	159.2	48.3	20.9	39.5
16	67.0	76.8	108.7	296.4	93.3	128.4	599.3	857.2	167.9	47.2	20.9	38.4
17	62.6	87.8	112.0	200.9	83.4	114.2	556.5	708.0	155.9	43.9	20.9	37.3
18	60.4	219.5	154.8	132.8	82.3	88.9	373.2	639.9	117.4	41.7	20.9	37.3
19	58.2	144.9	277.7	105.4	82.3	85.6	204.2	434.7	120.7	40.6	20.9	37.3
20	54.9	132.8	183.3	101.0	79.0	85.6	161.4	540.0	118.5	38.4	20.9	37.3
21	87.8	117.4	155.9	98.8	124.0	84.5	126.2	854.0	110.9	38.4	20.9	37.3
22	186.6	106.5	140.5	101.0	120.7	90.0	98.8	463.2	103.2	37.3	20.9	37.3
23	138.3	106.5	129.5	103.2	95.5	95.5	88.9	326.0	95.5	36.2	20.9	37.3
24	116.3	99.9	138.3	105.4	71.3	96.6	104.3	863.8	90.0	36.2	20.9	38.4
25	108.7	95.5	159.2	129.5	59.3	91.1	1,931.8	540.0	85.6	35.1	20.9	35.1
26	104.3	91.1	136.1	222.8	59.3	85.6	792.5	351.2	105.4	35.1	20.9	31.8
27	103.2	95.5	125.1	182.2	57.1	95.5	537.8	279.9	84.5	34.0	20.9	28.5
28	99.9	84.5	119.6	170.1	54.9	93.3	434.7	236.0	79.0	34.0	20.9	26.3
29	92.2	82.3	128.4	140.5	52.7	95.5	556.5	205.3	73.5	34.0	20.9	23.1
30	90.0		116.3	121.8	52.7	95.5	354.5	215.1	70.2	32.9	22.0	22.0
31	84.5		101.0		58.2		210.7	223.9		32.9		22.0
Average	170.5	92.8	117.4	152.0	95.1	84.2	363.4	396.3	138.6	47.7	23.3	36.3
Maximum	1,658.5	219.5	277.7	375.4	175.6	157.0	1,931.8	1,434.6	378.7	69.2	31.8	129.5
Minimum	25.2	70.2	79.0	97.7	52.7	51.6	88.9	144.9	70.2	32.9	20.9	22.0

Average annual discharge = 144 (m^3/sec)

Annual inflow volume = 4,549 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1965

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.0	64.8	129.5	347.9	249.2	176.7	126.2	219.5	93.3	42.8	20.9	18.7
2	22.0	68.1	125.1	199.8	225.0	182.2	192.1	144.9	91.1	41.7	20.9	18.7
3	22.0	154.8	127.3	170.1	207.5	184.4	167.9	133.9	99.9	38.4	20.9	18.7
4	46.1	347.9	126.2	267.8	207.5	184.4	189.9	152.6	88.9	41.7	20.9	18.7
5	29.6	172.3	122.9	220.6	203.1	180.0	144.9	155.9	75.7	37.3	29.6	18.7
6	27.4	74.6	130.6	332.6	209.6	208.5	130.6	189.9	67.0	30.7	40.6	18.7
7	26.3	95.5	127.3	472.0	211.8	193.2	124.0	170.1	64.8	28.5	26.3	17.6
8	26.3	88.9	158.1	373.2	225.0	155.9	128.4	136.1	70.2	28.5	23.1	17.6
9	27.4	77.9	222.8	326.0	219.5	152.6	187.7	180.0	71.3	30.7	22.0	17.6
10	24.1	71.3	138.3	274.4	182.2	153.7	164.6	176.7	67.0	31.8	20.9	17.6
11	23.1	74.6	122.9	256.8	180.0	147.1	131.7	128.4	68.1	29.6	20.9	17.6
12	23.1	76.8	116.3	237.1	165.7	144.9	127.3	116.3	64.8	29.6	20.9	16.5
13	23.1	126.2	122.9	256.8	158.1	155.9	125.1	102.1	61.5	39.5	20.9	16.5
14	22.0	116.3	133.9	229.4	163.5	162.4	118.5	113.1	62.6	57.1	45.0	16.5
15	22.0	95.5	140.5	206.4	178.9	161.4	222.8	104.3	57.1	26.3	39.5	16.5
16	22.0	142.7	143.8	217.3	178.9	149.3	444.5	101.0	54.9	24.1	27.4	16.5
17	22.0	909.9	135.0	215.1	180.0	135.0	239.3	132.8	53.8	24.1	22.0	15.4
18	22.0	441.2	144.9	363.3	184.4	118.5	397.3	110.9	54.9	24.1	20.9	15.4
19	571.9	270.0	275.5	549.9	187.7	119.6	248.1	114.2	75.7	23.1	19.8	15.4
20	175.6	217.3	220.6	332.6	222.8	157.0	354.5	142.7	68.1	22.0	20.9	15.4
21	86.7	182.2	138.3	238.2	277.7	171.2	171.2	112.0	69.2	20.9	20.9	15.4
22	69.2	163.5	124.0	223.9	441.2	172.3	142.7	444.5	99.9	20.9	20.9	14.3
23	64.8	152.6	115.3	275.5	388.6	173.4	351.2	176.7	62.6	19.8	20.9	14.3
24	58.2	144.9	106.5	1,034.0	274.4	160.3	472.0	400.6	52.7	20.9	20.9	15.4
25	51.6	141.6	110.9	512.6	195.4	160.3	633.3	189.9	57.1	20.9	20.9	16.5
26	49.4	142.7	132.8	369.9	176.7	153.7	838.6	149.3	56.0	20.9	19.8	16.5
27	41.7	138.3	135.0	326.0	185.5	148.2	326.0	120.7	51.6	20.9	19.8	15.4
28	48.3	136.1	114.2	310.6	187.7	157.0	191.0	196.5	48.3	20.9	19.8	14.3
29	48.3		110.9	268.9	178.9	153.7	157.0	160.3	50.5	20.9	18.7	14.3
30	77.9		109.8	251.4	182.2	137.2	165.7	135.0	45.0	20.9	18.7	14.3
31	70.2		218.4		173.4		193.2	105.4		20.9		14.3
Average	60.2	174.6	141.3	322.0	213.0	160.3	245.4	161.8	66.8	28.4	23.5	16.4
Maximum	571.9	909.9	275.5	1,034.0	441.2	208.5	838.6	444.5	99.9	57.1	45.0	18.7
Minimum	22.0	64.8	106.5	170.1	158.1	118.5	118.5	101.0	45.0	19.8	18.7	14.3

Average annual discharge = 134 (m^3/sec)

Annual inflow volume = 4,227 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1966

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	14.3	13.2	96.6	176.7	162.4	108.7	170.1	1,115.2	144.9	137.2	43.9	30.7
2	14.3	13.2	86.7	159.2	139.4	91.1	110.9	565.3	102.1	133.9	45.0	29.6
3	14.3	13.2	84.5	165.7	128.4	84.5	126.2	447.8	540.0	138.3	45.0	29.6
4	14.3	13.2	149.3	172.3	142.7	85.6	271.1	397.3	193.2	227.2	46.1	29.6
5	14.3	13.2	180.0	151.5	153.7	99.9	158.1	410.5	170.1	172.3	43.9	29.6
6	14.3	13.2	126.2	138.3	152.6	87.8	112.0	556.5	149.3	182.2	41.7	29.6
7	14.3	13.2	105.4	230.5	163.5	85.6	79.0	1,069.1	203.1	133.9	42.8	29.6
8	13.2	57.1	108.7	152.6	171.2	105.4	86.7	493.9	2,366.5	127.3	64.8	28.5
9	13.2	76.8	107.6	131.7	171.2	117.4	80.1	356.7	3,069.0	120.7	52.7	28.5
10	13.2	68.1	106.5	122.9	164.6	107.6	75.7	341.4	472.0	319.4	38.4	28.5
11	13.2	61.5	124.0	118.5	341.4	76.8	62.6	332.6	356.7	222.8	37.3	28.5
12	13.2	351.2	129.5	115.3	236.0	70.2	211.8	236.0	281.0	159.2	37.3	28.5
13	13.2	412.7	130.6	137.2	198.7	85.6	254.6	251.4	270.0	139.4	37.3	28.5
14	13.2	205.3	130.6	232.7	158.1	86.7	198.7	222.8	249.2	130.6	37.3	27.4
15	13.2	107.6	133.9	183.3	130.6	86.7	99.9	319.4	237.1	128.4	36.2	27.4
16	13.2	73.5	135.0	176.7	112.0	126.2	132.8	209.6	223.9	125.1	36.2	27.4
17	13.2	53.8	129.5	191.0	115.3	126.2	97.7	193.2	244.8	122.9	36.2	27.4
18	13.2	43.9	289.8	151.5	116.3	153.7	95.5	200.9	226.1	119.6	35.1	27.4
19	13.2	40.6	173.4	127.3	119.6	262.3	88.9	310.6	260.1	116.3	34.0	27.4
20	13.2	38.4	153.7	124.0	124.0	205.3	204.2	400.6	217.3	279.9	34.0	26.3
21	13.2	227.2	122.9	130.6	120.7	155.9	95.5	198.7	207.5	108.7	34.0	26.3
22	13.2	155.9	176.7	159.2	120.7	193.2	287.6	132.8	191.0	82.3	32.9	26.3
23	13.2	69.2	319.4	129.5	125.1	302.9	438.0	120.7	204.2	82.3	31.8	26.3
24	13.2	61.5	251.4	131.7	126.2	441.2	264.5	125.1	176.7	83.4	31.8	26.3
25	13.2	59.3	202.0	116.3	125.1	310.6	940.7	124.0	161.4	86.7	31.8	47.2
26	13.2	297.5	193.2	116.3	142.7	143.8	1,074.6	98.8	157.0	86.7	31.8	48.3
27	13.2	195.4	472.0	141.6	152.6	114.2	268.9	107.6	154.8	77.9	31.8	41.7
28	13.2	143.8	238.2	208.5	131.7	150.4	322.7	114.2	149.3	64.8	31.8	39.5
29	13.2		184.4	217.3	157.0	182.2	233.8	84.5	142.7	62.6	30.7	36.2
30	13.2		185.5	203.1	221.7	287.6	416.0	93.3	136.1	54.9	30.7	38.4
31	13.2		174.5		161.4		1,071.3	112.0		45.0		49.4
Average	13.4	103.3	167.8	157.1	154.4	151.2	262.3	314.3	388.6	131.4	38.2	31.5
Maximum	14.3	412.7	472.0	232.7	341.4	441.2	1,074.6	1,115.2	3,069.0	319.4	64.8	49.4
Minimum	13.2	13.2	84.5	115.3	112.0	70.2	62.6	84.5	102.1	45.0	30.7	26.3

Average annual discharge = 160 (m^3/sec)

Annual inflow volume = 5,034 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1967

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	46.1	18.7	81.2	335.9	317.2	118.5	141.6	214.0	105.4	57.1	39.5	25.2
2	38.4	17.6	82.3	829.8	286.5	130.6	128.4	203.1	144.9	56.0	38.4	25.2
3	36.2	17.6	81.2	317.2	171.2	128.4	90.0	904.4	132.8	54.9	37.3	621.3
4	35.1	17.6	81.2	204.2	163.5	133.9	138.3	341.4	127.3	97.7	37.3	101.0
5	34.0	17.6	82.3	165.7	139.4	118.5	108.7	531.3	109.8	67.0	36.2	60.4
6	34.0	17.6	81.2	165.7	127.3	109.8	105.4	646.5	102.1	58.2	35.1	50.5
7	29.6	17.6	81.2	151.5	109.8	128.4	114.2	264.5	297.5	54.9	34.0	43.9
8	29.6	18.7	72.4	147.1	116.3	136.1	131.7	366.6	96.6	52.7	34.0	40.6
9	29.6	17.6	72.4	124.0	132.8	124.0	144.9	243.7	85.6	50.5	34.0	38.4
10	28.5	17.6	74.6	125.1	139.4	104.3	155.9	196.5	99.9	52.7	32.9	36.2
11	27.4	17.6	72.4	116.3	138.3	112.0	144.9	184.4	220.6	50.5	32.9	37.3
12	26.3	18.7	155.9	109.8	120.7	114.2	114.2	332.6	214.0	56.0	31.8	41.7
13	25.2	19.8	487.3	108.7	106.5	126.2	252.5	173.4	397.3	50.5	30.7	42.8
14	24.1	18.7	227.2	126.2	99.9	120.7	98.8	1,055.9	363.3	47.2	29.6	40.6
15	23.1	18.7	171.2	133.9	98.8	119.6	93.3	197.6	151.5	46.1	29.6	40.6
16	22.0	18.7	587.2	140.5	105.4	189.9	115.3	189.9	169.0	43.9	29.6	39.5
17	22.0	32.9	319.4	148.2	108.7	176.7	87.8	152.6	131.7	42.8	30.7	39.5
18	20.9	71.3	253.6	162.4	118.5	92.2	92.2	181.1	105.4	41.7	29.6	38.4
19	20.9	182.2	225.0	157.0	119.6	77.9	93.3	211.8	131.7	47.2	29.6	38.4
20	19.8	658.6	214.0	161.4	132.8	70.2	1,124.0	326.0	95.5	46.1	29.6	37.3
21	19.8	245.9	205.3	155.9	142.7	69.2	240.4	175.6	84.5	41.7	28.5	36.2
22	19.8	148.2	204.2	154.8	165.7	70.2	200.9	153.7	79.0	40.6	28.5	34.0
23	19.8	98.8	203.1	158.1	172.3	73.5	1,055.9	142.7	75.7	39.5	30.7	34.0
24	19.8	86.7	198.7	157.0	175.6	74.6	360.0	196.5	74.6	45.0	30.7	101.0
25	19.8	76.8	1,227.1	161.4	161.4	88.9	319.4	176.7	95.5	110.9	30.7	114.2
26	18.7	76.8	816.6	164.6	146.0	94.4	255.7	164.6	105.4	92.2	29.6	736.5
27	18.7	74.6	251.4	205.3	116.3	83.4	590.5	141.6	86.7	58.2	28.5	577.4
28	18.7	77.9	206.4	624.6	102.1	79.0	227.2	164.6	70.2	48.3	29.6	144.9
29	18.7		193.2	385.3	96.6	85.6	204.2	130.6	63.7	43.9	28.5	116.3
30	18.7		175.6	194.3	97.7	263.4	562.0	130.6	60.4	41.7	26.3	99.9
31	18.7		163.5		107.6		194.3	132.8		40.6		91.1
Average	25.3	75.7	237.1	209.7	139.9	113.8	247.9	278.3	135.9	54.1	31.8	113.7
Maximum	46.1	658.6	1,227.1	829.8	317.2	263.4	1,124.0	1,055.9	397.3	110.9	39.5	736.5
Minimum	18.7	17.6	72.4	108.7	96.6	69.2	87.8	130.6	60.4	39.5	26.3	25.2

Average annual discharge = 139 (m^3/sec)

Annual inflow volume = 4,393 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1968

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	85.6	137.2	157.0	114.2	148.2	87.8	86.7	205.3	114.2	51.6	117.4	27.4
2	81.2	122.9	152.6	108.7	153.7	88.9	91.1	207.5	105.4	48.3	147.1	26.3
3	77.9	116.3	151.5	104.3	125.1	88.9	87.8	158.1	98.8	47.2	70.2	25.2
4	73.5	112.0	149.3	104.3	108.7	125.1	106.5	351.2	96.6	92.2	60.4	25.2
5	67.0	105.4	151.5	114.2	105.4	108.7	99.9	292.0	91.1	79.0	58.2	25.2
6	75.7	170.1	149.3	142.7	97.7	88.9	113.1	726.6	87.8	65.9	54.9	25.2
7	73.5	142.7	148.2	142.7	91.1	88.9	93.3	203.1	85.6	239.3	50.5	25.2
8	63.7	120.7	149.3	137.2	77.9	104.3	105.4	219.5	81.2	92.2	47.2	24.1
9	59.3	110.9	149.3	135.0	67.0	105.4	233.8	299.7	88.9	62.6	45.0	24.1
10	64.8	108.7	146.0	128.4	62.6	118.5	191.0	279.9	80.1	73.5	42.8	25.2
11	72.4	107.6	150.4	119.6	67.0	114.2	148.2	940.7	74.6	61.5	41.7	34.0
12	70.2	107.6	149.3	118.5	73.5	200.9	244.8	385.3	87.8	49.4	48.3	91.1
13	73.5	106.5	144.9	116.3	84.5	112.0	162.4	305.1	76.8	46.1	46.1	43.9
14	68.1	116.3	147.1	239.3	93.3	105.4	265.6	450.0	73.5	90.0	40.6	32.9
15	63.7	109.8	138.3	412.7	81.2	106.5	138.3	344.7	70.2	86.7	40.6	30.7
16	62.6	105.4	136.1	203.1	79.0	106.5	138.3	255.7	74.6	64.8	38.4	28.5
17	62.6	106.5	140.5	170.1	75.7	107.6	110.9	257.9	71.3	56.0	37.3	27.4
18	60.4	107.6	306.2	155.9	77.9	104.3	104.3	431.4	69.2	56.0	36.2	26.3
19	59.3	116.3	459.9	153.7	82.3	107.6	144.9	575.2	68.1	48.3	36.2	25.2
20	400.6	614.7	307.3	152.6	98.8	107.6	146.0	322.7	67.0	45.0	34.0	25.2
21	341.4	194.3	247.0	154.8	130.6	104.3	223.9	223.9	61.5	43.9	34.0	24.1
22	194.3	180.0	193.2	151.5	207.5	102.1	165.7	375.4	59.3	41.7	32.9	25.2
23	138.3	167.9	176.7	184.4	185.5	101.0	216.2	243.7	57.1	40.6	32.9	25.2
24	135.0	160.3	162.4	161.4	109.8	101.0	154.8	203.1	54.9	40.6	30.7	25.2
25	131.7	157.0	151.5	150.4	85.6	149.3	108.7	209.6	54.9	39.5	29.6	27.4
26	135.0	163.5	252.5	144.9	83.4	178.9	91.1	165.7	54.9	38.4	28.5	27.4
27	220.6	332.6	172.3	149.3	88.9	124.0	101.0	142.7	53.8	37.3	28.5	26.3
28	375.4	245.9	142.7	148.2	85.6	139.4	209.6	130.6	59.3	36.2	28.5	25.2
29	240.4	181.1	122.9	148.2	83.4	118.5	1,305.1	122.9	57.1	35.1	28.5	24.1
30	152.6		114.2	149.3	84.5	97.7	242.6	120.7	53.8	37.3	28.5	24.1
31	146.0		116.3		88.9		184.4	119.6		38.4		23.1
Average	126.7	159.6	175.3	153.9	99.5	113.1	187.6	299.0	74.3	60.8	46.5	28.9
Maximum	400.6	614.7	459.9	412.7	207.5	200.9	1,305.1	940.7	114.2	239.3	147.1	91.1
Minimum	59.3	105.4	114.2	104.3	62.6	87.8	86.7	119.6	53.8	35.1	28.5	23.1

Average annual discharge = 127 (m^3/sec)

Annual inflow volume = 4,024 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1969

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	23.1	279.9	96.6	139.4	172.3	184.4	115.3	110.9	75.7	79.0	34.0	23.1
2	23.1	95.5	97.7	139.4	167.9	164.6	95.5	104.3	70.2	159.2	36.2	23.1
3	23.1	65.9	104.3	132.8	161.4	149.3	96.6	148.2	68.1	72.4	35.1	23.1
4	23.1	57.1	105.4	122.9	153.7	157.0	102.1	266.7	75.7	49.4	37.3	22.0
5	23.1	58.2	108.7	114.2	152.6	130.6	126.2	630.0	63.7	45.0	36.2	22.0
6	23.1	48.3	116.3	105.4	147.1	118.5	104.3	1,729.9	131.7	41.7	36.2	22.0
7	23.1	46.1	117.4	107.6	146.0	107.6	105.4	391.9	96.6	38.4	34.0	22.0
8	23.1	43.9	118.5	121.8	148.2	103.2	141.6	254.6	73.5	36.2	32.9	22.0
9	22.0	45.0	118.5	129.5	157.0	96.6	181.1	344.7	118.5	36.2	32.9	20.9
10	22.0	43.9	115.3	130.6	189.9	93.3	159.2	459.9	70.2	35.1	31.8	20.9
11	22.0	43.9	117.4	128.4	212.9	94.4	124.0	272.2	62.6	142.7	31.8	20.9
12	23.1	41.7	122.9	125.1	329.3	93.3	101.0	262.3	62.6	99.9	31.8	20.9
13	30.7	45.0	128.4	116.3	630.0	99.9	118.5	215.1	63.7	35.1	31.8	20.9
14	30.7	73.5	130.6	121.8	466.5	96.6	289.8	196.5	77.9	51.6	30.7	20.9
15	26.3	54.9	132.8	125.1	250.3	95.5	180.0	253.6	101.0	116.3	28.5	19.8
16	25.2	47.2	128.4	157.0	184.4	96.6	157.0	267.8	83.4	79.0	27.4	19.8
17	24.1	110.9	125.1	124.0	154.8	99.9	116.3	410.5	73.5	51.6	26.3	19.8
18	23.1	96.6	154.8	106.5	148.2	109.8	110.9	351.2	71.3	48.3	26.3	19.8
19	23.1	71.3	490.6	92.2	144.9	124.0	105.4	259.0	62.6	46.1	25.2	19.8
20	23.1	60.4	335.9	375.4	130.6	135.0	188.8	232.7	58.2	43.9	25.2	18.7
21	23.1	56.0	173.4	237.1	125.1	126.2	310.6	193.2	57.1	40.6	25.2	18.7
22	23.1	52.7	162.4	151.5	135.0	116.3	204.2	225.0	51.6	38.4	25.2	18.7
23	23.1	51.6	322.7	124.0	144.9	128.4	149.3	161.4	54.9	38.4	25.2	18.7
24	23.1	52.7	187.7	108.7	142.7	112.0	1,230.4	136.1	57.1	36.2	25.2	17.6
25	22.0	65.9	309.5	93.3	124.0	102.1	310.6	149.3	48.3	35.1	24.1	17.6
26	69.2	70.2	593.8	85.6	122.9	98.8	287.6	153.7	41.7	36.2	24.1	17.6
27	97.7	276.6	252.5	79.0	115.3	94.4	267.8	106.5	41.7	35.1	23.1	16.5
28	56.0	112.0	183.3	114.2	110.9	143.8	434.7	97.7	41.7	58.2	23.1	16.5
29	43.9		166.8	571.9	116.3	103.2	233.8	90.0	40.6	69.2	23.1	16.5
30	36.2		153.7	239.3	122.9	137.2	158.1	83.4	40.6	50.5	23.1	16.5
31	34.0		151.5		125.1		122.9	81.2		35.1		17.6
Average	30.0	77.4	181.4	150.7	181.7	117.1	207.4	278.7	67.9	57.4	29.1	19.8
Maximum	97.7	279.9	593.8	571.9	630.0	184.4	1,230.4	1,729.9	131.7	159.2	37.3	23.1
Minimum	22.0	41.7	96.6	79.0	110.9	93.3	95.5	81.2	40.6	35.1	23.1	16.5

Average annual discharge = 117 (m^3/sec)

Annual inflow volume = 3,694 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1970

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.6	25.2	90.0	57.1	67.0	43.9	174.5	72.4	1,469.7	72.4	34.0	19.8
2	17.6	24.1	52.7	56.0	70.2	46.1	403.9	93.3	294.2	70.2	34.0	19.8
3	17.6	23.1	43.9	58.2	58.2	47.2	228.3	65.9	178.9	65.9	31.8	19.8
4	17.6	22.0	41.7	64.8	56.0	199.8	248.1	116.3	832.0	61.5	31.8	19.8
5	17.6	22.0	40.6	74.6	59.3	120.7	133.9	208.5	278.8	59.3	30.7	19.8
6	17.6	22.0	37.3	85.6	65.9	63.7	133.9	85.6	236.0	82.3	30.7	19.8
7	17.6	20.9	34.0	86.7	84.5	48.3	121.8	71.3	356.7	73.5	30.7	19.8
8	16.5	20.9	32.9	79.0	56.0	38.4	120.7	75.7	599.3	60.4	29.6	19.8
9	16.5	20.9	34.0	82.3	47.2	34.0	117.4	133.9	292.0	59.3	28.5	19.8
10	16.5	20.9	35.1	88.9	48.3	34.0	296.4	484.1	248.1	59.3	27.4	18.7
11	17.6	20.9	54.9	96.6	50.5	35.1	116.3	129.5	450.0	50.5	26.3	18.7
12	18.7	19.8	48.3	91.1	54.9	69.2	80.1	131.7	344.7	47.2	26.3	18.7
13	18.7	19.8	94.4	82.3	61.5	319.4	124.0	670.7	283.2	46.1	26.3	18.7
14	18.7	19.8	153.7	81.2	64.8	102.1	95.5	282.1	282.1	45.0	26.3	18.7
15	18.7	20.9	193.2	79.0	51.6	187.7	65.9	281.0	191.0	43.9	24.1	18.7
16	18.7	20.9	214.0	118.5	56.0	102.1	93.3	221.7	185.5	41.7	24.1	18.7
17	17.6	20.9	120.7	77.9	61.5	57.1	118.5	255.7	182.2	41.7	24.1	18.7
18	18.7	19.8	105.4	65.9	65.9	51.6	127.3	577.4	188.8	40.6	23.1	18.7
19	17.6	19.8	91.1	70.2	59.3	43.9	68.1	257.9	273.3	39.5	22.0	18.7
20	17.6	20.9	74.6	64.8	61.5	40.6	87.8	210.7	285.4	39.5	22.0	18.7
21	17.6	23.1	76.8	65.9	65.9	40.6	80.1	1,006.5	180.0	39.5	20.9	19.8
22	17.6	25.2	79.0	86.7	59.3	43.9	81.2	283.2	170.1	136.1	20.9	18.7
23	17.6	28.5	81.2	91.1	109.8	56.0	58.2	351.2	130.6	124.0	20.9	18.7
24	17.6	26.3	83.4	96.6	68.1	43.9	54.9	341.4	91.1	82.3	20.9	18.7
25	206.4	27.4	90.0	103.2	52.7	43.9	46.1	453.3	70.2	75.7	20.9	18.7
26	101.0	38.4	84.5	109.8	46.1	64.8	42.8	777.1	75.7	65.9	20.9	18.7
27	40.6	31.8	132.8	85.6	35.1	61.5	155.9	356.7	74.6	53.8	20.9	18.7
28	30.7	375.4	136.1	85.6	34.0	194.3	125.1	263.4	69.2	46.1	20.9	18.7
29	26.3		99.9	68.1	40.6	161.4	80.1	453.3	69.2	38.4	20.9	17.6
30	26.3		74.6	60.4	39.5	106.5	101.0	276.6	71.3	37.3	20.9	17.6
31	26.3		63.7		49.4		86.7	1,145.9		35.1		17.6
Average	28.5	35.8	83.7	80.5	58.1	83.4	124.8	326.9	281.8	59.2	25.4	18.9
Maximum	206.4	375.4	214.0	118.5	109.8	319.4	403.9	1,145.9	1,469.7	136.1	34.0	19.8
Minimum	16.5	19.8	32.9	56.0	34.0	34.0	42.8	65.9	69.2	35.1	20.9	17.6

Average annual discharge = 101 (m^3/sec)

Annual inflow volume = 3,182 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1971

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.6	14.3	40.6	48.3	65.9	230.5	105.4	867.1	288.7	41.7	37.3	24.1
2	17.6	14.3	34.0	52.7	67.0	157.0	658.6	1,288.6	221.7	40.6	67.0	24.1
3	16.5	14.3	29.6	53.8	64.8	128.4	281.0	319.4	244.8	40.6	52.7	24.1
4	17.6	14.3	37.3	64.8	67.0	112.0	225.0	228.3	194.3	38.4	40.6	23.1
5	17.6	14.3	39.5	91.1	67.0	99.9	273.3	226.1	162.4	38.4	36.2	24.1
6	17.6	14.3	45.0	73.5	56.0	91.1	175.6	191.0	112.0	37.3	34.0	24.1
7	17.6	14.3	43.9	65.9	56.0	97.7	127.3	838.6	113.1	36.2	32.9	24.1
8	17.6	14.3	43.9	62.6	57.1	103.2	144.9	487.3	91.1	35.1	32.9	23.1
9	16.5	14.3	42.8	59.3	47.2	130.6	124.0	506.0	87.8	35.1	30.7	23.1
10	16.5	15.4	43.9	58.2	52.7	627.8	94.4	298.6	81.2	35.1	30.7	23.1
11	16.5	16.5	48.3	51.6	47.2	255.7	92.2	233.8	88.9	34.0	29.6	23.1
12	15.4	17.6	52.7	41.7	43.9	163.5	114.2	198.7	84.5	34.0	28.5	23.1
13	15.4	15.4	56.0	37.3	40.6	117.4	692.6	167.9	80.1	34.0	27.4	23.1
14	15.4	14.3	54.9	48.3	53.8	354.5	237.1	159.2	70.2	34.0	27.4	23.1
15	14.3	14.3	54.9	39.5	43.9	180.0	137.2	138.3	64.8	32.9	25.2	22.0
16	14.3	14.3	53.8	48.3	52.7	172.3	214.0	121.8	64.8	34.0	25.2	23.1
17	14.3	14.3	53.8	60.4	43.9	103.2	313.9	137.2	63.7	34.0	25.2	23.1
18	14.3	14.3	56.0	51.6	47.2	102.1	174.5	109.8	57.1	32.9	25.2	22.0
19	14.3	16.5	57.1	46.1	51.6	88.9	153.7	105.4	57.1	32.9	25.2	22.0
20	14.3	16.5	54.9	43.9	68.1	86.7	133.9	160.3	54.9	32.9	25.2	22.0
21	14.3	15.4	52.7	281.0	133.9	172.3	84.5	140.5	52.7	31.8	25.2	22.0
22	14.3	15.4	46.1	108.7	135.0	537.8	108.7	114.2	51.6	31.8	25.2	23.1
23	14.3	14.3	43.9	95.5	93.3	524.7	81.2	102.1	50.5	31.8	25.2	23.1
24	14.3	14.3	41.7	79.0	95.5	281.0	75.7	102.1	48.3	30.7	24.1	22.0
25	15.4	14.3	43.9	75.7	108.7	275.5	106.5	186.6	46.1	29.6	25.2	22.0
26	15.4	17.6	45.0	75.7	101.0	242.6	307.3	1,052.6	45.0	28.5	25.2	22.0
27	16.5	459.9	47.2	79.0	118.5	186.6	147.1	300.8	45.0	28.5	25.2	22.0
28	16.5	69.2	48.3	93.3	142.7	262.3	106.5	202.0	45.0	27.4	24.1	22.0
29	15.4		45.0	122.9	114.2	141.6	978.0	162.4	43.9	27.4	24.1	22.0
30	15.4		40.6	82.3	95.5	106.5	326.0	472.0	42.8	27.4	24.1	22.0
31	14.3		42.8		136.1		198.7	244.8		27.4		22.0
Average	15.7	32.8	46.5	73.1	76.4	204.5	225.6	318.2	91.8	33.5	30.3	22.8
Maximum	17.6	459.9	57.1	281.0	142.7	627.8	978.0	1,288.6	288.7	41.7	67.0	24.1
Minimum	14.3	14.3	29.6	37.3	40.6	86.7	75.7	102.1	42.8	27.4	24.1	22.0

Average annual discharge = 98 (m^3/sec)

Annual inflow volume = 3,093 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1972

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	22.0	519.2	57.1	107.6	82.3	113.1	106.5	79.0	164.6	64.8	52.7	31.1
2	22.0	221.7	64.8	103.2	70.2	107.6	73.5	73.5	121.8	58.2	49.4	29.6
3	20.9	84.5	73.5	94.4	64.8	90.0	263.4	65.9	105.4	56.0	47.2	27.4
4	22.0	58.2	79.0	90.0	63.7	82.3	155.9	53.8	125.1	52.7	46.1	26.3
5	20.9	47.2	106.5	180.0	65.9	71.3	178.9	286.5	92.2	50.5	45.0	25.2
6	20.9	43.9	75.7	118.5	74.6	60.4	164.6	2,093.2	92.2	52.7	43.9	25.2
7	20.9	39.5	65.9	97.7	92.2	51.6	173.4	43.9	135.0	56.0	42.8	24.1
8	20.9	34.0	341.4	85.6	83.4	52.7	92.2	212.9	163.5	60.4	42.8	24.1
9	20.9	29.6	244.8	104.3	94.4	46.1	1,531.2	296.4	329.3	48.3	42.8	25.2
10	20.9	27.4	129.5	82.3	93.3	42.8	453.3	129.5	534.5	48.3	42.8	140.5
11	20.9	27.4	104.3	71.3	98.8	47.2	612.5	106.5	133.9	47.2	41.7	95.5
12	20.9	354.5	97.7	81.2	101.0	58.2	385.3	105.4	99.9	46.1	40.6	40.6
13	20.9	184.4	306.2	86.7	108.7	58.2	214.0	122.9	85.6	41.7	39.5	34.0
14	20.9	84.5	148.2	93.3	115.3	65.9	128.4	180.0	90.0	40.6	37.3	32.9
15	20.9	63.7	121.8	94.4	106.5	70.2	120.7	114.2	73.5	38.4	36.2	35.1
16	20.9	58.2	113.1	160.3	102.1	71.3	95.5	126.2	133.9	39.5	35.1	31.8
17	20.9	56.0	121.8	263.4	103.2	76.8	148.2	227.2	192.1	39.5	34.0	34.0
18	20.9	53.8	110.9	204.2	116.3	77.9	104.3	126.2	81.2	70.2	32.9	46.1
19	20.9	54.9	119.6	171.2	113.1	68.1	125.1	310.6	271.1	175.6	31.8	40.6
20	20.9	62.6	243.7	137.2	120.7	52.7	103.2	294.2	194.3	82.3	31.8	59.3
21	24.1	69.2	182.2	104.3	119.6	52.7	81.2	166.8	118.5	60.4	29.6	41.7
22	150.4	65.9	133.9	90.0	107.6	64.8	70.2	107.6	85.6	250.3	31.8	35.1
23	49.4	62.6	130.6	83.4	233.8	73.5	62.6	95.5	76.8	121.8	35.1	32.9
24	27.4	69.2	139.4	87.8	310.6	68.1	87.8	105.4	75.7	90.0	37.3	35.1
25	24.1	67.0	155.9	88.9	125.1	77.9	77.9	131.7	70.2	71.3	38.4	40.6
26	23.1	65.9	180.0	85.6	93.3	119.6	90.0	87.8	65.9	59.3	41.7	48.3
27	22.0	62.6	290.9	86.7	83.4	82.3	65.9	81.2	64.8	51.6	40.6	107.6
28	22.0	67.0	207.5	153.7	85.6	239.3	61.5	120.7	62.6	45.0	35.1	109.8
29	22.0	56.0	196.5	164.6	86.7	115.3	69.2	290.9	62.6	41.7	34.0	82.3
30	22.0		203.1	110.9	90.0	105.4	158.1	220.6	73.5	40.6	32.9	62.6
31	117.4		131.7		112.0		106.5	204.2		38.4		52.7
Average	29.8	92.8	150.9	116.1	107.0	78.8	198.7	214.9	132.5	65.8	39.1	47.7
Maximum	150.4	519.2	341.4	263.4	310.6	239.3	1,531.2	2,093.2	534.5	250.3	52.7	140.5
Minimum	20.9	27.4	57.1	71.3	63.7	42.8	61.5	43.9	62.6	38.4	29.6	24.1

Average annual discharge = 106 (m^3/sec)

Annual inflow volume = 3,365 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1973

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	50.5	69.2	176.7	271.1	166.8	81.2	103.2	93.3	509.3	140.5	36.2	23.1
2	46.1	65.9	219.5	205.3	171.2	71.3	148.2	122.9	295.3	90.0	35.1	22.0
3	42.8	67.0	165.7	225.0	143.8	73.5	155.9	412.7	248.1	73.5	34.0	22.0
4	40.6	63.7	142.7	222.8	135.0	80.1	103.2	268.9	181.1	71.3	32.9	22.0
5	37.3	63.7	127.3	192.1	138.3	91.1	407.2	180.0	155.9	64.8	32.9	22.0
6	58.2	65.9	118.5	210.7	137.2	103.2	148.2	506.0	133.9	59.3	31.8	22.0
7	63.7	65.9	115.3	166.8	121.8	107.6	101.0	308.4	157.0	54.9	31.8	22.0
8	52.7	65.9	265.6	149.3	148.2	113.1	139.4	857.2	119.6	52.7	31.8	22.0
9	43.9	65.9	502.7	141.6	136.1	113.1	112.0	3,820.8	103.2	51.6	31.8	20.9
10	40.6	71.3	1,814.4	140.5	119.6	118.5	62.6	935.2	94.4	50.5	31.8	20.9
11	37.3	86.7	689.3	185.5	80.1	105.4	64.8	500.5	106.5	51.6	30.7	20.9
12	69.2	87.8	410.5	222.8	51.6	152.6	356.7	466.5	166.8	52.7	30.7	22.0
13	127.3	91.1	301.8	172.3	48.3	173.4	1,015.3	677.2	112.0	51.6	29.6	22.0
14	65.9	93.3	279.9	159.2	47.2	147.1	119.6	630.0	127.3	51.6	29.6	22.0
15	56.0	92.2	251.4	161.4	69.2	107.6	388.6	502.7	132.8	50.5	29.6	20.9
16	52.7	86.7	250.3	105.4	76.8	112.0	214.0	407.2	107.6	68.1	28.5	34.0
17	52.7	86.7	241.5	95.5	215.1	121.8	75.7	335.9	124.0	73.5	28.5	85.6
18	57.1	80.1	208.5	117.4	124.0	129.5	84.5	313.9	219.5	62.6	27.4	41.7
19	425.9	74.6	163.5	146.0	88.9	121.8	257.9	416.0	142.7	58.2	27.4	32.9
20	1,034.0	74.6	195.4	169.0	69.2	144.9	256.8	317.2	416.0	57.1	27.4	26.3
21	273.3	75.7	182.2	182.2	69.2	182.2	270.0	583.9	173.4	56.0	26.3	24.1
22	148.2	71.3	151.5	138.3	74.6	143.8	97.7	429.2	120.7	54.9	26.3	23.1
23	218.4	73.5	170.1	174.5	82.3	106.5	67.0	302.9	79.0	52.7	25.2	23.1
24	101.0	301.8	214.0	177.8	86.7	148.2	244.8	257.9	108.7	51.6	25.2	23.1
25	87.8	1,021.9	254.6	174.5	92.2	205.3	184.4	158.1	297.5	49.4	25.2	23.1
26	84.5	826.5	253.6	188.8	92.2	317.2	351.2	182.2	119.6	47.2	24.1	23.1
27	83.4	309.5	257.9	189.9	107.6	141.6	493.9	553.2	87.8	46.1	24.1	23.1
28	79.0	218.4	244.8	150.4	112.0	103.2	203.1	125.1	81.2	42.8	24.1	23.1
29	71.3		220.6	160.3	95.5	109.8	137.2	102.1	73.5	40.6	23.1	23.1
30	72.4		223.9	161.4	97.7	93.3	157.0	87.8	102.1	38.4	23.1	23.1
31	73.5		254.6		91.1		142.7	673.9		37.3		23.1
Average	120.9	157.7	292.5	171.9	106.1	127.3	215.0	500.9	163.2	58.2	28.9	25.8
Maximum	1,034.0	1,021.9	1,814.4	271.1	215.1	317.2	1,015.3	3,820.8	509.3	140.5	36.2	85.6
Minimum	37.3	63.7	115.3	95.5	47.2	71.3	62.6	87.8	73.5	37.3	23.1	20.9

Average annual discharge = 165 (m^3/sec)

Annual inflow volume = 5,189 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1974

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	23.1	27.4	72.4	104.3	68.1	52.7	86.7	119.6	88.9	73.5	17.6	14.3
2	23.1	46.1	87.8	92.2	68.1	46.1	86.7	144.9	83.4	46.1	17.6	14.3
3	22.0	378.7	99.9	101.0	64.8	61.5	138.3	463.2	56.0	39.5	17.6	22.0
4	20.9	114.2	104.3	103.2	69.2	52.7	140.5	332.6	62.6	37.3	17.6	23.1
5	20.9	81.2	102.1	84.5	67.0	56.0	92.2	237.1	46.1	37.3	17.6	20.9
6	19.8	73.5	83.4	81.2	65.9	165.7	82.3	183.3	49.4	36.2	17.6	17.6
7	18.7	65.9	82.3	77.9	64.8	73.5	79.0	129.5	48.3	35.1	17.6	17.6
8	18.7	57.1	94.4	74.6	70.2	50.5	81.2	94.4	83.4	32.9	16.5	16.5
9	17.6	53.8	104.3	133.9	74.6	62.6	99.9	81.2	51.6	29.6	17.6	16.5
10	17.6	48.3	92.2	88.9	68.1	52.7	326.0	71.3	50.5	29.6	16.5	16.5
11	17.6	47.2	90.0	77.9	64.8	65.9	181.1	93.3	48.3	28.5	16.5	15.4
12	17.6	46.1	81.2	77.9	46.1	52.7	128.4	151.5	42.8	27.4	16.5	15.4
13	18.7	45.0	72.4	82.3	41.7	37.3	172.3	154.8	41.7	27.4	16.5	15.4
14	29.6	43.9	69.2	87.8	39.5	40.6	118.5	221.7	37.3	26.3	16.5	15.4
15	27.4	50.5	67.0	92.2	41.7	42.8	268.9	194.3	37.3	26.3	16.5	19.8
16	26.3	59.3	71.3	85.6	58.2	42.8	188.8	107.6	41.7	25.2	16.5	37.3
17	24.1	68.1	73.5	76.8	73.5	42.8	219.5	77.9	36.2	25.2	15.4	29.6
18	23.1	72.4	63.7	81.2	57.1	42.8	129.5	69.2	36.2	25.2	15.4	18.7
19	22.0	60.4	73.5	85.6	56.0	63.7	136.1	64.8	36.2	24.1	15.4	20.9
20	261.2	60.4	106.5	79.0	61.5	160.3	385.3	77.9	37.3	24.1	15.4	19.8
21	137.2	60.4	113.1	85.6	58.2	143.8	137.2	69.2	41.7	23.1	15.4	18.7
22	62.6	130.6	129.5	76.8	51.6	74.6	272.2	75.7	36.2	22.0	15.4	17.6
23	49.4	198.7	170.1	61.5	36.2	326.0	147.1	63.7	35.1	22.0	15.4	17.6
24	47.2	87.8	341.4	69.2	32.9	1,069.1	360.0	61.5	34.0	20.9	15.4	16.5
25	46.1	69.2	279.9	79.0	30.7	397.3	266.7	87.8	50.5	19.8	14.3	16.5
26	34.0	73.5	154.8	84.5	39.5	216.2	338.1	59.3	67.0	18.7	14.3	16.5
27	29.6	71.3	115.3	79.0	77.9	135.0	167.9	65.9	38.4	18.7	14.3	16.5
28	28.5	70.2	124.0	72.4	71.3	108.7	110.9	56.0	54.9	18.7	14.3	16.5
29	28.5		105.4	69.2	63.7	99.9	107.6	51.6	45.0	17.6	14.3	16.5
30	27.4		115.3	65.9	58.2	88.9	101.0	61.5	73.5	17.6	14.3	16.5
31	27.4		107.6		57.1		210.7	61.5		17.6		16.5
Average	38.3	80.8	111.2	83.7	58.0	130.8	172.9	122.0	49.7	28.2	16.0	18.4
Maximum	261.2	378.7	341.4	133.9	77.9	1,069.1	385.3	463.2	88.9	73.5	17.6	37.3
Minimum	17.6	27.4	63.7	61.5	30.7	37.3	79.0	51.6	34.0	17.6	14.3	14.3

Average annual discharge = 76 (m^3/sec)

Annual inflow volume = 2,393 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1975

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	16.5	65.9	118.5	159.2	104.3	106.5	95.5	118.5	369.9	106.5	39.5	26.3
2	16.5	38.4	93.3	166.8	99.9	101.0	104.3	407.2	519.2	105.4	38.4	25.2
3	15.4	29.6	87.8	199.8	104.3	108.7	83.4	293.1	351.2	76.8	38.4	24.1
4	15.4	27.4	202.0	184.4	149.3	98.8	102.1	304.0	260.1	79.0	38.4	24.1
5	15.4	25.2	170.1	163.5	149.3	96.6	107.6	643.2	332.6	76.8	38.4	23.1
6	15.4	29.6	107.6	152.6	109.8	94.4	91.1	329.3	212.9	76.8	37.3	23.1
7	15.4	27.4	92.2	147.1	99.9	97.7	103.2	293.1	391.9	73.5	36.2	23.1
8	15.4	58.2	86.7	141.6	98.8	122.9	106.5	228.3	208.5	71.3	36.2	23.1
9	15.4	81.2	83.4	118.5	74.6	116.3	98.8	203.1	226.1	69.2	37.3	23.1
10	14.3	56.0	132.8	104.3	109.8	103.2	98.8	151.5	233.8	65.9	36.2	22.0
11	15.4	43.9	322.7	106.5	104.3	85.6	93.3	180.0	875.9	63.7	32.9	22.0
12	15.4	42.8	142.7	104.3	107.6	86.7	157.0	984.6	375.4	62.6	29.6	22.0
13	15.4	400.6	114.2	103.2	116.3	88.9	125.1	329.3	299.7	61.5	31.8	22.0
14	15.4	167.9	116.3	90.0	117.4	104.3	188.8	206.4	270.0	60.4	29.6	22.0
15	15.4	95.5	119.6	80.1	108.7	104.3	763.9	178.9	326.0	58.2	28.5	22.0
16	14.3	74.6	112.0	81.2	152.6	104.3	1,544.4	242.6	158.1	56.0	29.6	20.9
17	14.3	69.2	113.1	103.2	329.3	113.1	407.2	256.8	341.4	54.9	29.6	20.9
18	14.3	67.0	113.1	110.9	172.3	106.5	198.7	807.9	248.1	53.8	29.6	20.9
19	14.3	64.8	114.2	118.5	116.3	114.2	276.6	965.9	276.6	52.7	30.7	20.9
20	13.2	65.9	112.0	105.4	114.2	147.1	217.3	2,205.1	264.5	52.7	30.7	20.9
21	13.2	62.6	106.5	104.3	114.2	116.3	434.7	587.2	265.6	49.4	30.7	20.9
22	16.5	58.2	158.1	126.2	98.8	95.5	199.8	863.8	271.1	47.2	31.8	20.9
23	22.0	62.6	540.0	231.6	92.2	97.7	167.9	935.2	150.4	47.2	30.7	20.9
24	17.6	60.4	256.8	141.6	98.8	92.2	220.6	425.9	125.1	46.1	30.7	20.9
25	17.6	68.1	178.9	160.3	99.9	80.1	194.3	310.6	105.4	43.9	30.7	20.9
26	17.6	76.8	158.1	322.7	105.4	83.4	173.4	217.3	97.7	42.8	29.6	20.9
27	17.6	79.0	151.5	338.1	101.0	90.0	157.0	189.9	76.8	43.9	29.6	20.9
28	17.6	136.1	150.4	159.2	107.6	192.1	196.5	2,220.5	77.9	43.9	29.6	20.9
29	17.6		151.5	118.5	129.5	178.9	283.2	680.5	86.7	41.7	29.6	20.9
30	31.8		152.6	107.6	125.1	92.2	147.1	484.1	86.7	41.7	28.5	20.9
31	91.1		152.6		101.0		125.1	410.5		40.6		20.9
Average	18.8	76.2	152.0	145.0	119.7	107.3	234.3	537.2	262.8	60.2	32.7	22.0
Maximum	91.1	400.6	540.0	338.1	329.3	192.1	1,544.4	2,220.5	875.9	106.5	39.5	26.3
Minimum	13.2	25.2	83.4	80.1	74.6	80.1	83.4	118.5	76.8	40.6	28.5	20.9

Average annual discharge = 148 (m^3/sec)

Annual inflow volume = 4,669 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1976

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.8	103.2	192.1	153.7	161.4	154.8	113.1	4,068.9	281.0	198.7	42.8	28.5
2	18.7	86.7	216.2	151.5	163.5	154.8	144.9	4,255.5	459.9	104.3	41.7	29.6
3	18.7	64.8	209.6	149.3	163.5	154.8	164.6	957.1	655.3	87.8	40.6	37.3
4	18.7	58.2	215.1	125.1	161.4	148.2	130.6	811.1	524.7	80.1	39.5	34.0
5	18.7	52.7	212.9	278.8	147.1	150.4	99.9	1,087.8	354.5	77.9	38.4	31.8
6	18.7	49.4	180.0	231.6	141.6	153.7	116.3	1,087.8	257.9	70.2	38.4	31.8
7	17.6	47.2	163.5	172.3	151.5	129.5	121.8	2,420.3	229.4	99.9	38.4	30.7
8	17.6	47.2	151.5	176.7	158.1	135.0	137.2	882.5	281.0	88.9	37.3	29.6
9	17.6	47.2	268.9	214.0	147.1	135.0	214.0	602.6	191.0	73.5	37.3	29.6
10	17.6	47.2	178.9	281.0	166.8	174.5	609.2	463.2	174.5	67.0	36.2	28.5
11	17.6	48.3	138.3	253.6	180.0	147.1	288.7	360.0	167.9	62.6	36.2	28.5
12	17.6	65.9	124.0	200.9	172.3	181.1	276.6	416.0	164.6	60.4	36.2	27.4
13	27.4	110.9	149.3	181.1	192.1	266.7	329.3	276.6	181.1	59.3	35.1	27.4
14	203.1	161.4	142.7	178.9	175.6	212.9	400.6	540.0	151.5	57.1	34.0	26.3
15	48.3	1,142.6	165.7	182.2	157.0	294.2	453.3	322.7	138.3	56.0	34.0	26.3
16	31.8	366.6	571.9	184.4	165.7	227.2	1,043.8	394.0	130.6	56.0	32.9	26.3
17	28.5	254.6	577.4	218.4	257.9	281.0	347.9	288.7	129.5	53.8	31.8	25.2
18	26.3	478.6	375.4	210.7	203.1	228.3	1,587.2	317.2	157.0	51.6	32.9	25.2
19	24.1	431.4	308.4	208.5	216.2	189.9	540.0	366.6	112.0	50.5	32.9	25.2
20	23.1	288.7	397.3	243.7	173.4	126.2	571.9	378.7	104.3	47.2	31.8	25.2
21	22.0	226.1	322.7	262.3	151.5	147.1	524.7	266.7	99.9	46.1	31.8	25.2
22	22.0	186.6	264.5	260.1	144.9	155.9	369.9	216.2	95.5	43.9	30.7	24.1
23	22.0	164.6	227.2	244.8	139.4	140.5	410.5	189.9	91.1	41.7	30.7	24.1
24	23.1	147.1	198.7	299.7	199.8	107.6	537.8	198.7	88.9	40.6	30.7	24.1
25	25.2	375.4	188.8	284.3	191.0	103.2	341.4	232.7	85.6	83.4	31.8	24.1
26	34.0	363.3	192.1	242.6	154.8	104.3	811.1	184.4	82.3	57.1	30.7	25.2
27	587.2	242.6	247.0	232.7	132.8	104.3	466.5	322.7	81.2	49.4	29.6	26.3
28	205.3	207.5	262.3	248.1	136.1	110.9	257.9	205.3	80.1	48.3	30.7	25.2
29	85.6	192.1	204.2	222.8	137.2	114.2	242.6	191.0	79.0	48.3	29.6	24.1
30	67.0		175.6	182.2	141.6	117.4	236.0	184.4	198.7	46.1	28.5	24.1
31	60.4		175.6		157.0		196.5	119.6		45.0		24.1
Average	57.6	208.9	238.6	215.9	165.8	161.7	389.9	729.3	194.3	66.2	34.5	27.3
Maximum	587.2	1,142.6	577.4	299.7	257.9	294.2	1,587.2	4,255.5	655.3	198.7	42.8	37.3
Minimum	17.6	47.2	124.0	125.1	132.8	103.2	99.9	119.6	79.0	40.6	28.5	24.1

Average annual discharge = 208 (m^3/sec)

Annual inflow volume = 6,581 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1977

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.3	81.2	54.9	68.1	101.0	104.3	137.2	114.2	166.8	82.3	50.5	70.2
2	26.3	85.6	52.7	65.9	104.3	104.3	310.6	363.3	163.5	85.6	46.1	45.0
3	25.2	80.1	52.7	64.8	397.3	101.0	410.5	288.7	251.4	95.5	292.0	41.7
4	24.1	71.3	54.9	68.1	234.9	103.2	222.8	1,668.4	125.1	73.5	112.0	40.6
5	24.1	69.2	54.9	92.2	141.6	97.7	218.4	699.2	221.7	73.5	63.7	40.6
6	24.1	62.6	64.8	180.0	112.0	79.0	1,478.5	410.5	332.6	86.7	53.8	39.5
7	23.1	58.2	70.2	125.1	95.5	73.5	229.4	309.5	116.3	69.2	48.3	38.4
8	23.1	54.9	81.2	86.7	86.7	68.1	255.7	322.7	319.4	65.9	46.1	38.4
9	24.1	57.1	80.1	77.9	174.5	69.2	181.1	238.2	104.3	62.6	46.1	36.2
10	38.4	65.9	80.1	109.8	188.8	74.6	159.2	225.0	172.3	102.1	46.1	37.3
11	129.5	68.1	73.5	87.8	175.6	68.1	652.0	238.2	157.0	60.4	43.9	39.5
12	31.8	65.9	67.0	107.6	107.6	79.0	278.8	307.3	116.3	57.1	45.0	65.9
13	24.1	64.8	68.1	94.4	126.2	97.7	391.9	218.4	158.1	54.9	45.0	42.8
14	22.0	65.9	93.3	98.8	128.4	138.3	792.5	229.4	121.8	53.8	46.1	41.7
15	22.0	64.8	68.1	91.1	114.2	93.3	1,466.4	166.8	112.0	53.8	43.9	39.5
16	23.1	63.7	77.9	77.9	94.4	73.5	1,227.1	434.7	98.8	137.2	43.9	38.4
17	23.1	63.7	62.6	87.8	88.9	77.9	658.6	203.1	119.6	77.9	41.7	37.3
18	24.1	65.9	57.1	106.5	92.2	82.3	329.3	245.9	356.7	58.2	41.7	36.2
19	26.3	68.1	53.8	310.6	97.7	73.5	313.9	341.4	217.3	53.8	40.6	38.4
20	27.4	67.0	48.3	231.6	108.7	79.0	322.7	279.9	124.0	52.7	41.7	39.5
21	26.3	61.5	48.3	129.5	101.0	86.7	385.3	219.5	120.7	53.8	41.7	40.6
22	26.3	40.6	58.2	107.6	101.0	94.4	531.3	234.9	122.9	52.7	39.5	40.6
23	29.6	52.7	67.0	108.7	97.7	110.9	403.9	244.8	121.8	52.7	42.8	38.4
24	281.0	51.6	71.3	110.9	88.9	288.7	593.8	245.9	112.0	47.2	41.7	40.6
25	540.0	48.3	76.8	99.9	162.4	143.8	553.2	205.3	101.0	636.6	40.6	351.2
26	262.3	48.3	73.5	96.6	108.7	493.9	403.9	151.5	91.1	196.5	43.9	475.3
27	180.0	58.2	77.9	91.1	113.1	187.7	319.4	116.3	90.0	96.6	43.9	182.2
28	115.3	60.4	69.2	125.1	120.7	171.2	223.9	162.4	87.8	75.7	38.4	92.2
29	87.8		69.2	116.3	121.8	416.0	141.6	132.8	94.4	62.6	35.1	59.3
30	77.9		71.3	117.4	155.9	173.4	194.3	319.4	152.6	59.3	86.7	37.3
31	82.3		71.3		117.4		115.3	210.7		53.8		34.0
Average	74.9	63.0	66.8	111.2	130.9	130.1	448.5	308.0	155.0	91.7	56.4	72.2
Maximum	540.0	85.6	93.3	310.6	397.3	493.9	1,478.5	1,668.4	356.7	636.6	292.0	475.3
Minimum	22.0	40.6	48.3	64.8	86.7	68.1	115.3	114.2	87.8	47.2	35.1	34.0

Average annual discharge = 143 (m^3/sec)

Annual inflow volume = 4,521 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1978

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	63.7	110.9	241.5	184.4	186.6	120.7	195.4	456.6	182.2	130.6	51.6	52.7
2	62.6	101.0	194.3	183.3	186.6	135.0	186.6	441.2	169.0	118.5	49.4	52.7
3	61.5	92.2	165.7	184.4	194.3	153.7	450.0	1,361.1	177.8	112.0	47.2	51.6
4	59.3	85.6	210.7	187.7	205.3	148.2	245.9	317.2	164.6	102.1	79.0	50.5
5	56.0	80.1	335.9	181.1	200.9	166.8	419.3	275.5	142.7	95.5	69.2	49.4
6	56.0	101.0	257.9	178.9	203.1	161.4	1,709.0	249.2	149.3	88.9	218.4	53.8
7	54.9	122.9	195.4	189.9	204.2	155.9	931.9	177.8	153.7	83.4	206.4	50.5
8	53.8	90.0	172.3	205.3	176.7	155.9	407.2	232.7	142.7	82.3	133.9	51.6
9	49.4	73.5	162.4	215.1	186.6	152.6	275.5	1,804.5	148.2	81.2	144.9	53.8
10	47.2	80.1	249.2	228.3	185.5	128.4	319.4	1,040.6	172.3	80.1	96.6	56.0
11	43.9	79.0	322.7	227.2	184.4	124.0	206.4	894.6	166.8	79.0	85.6	57.1
12	43.9	84.5	247.0	248.1	165.7	107.6	185.5	695.9	176.7	79.0	76.8	58.2
13	54.9	95.5	200.9	250.3	153.7	155.9	378.7	854.0	143.8	77.9	147.1	59.3
14	118.5	99.9	194.3	268.9	149.3	170.1	356.7	497.2	255.7	75.7	161.4	59.3
15	69.2	120.7	185.5	271.1	153.7	122.9	257.9	385.3	209.6	73.5	85.6	56.0
16	56.0	119.6	891.3	261.2	173.4	119.6	271.1	630.0	176.7	67.0	61.5	51.6
17	53.8	118.5	3,603.5	306.2	176.7	112.0	344.7	419.3	176.7	61.5	57.1	46.1
18	51.6	120.7	773.8	502.7	182.2	110.9	309.5	407.2	147.1	58.2	54.9	41.7
19	51.6	109.8	509.3	251.4	158.1	109.8	438.0	792.5	158.1	54.9	48.3	37.3
20	51.6	105.4	400.6	200.9	165.7	107.6	335.9	478.6	138.3	54.9	49.4	34.0
21	53.8	101.0	347.9	184.4	148.2	149.3	901.2	422.6	128.4	57.1	49.4	29.6
22	52.7	102.1	306.2	174.5	152.6	167.9	587.2	565.3	143.8	57.1	62.6	26.3
23	61.5	106.5	279.9	205.3	153.7	153.7	658.6	284.3	249.2	58.2	60.4	22.0
24	60.4	104.3	268.9	203.1	183.3	148.2	614.7	264.5	185.5	57.1	52.7	17.6
25	57.1	121.8	252.5	187.7	296.4	137.2	605.9	234.9	127.3	59.3	51.6	13.2
26	57.1	132.8	234.9	185.5	219.5	132.8	568.6	219.5	109.8	57.1	51.6	12.1
27	60.4	118.5	229.4	181.1	202.0	200.9	602.6	210.7	271.1	56.0	52.7	12.1
28	274.4	126.2	251.4	187.7	159.2	163.5	472.0	267.8	221.7	58.2	52.7	12.1
29	288.7		230.5	192.1	158.1	273.3	403.9	216.2	163.5	60.4	51.6	12.1
30	152.6		215.1	186.6	163.5	1,227.1	1,171.2	196.5	144.9	58.2	52.7	12.1
31	125.1		195.4		132.8		558.7	207.5		54.9		12.1
Average	77.5	103.7	397.6	220.5	179.4	182.4	495.8	500.0	169.9	73.9	82.1	38.8
Maximum	288.7	132.8	3,603.5	502.7	296.4	1,227.1	1,709.0	1,804.5	271.1	130.6	218.4	59.3
Minimum	43.9	73.5	162.4	174.5	132.8	107.6	185.5	177.8	109.8	54.9	47.2	12.1

Average annual discharge = 212 (m^3/sec)

Annual inflow volume = 6,671 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1979

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	9.9	37.3	70.2	192.1	104.3	64.8	112.0	67.0	109.8	103.2	60.4	51.6
2	9.9	46.1	113.1	163.5	117.4	198.7	98.8	714.6	109.8	93.3	50.5	48.3
3	9.9	38.4	252.5	208.5	112.0	87.8	112.0	80.1	110.9	87.8	50.5	48.3
4	9.9	41.7	484.1	313.9	105.4	73.5	113.1	869.3	128.4	76.8	49.4	50.5
5	9.9	41.7	872.6	233.8	93.3	71.3	129.5	225.0	133.9	72.4	49.4	50.5
6	9.9	38.4	777.1	195.4	86.7	80.1	84.5	175.6	155.9	77.9	45.0	49.4
7	9.9	37.3	497.2	205.3	76.8	77.9	84.5	167.9	142.7	72.4	43.9	48.3
8	9.9	36.2	453.3	218.4	77.9	116.3	73.5	378.7	209.6	71.3	57.1	46.1
9	9.9	37.3	344.7	209.6	107.6	138.3	121.8	341.4	88.9	70.2	103.2	46.1
10	9.9	38.4	310.6	196.5	144.9	116.3	118.5	354.5	86.7	69.2	69.2	46.1
11	9.9	37.3	234.9	191.0	114.2	110.9	83.4	344.7	232.7	69.2	58.2	46.1
12	11.0	34.0	208.5	189.9	75.7	107.6	173.4	322.7	186.6	69.2	50.5	46.1
13	13.2	31.8	209.6	181.1	85.6	400.6	725.5	298.6	90.0	86.7	47.2	46.1
14	35.1	30.7	195.4	158.1	85.6	165.7	248.1	254.6	169.0	91.1	45.0	45.0
15	67.0	27.4	181.1	154.8	97.7	93.3	99.9	310.6	138.3	82.3	46.1	45.0
16	41.7	26.3	166.8	135.0	115.3	65.9	97.7	274.4	130.6	69.2	50.5	47.2
17	28.5	30.7	962.6	136.1	84.5	65.9	85.6	157.0	101.0	65.9	56.0	45.0
18	24.1	25.2	263.4	129.5	65.9	63.7	67.0	128.4	209.6	62.6	51.6	45.0
19	25.2	295.3	217.3	120.7	63.7	95.5	61.5	188.8	261.2	58.2	51.6	45.0
20	26.3	509.3	212.9	135.0	69.2	99.9	186.6	169.0	207.5	57.1	49.4	45.0
21	31.8	105.4	225.0	110.9	98.8	115.3	125.1	101.0	223.9	58.2	47.2	43.9
22	31.8	72.4	229.4	102.1	120.7	139.4	317.2	93.3	131.7	61.5	45.0	42.8
23	29.6	62.6	227.2	96.6	98.8	136.1	106.5	211.8	137.2	60.4	45.0	42.8
24	28.5	62.6	222.8	104.3	84.5	139.4	192.1	289.8	127.3	54.9	53.8	38.4
25	28.5	87.8	225.0	107.6	116.3	139.4	79.0	204.2	243.7	53.8	147.1	35.1
26	29.6	87.8	209.6	106.5	210.7	122.9	53.8	144.9	175.6	52.7	76.8	71.3
27	28.5	86.7	217.3	107.6	172.3	116.3	50.5	116.3	139.4	52.7	63.7	69.2
28	27.4	77.9	231.6	116.3	107.6	109.8	76.8	105.4	127.3	52.7	58.2	46.1
29	30.7		207.5	113.1	81.2	103.2	53.8	133.9	102.1	52.7	52.7	42.8
30	117.4		248.1	110.9	63.7	103.2	50.5	117.4	108.7	50.5	53.8	50.5
31	39.5		264.5		53.8		103.2	107.6		51.6		70.2
Average	26.0	74.4	307.6	158.1	99.7	117.3	131.8	240.3	150.7	68.0	57.6	48.2
Maximum	117.4	509.3	962.6	313.9	210.7	400.6	725.5	869.3	261.2	103.2	147.1	71.3
Minimum	9.9	25.2	70.2	96.6	53.8	63.7	50.5	67.0	86.7	50.5	43.9	35.1

Average annual discharge = 124 (m^3/sec)

Annual inflow volume = 3,902 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1980

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	120.7	53.8	106.5	132.8	119.6	133.9	74.6	157.0	242.6	43.9	49.4	48.3
2	113.1	51.6	94.4	137.2	119.6	130.6	83.4	212.9	51.6	43.9	48.3	46.1
3	71.3	170.1	82.3	151.5	118.5	125.1	107.6	1,062.5	29.6	43.9	46.1	43.9
4	59.3	124.0	73.5	110.9	116.3	106.5	215.1	400.6	34.0	40.6	43.9	41.7
5	58.2	103.2	614.7	118.5	112.0	94.4	199.8	309.5	62.6	38.4	41.7	40.6
6	61.5	86.7	699.2	130.6	115.3	86.7	157.0	177.8	87.8	40.6	41.7	37.3
7	62.6	80.1	231.6	135.0	121.8	81.2	90.0	195.4	88.9	38.4	39.5	36.2
8	60.4	73.5	222.8	118.5	121.8	81.2	71.3	164.6	81.2	161.4	38.4	36.2
9	58.2	68.1	161.4	125.1	120.7	92.2	90.0	580.6	93.3	92.2	37.3	36.2
10	57.1	62.6	124.0	132.8	114.2	94.4	64.8	71.3	284.3	51.6	37.3	35.1
11	56.0	59.3	113.1	127.3	99.9	112.0	394.0	38.4	97.7	60.4	36.2	34.0
12	54.9	54.9	140.5	104.3	99.9	118.5	143.8	43.9	121.8	48.3	36.2	35.1
13	53.8	59.3	103.2	93.3	97.7	243.7	115.3	63.7	202.0	42.8	35.1	35.1
14	52.7	68.1	90.0	99.9	110.9	229.4	194.3	87.8	130.6	40.6	35.1	34.0
15	50.5	218.4	185.5	93.3	117.4	138.3	203.1	101.0	92.2	38.4	34.0	34.0
16	54.9	165.7	170.1	95.5	116.3	114.2	95.5	83.4	73.5	40.6	34.0	34.0
17	54.9	114.2	133.9	119.6	105.4	99.9	103.2	170.1	63.7	38.4	32.9	31.8
18	50.5	102.1	255.7	133.9	94.4	105.4	81.2	103.2	52.7	43.9	31.8	31.8
19	54.9	92.2	159.2	132.8	98.8	107.6	92.2	79.0	53.8	52.7	31.8	31.8
20	56.0	122.9	129.5	139.4	109.8	114.2	154.8	73.5	61.5	45.0	30.7	30.7
21	57.1	108.7	125.1	140.5	93.3	189.9	120.7	64.8	53.8	43.9	30.7	30.7
22	53.8	118.5	307.3	122.9	84.5	131.7	77.9	57.1	43.9	39.5	30.7	30.7
23	52.7	133.9	184.4	105.4	77.9	118.5	106.5	51.6	40.6	36.2	29.6	31.8
24	52.7	112.0	177.8	106.5	77.9	1,047.1	76.8	92.2	37.3	34.0	29.6	38.4
25	52.7	93.3	169.0	118.5	83.4	261.2	80.1	91.1	73.5	34.0	28.5	35.1
26	65.9	82.3	197.6	119.6	86.7	271.1	197.6	91.1	48.3	37.3	31.8	45.0
27	86.7	160.3	136.1	114.2	96.6	129.5	296.4	92.2	41.7	36.2	322.7	57.1
28	93.3	253.6	143.8	120.7	120.7	97.7	245.9	75.7	41.7	36.2	101.0	39.5
29	85.6	129.5	138.3	119.6	124.0	76.8	239.3	71.3	38.4	37.3	61.5	34.0
30	73.5		129.5	115.3	110.9	106.5	200.9	76.8	40.6	45.0	50.5	31.8
31	67.0		128.4		125.1		138.3	159.2		58.2		30.7
Average	64.6	107.7	184.8	120.5	106.8	161.3	145.5	164.5	82.2	47.9	49.3	36.8
Maximum	120.7	253.6	699.2	151.5	125.1	1,047.1	394.0	1,062.5	284.3	161.4	322.7	57.1
Minimum	50.5	51.6	73.5	93.3	77.9	76.8	64.8	38.4	29.6	34.0	28.5	30.7

Average annual discharge = 106 (m^3/sec)

Annual inflow volume = 3,352 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1981

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	31.8	99.9	274.4	335.9	136.1	181.1	157.0	301.8	65.9	62.6	29.6	23.1
2	31.8	85.6	182.2	295.3	157.0	133.9	191.0	261.2	64.8	87.8	28.5	23.1
3	34.0	85.6	142.7	388.6	188.8	101.0	93.3	239.3	73.5	60.4	29.6	24.1
4	73.5	128.4	131.7	347.9	166.8	87.8	110.9	250.3	70.2	52.7	29.6	24.1
5	130.6	450.0	130.6	256.8	261.2	76.8	233.8	515.9	68.1	49.4	29.6	24.1
6	90.0	236.0	627.8	205.3	184.4	77.9	178.9	447.8	61.5	43.9	29.6	23.1
7	57.1	175.6	553.2	210.7	138.3	93.3	84.5	509.3	54.9	42.8	29.6	23.1
8	38.4	154.8	319.4	177.8	128.4	124.0	128.4	397.3	53.8	41.7	29.6	23.1
9	41.7	147.1	252.5	197.6	133.9	143.8	425.9	568.6	53.8	40.6	29.6	22.0
10	40.6	142.7	356.7	200.9	112.0	114.2	229.4	332.6	51.6	39.5	28.5	22.0
11	38.4	133.9	273.3	195.4	101.0	97.7	162.4	290.9	50.5	38.4	28.5	22.0
12	37.3	149.3	210.7	223.9	118.5	74.6	143.8	223.9	51.6	37.3	31.8	20.9
13	36.2	181.1	204.2	234.9	125.1	61.5	397.3	244.8	51.6	36.2	34.0	19.8
14	36.2	745.3	293.1	225.0	148.2	58.2	987.9	199.8	53.8	35.1	31.8	20.9
15	36.2	347.9	278.8	250.3	141.6	58.2	157.0	288.7	49.4	34.0	30.7	20.9
16	36.2	244.8	233.8	478.6	117.4	61.5	257.9	206.4	46.1	38.4	29.6	22.0
17	36.2	197.6	214.0	286.5	120.7	53.8	90.0	148.2	47.2	40.6	29.6	23.1
18	35.1	180.0	223.9	212.9	139.4	62.6	429.2	135.0	64.8	38.4	29.6	23.1
19	35.1	196.5	228.3	185.5	153.7	73.5	239.3	119.6	64.8	37.3	29.6	22.0
20	34.0	166.8	524.7	208.5	139.4	68.1	118.5	114.2	54.9	35.1	27.4	22.0
21	34.0	159.2	792.5	397.3	135.0	75.7	77.9	104.3	52.7	34.0	27.4	22.0
22	34.0	151.5	444.5	262.3	101.0	65.9	186.6	125.1	50.5	32.9	26.3	22.0
23	69.2	130.6	329.3	171.2	93.3	63.7	225.0	110.9	50.5	31.8	26.3	22.0
24	290.9	153.7	289.8	173.4	137.2	62.6	1,021.9	86.7	48.3	31.8	25.2	22.0
25	294.2	243.7	282.1	191.0	151.5	85.6	863.8	74.6	48.3	31.8	24.1	22.0
26	136.1	147.1	244.8	207.5	138.3	60.4	366.6	73.5	47.2	30.7	24.1	20.9
27	93.3	125.1	228.3	173.4	110.9	76.8	268.9	129.5	56.0	29.6	24.1	20.9
28	164.6	195.4	237.1	153.7	110.9	76.8	665.2	77.9	48.3	27.4	23.1	22.0
29	139.4		307.3	136.1	103.2	88.9	497.2	152.6	62.6	31.8	23.1	22.0
30	186.6		1,363.3	144.9	101.0	176.7	575.2	77.9	93.3	32.9	23.1	22.0
31	140.5		528.0		335.9		419.3	68.1		30.7		22.0
Average	81.1	198.4	345.3	237.6	142.9	87.9	322.1	221.8	57.0	39.9	28.1	22.2
Maximum	294.2	745.3	1,363.3	478.6	335.9	181.1	1,021.9	568.6	93.3	87.8	34.0	24.1
Minimum	31.8	85.6	130.6	136.1	93.3	53.8	77.9	68.1	46.1	27.4	23.1	19.8

Average annual discharge = 149 (m^3/sec)

Annual inflow volume = 4,692 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1982

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.9	34.0	257.9	310.6	297.5	164.6	400.6	1,062.5	73.5	40.6	39.5	35.1
2	20.9	31.8	236.0	292.0	354.5	116.3	165.7	481.9	72.4	38.4	38.4	41.7
3	20.9	30.7	135.0	278.8	281.0	99.9	135.0	266.7	68.1	34.0	37.3	46.1
4	23.1	51.6	106.5	275.5	241.5	105.4	98.8	209.6	67.0	30.7	36.2	40.6
5	31.8	40.6	273.3	256.8	247.0	113.1	97.7	940.7	63.7	28.5	36.2	38.4
6	25.2	36.2	231.6	236.0	239.3	133.9	93.3	322.7	61.5	25.2	36.2	38.4
7	23.1	32.9	155.9	219.5	313.9	143.8	120.7	1,463.1	59.3	23.1	36.2	37.3
8	22.0	35.1	137.2	143.8	250.3	142.7	140.5	425.9	60.4	22.0	36.2	40.6
9	20.9	29.6	115.3	142.7	207.5	133.9	94.4	627.8	58.2	22.0	36.2	87.8
10	20.9	34.0	412.7	158.1	198.7	137.2	86.7	863.8	54.9	25.2	37.3	96.6
11	20.9	76.8	216.2	149.3	388.6	131.7	71.3	515.9	52.7	23.1	37.3	49.4
12	20.9	58.2	172.3	142.7	276.6	130.6	87.8	394.0	51.6	139.4	36.2	45.0
13	20.9	31.8	139.4	143.8	197.6	149.3	150.4	459.9	54.9	60.4	35.1	51.6
14	20.9	35.1	147.1	148.2	163.5	136.1	104.3	317.2	57.1	45.0	34.0	54.9
15	20.9	32.9	151.5	149.3	169.0	231.6	86.7	326.0	52.7	34.0	94.4	47.2
16	20.9	34.0	243.7	450.0	143.8	199.8	102.1	329.3	47.2	36.2	388.6	43.9
17	20.9	39.5	252.5	872.6	136.1	167.9	112.0	207.5	45.0	34.0	83.4	40.6
18	19.8	34.0	187.7	519.2	124.0	138.3	118.5	154.8	42.8	26.3	87.8	38.4
19	19.8	41.7	172.3	338.1	140.5	114.2	254.6	193.2	46.1	34.0	76.8	38.4
20	19.8	240.4	160.3	268.9	112.0	113.1	373.2	142.7	41.7	34.0	63.7	37.3
21	18.7	141.6	160.3	223.9	106.5	136.1	283.2	125.1	74.6	32.9	65.9	36.2
22	31.8	81.2	468.7	216.2	107.6	106.5	157.0	121.8	255.7	38.4	51.6	36.2
23	52.7	65.9	568.6	200.9	305.1	99.9	487.3	118.5	103.2	41.7	43.9	38.4
24	27.4	61.5	987.9	241.5	232.7	87.8	991.2	239.3	76.8	46.1	41.7	41.7
25	24.1	53.8	938.5	220.6	149.3	69.2	182.2	137.2	59.3	37.3	39.5	37.3
26	27.4	48.3	468.7	233.8	153.7	62.6	262.3	121.8	53.8	34.0	38.4	36.2
27	29.6	47.2	363.3	373.2	185.5	137.2	120.7	98.8	48.3	38.4	38.4	35.1
28	32.9	152.6	338.1	648.7	187.7	133.9	211.8	90.0	45.0	192.1	37.3	41.7
29	29.6		310.6	531.3	161.4	96.6	204.2	86.7	45.0	73.5	37.3	69.2
30	29.6		329.3	335.9	197.6	208.5	308.4	99.9	43.9	48.3	36.2	50.5
31	36.2		332.6		187.7		590.5	86.7		41.7		45.0
Average	25.0	58.3	295.8	290.7	208.3	131.4	215.9	355.8	64.5	44.5	57.9	45.7
Maximum	52.7	240.4	987.9	872.6	388.6	231.6	991.2	1,463.1	255.7	192.1	388.6	96.6
Minimum	18.7	29.6	106.5	142.7	106.5	62.6	71.3	86.7	41.7	22.0	34.0	35.1

Average annual discharge = 150 (m^3/sec)

Annual inflow volume = 4,743 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1983

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	40.6	99.9	319.4	244.8	308.4	185.5	456.6	317.2	243.7	61.5	48.3	31.8
2	36.2	90.0	832.0	257.9	238.2	198.7	306.2	344.7	1,286.4	60.4	47.2	31.8
3	35.1	82.3	400.6	227.2	232.7	200.9	378.7	233.8	481.9	61.5	48.3	31.8
4	34.0	71.3	278.8	360.0	248.1	167.9	502.7	456.6	447.8	61.5	47.2	29.6
5	34.0	67.0	226.1	304.0	248.1	144.9	313.9	275.5	317.2	60.4	47.2	29.6
6	34.0	64.8	174.5	231.6	244.8	128.4	297.5	354.5	290.9	60.4	46.1	29.6
7	38.4	61.5	157.0	310.6	260.1	125.1	151.5	528.0	262.3	61.5	45.0	28.5
8	46.1	58.2	151.5	484.1	265.6	173.4	147.1	335.9	238.2	61.5	47.2	28.5
9	40.6	53.8	157.0	319.4	263.4	185.5	125.1	369.9	216.2	62.6	46.1	28.5
10	37.3	51.6	187.7	290.9	289.8	165.7	161.4	284.3	265.6	62.6	40.6	27.4
11	35.1	49.4	341.4	290.9	319.4	223.9	129.5	222.8	170.1	61.5	40.6	27.4
12	34.0	48.3	237.1	466.5	266.7	174.5	104.3	300.8	153.7	54.9	40.6	27.4
13	31.8	47.2	184.4	1,261.2	228.3	154.8	114.2	229.4	137.2	112.0	39.5	27.4
14	30.7	51.6	158.1	646.5	264.5	133.9	143.8	195.4	125.1	175.6	39.5	27.4
15	31.8	253.6	171.2	1,052.6	247.0	177.8	103.2	192.1	249.2	79.0	39.5	27.4
16	34.0	120.7	166.8	1,069.1	206.4	228.3	139.4	155.9	251.4	61.5	39.5	27.4
17	31.8	87.8	148.2	630.0	171.2	196.5	157.0	187.7	147.1	56.0	39.5	27.4
18	29.6	74.6	126.2	537.8	272.2	135.0	130.6	736.5	116.3	52.7	38.4	27.4
19	28.5	69.2	1,006.5	419.3	285.4	127.3	130.6	378.7	106.5	52.7	37.3	26.3
20	27.4	65.9	670.7	373.2	302.9	115.3	113.1	301.8	90.0	61.5	38.4	26.3
21	27.4	65.9	313.9	341.4	308.4	105.4	115.3	301.8	84.5	71.3	38.4	26.3
22	30.7	60.4	245.9	319.4	272.2	104.3	169.0	263.4	81.2	58.2	38.4	26.3
23	29.6	59.3	185.5	332.6	286.5	127.3	609.2	295.3	79.0	52.7	37.3	28.5
24	28.5	309.5	173.4	308.4	176.7	118.5	271.1	378.7	98.8	53.8	37.3	26.3
25	28.5	171.2	502.7	284.3	159.2	110.9	309.5	742.0	88.9	52.7	37.3	27.4
26	28.5	113.1	680.5	317.2	214.0	125.1	487.3	683.8	74.6	50.5	36.2	27.4
27	207.5	99.9	441.2	385.3	200.9	163.5	689.3	385.3	71.3	50.5	34.0	26.3
28	481.9	91.1	284.3	341.4	187.7	146.0	301.8	285.4	68.1	48.3	34.0	26.3
29	329.3		252.5	307.3	188.8	171.2	196.5	177.8	68.1	47.2	34.0	26.3
30	217.3		232.7	326.0	187.7	186.6	210.7	166.8	62.6	46.1	32.9	26.3
31	126.2		226.1		165.7		210.7	226.1		43.9		26.3
Average	71.8	90.7	310.8	434.7	242.3	156.7	247.6	332.5	212.5	63.1	40.5	27.9
Maximum	481.9	309.5	1,006.5	1,261.2	319.4	228.3	689.3	742.0	1,286.4	175.6	48.3	31.8
Minimum	27.4	47.2	126.2	227.2	159.2	104.3	103.2	155.9	62.6	43.9	32.9	26.3

Average annual discharge = 186 (m^3/sec)

Annual inflow volume = 5,879 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1984

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26.3	22.0	46.1	329.3	52.7	73.5	106.5	216.2	618.2	97.7	45.0	38.4
2	26.3	20.9	46.1	356.7	64.8	75.7	107.6	128.4	584.0	95.5	42.8	38.4
3	25.2	22.0	47.2	295.3	74.6	67.0	83.4	101.0	667.9	91.1	40.6	37.3
4	25.2	22.0	47.2	171.2	77.9	85.6	101.0	88.9	484.6	88.9	39.5	36.2
5	24.1	22.0	42.8	165.7	74.6	62.6	104.3	577.8	366.6	85.6	38.4	35.1
6	24.1	22.0	39.5	104.3	82.3	85.6	124.0	199.8	366.6	82.3	37.3	34.0
7	25.2	22.0	39.5	105.4	86.7	74.6	104.3	167.9	434.9	81.2	36.2	34.0
8	25.2	23.1	38.4	86.7	86.7	60.4	188.8	764.1	347.9	79.0	36.2	32.9
9	25.2	22.0	38.4	86.7	91.1	43.9	161.4	468.7	290.9	75.7	38.4	32.9
10	25.2	22.0	38.4	82.3	82.3	64.8	110.9	268.9	262.3	75.7	42.8	31.8
11	25.2	20.9	39.5	74.6	87.8	119.6	126.2	568.6	237.1	73.5	38.4	31.8
12	25.2	20.9	37.3	77.9	91.1	85.6	110.9	382.0	220.6	72.4	37.3	30.7
13	23.1	20.9	40.6	81.2	97.7	69.2	91.1	506.3	180.0	71.3	37.3	67.0
14	23.1	19.8	38.4	97.7	79.0	60.4	71.3	677.2	256.8	69.2	37.3	58.2
15	22.0	19.8	38.4	114.2	81.2	62.6	150.4	382.1	204.2	63.7	37.3	46.1
16	22.0	19.8	42.8	97.7	65.9	57.1	125.1	801.4	163.5	65.9	37.3	41.7
17	22.0	19.8	31.8	96.6	59.3	62.6	135.0	360.0	158.1	64.8	37.3	39.5
18	22.0	46.1	169.0	80.1	62.6	419.3	161.4	278.8	172.3	64.8	37.3	39.5
19	20.9	68.1	117.4	84.5	71.3	240.4	180.0	721.1	158.1	62.6	38.4	37.3
20	20.9	122.9	63.7	83.4	62.6	144.9	208.5	422.6	135.0	62.6	38.4	37.3
21	20.9	58.2	58.2	80.1	53.8	117.4	135.0	382.0	147.1	61.5	38.4	36.2
22	19.8	43.9	58.2	69.2	61.5	95.5	204.2	689.3	167.9	59.3	63.7	36.2
23	19.8	38.4	62.6	62.6	69.2	90.0	128.4	375.4	126.2	58.2	106.5	35.1
24	19.8	37.3	68.1	64.8	65.9	95.5	109.8	575.2	177.8	56.0	64.8	35.1
25	19.8	39.5	137.2	75.7	74.6	147.1	106.5	506.0	128.4	58.2	53.8	34.0
26	19.8	38.4	102.1	76.8	83.4	164.6	87.8	347.9	115.3	58.2	43.9	34.0
27	19.8	37.3	76.8	82.3	67.0	149.3	119.6	463.2	113.1	54.9	42.8	34.0
28	18.7	36.2	76.8	88.9	87.8	147.1	351.0	360.0	110.9	52.7	40.6	34.0
29	19.8	37.3	82.3	84.5	93.3	122.9	218.4	329.3	112.0	51.6	39.5	34.0
30	19.8		82.3	63.7	70.2	121.8	237.1	278.8	102.1	50.5	39.5	35.1
31	19.8		107.6		68.1		169.0	379.0		46.1		58.2
Average	22.4	33.3	63.1	114.0	75.1	108.9	142.5	411.9	253.7	68.7	43.6	38.3
Maximum	26.3	122.9	169.0	356.7	97.7	419.3	351.0	801.4	667.9	97.7	106.5	67.0
Minimum	18.7	19.8	31.8	62.6	52.7	43.9	71.3	88.9	102.1	46.1	36.2	30.7

Average annual discharge = 115 (m^3/sec)

Annual inflow volume = 3,633 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1985

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	75.7	53.8	69.2	63.7	79.0	63.7	75.7	222.8	69.2	56.0	50.5	49.4
2	52.7	51.6	67.0	61.5	210.7	65.9	59.3	222.8	67.0	56.0	50.5	49.4
3	43.9	51.6	70.2	61.5	86.7	71.3	47.2	304.1	64.8	57.1	50.5	49.4
4	42.8	52.7	65.9	76.8	70.2	67.0	43.9	497.0	62.6	56.0	50.5	48.3
5	59.3	99.9	63.7	64.8	63.7	71.3	45.0	453.3	80.1	88.9	50.5	48.3
6	57.1	68.1	69.2	75.7	62.6	72.4	52.7	354.5	67.0	81.2	49.4	48.3
7	48.3	62.6	71.3	126.2	68.1	71.3	181.1	1,649.7	62.6	77.9	48.3	48.3
8	46.1	61.5	58.2	178.9	77.9	109.8	250.3	447.8	67.0	68.1	48.3	80.1
9	43.9	59.3	57.1	207.5	104.3	69.2	93.3	298.6	64.8	173.4	48.3	75.7
10	41.7	57.1	52.7	169.0	169.0	90.0	121.8	268.9	63.7	144.9	49.4	53.8
11	40.6	57.1	52.7	126.2	101.0	155.9	81.2	240.4	64.8	87.8	50.5	50.5
12	40.6	56.0	51.6	103.2	95.5	60.4	149.3	239.3	69.2	76.8	50.5	48.3
13	40.6	57.1	50.5	88.9	84.5	64.8	264.5	177.8	69.2	71.3	50.5	49.4
14	40.6	57.1	48.3	86.7	81.2	67.0	194.3	157.0	71.3	68.1	49.4	48.3
15	40.6	57.1	47.2	77.9	67.0	74.6	193.2	148.2	73.5	69.2	49.4	51.6
16	40.6	57.1	47.2	74.6	62.6	68.1	438.0	132.8	63.7	72.4	49.4	102.1
17	40.6	57.1	45.0	75.7	58.2	64.8	354.5	122.9	73.5	65.9	49.4	102.1
18	39.5	57.1	51.6	84.5	57.1	61.5	212.9	115.3	114.2	64.8	48.3	69.2
19	48.3	57.1	48.3	80.1	54.9	63.7	206.4	105.4	74.6	61.5	48.3	59.3
20	48.3	57.1	45.0	76.8	75.7	64.8	279.9	108.7	62.6	60.4	48.3	54.9
21	73.5	58.2	47.2	81.2	90.0	67.0	151.5	102.1	61.5	58.2	48.3	50.5
22	57.1	54.9	47.2	79.0	82.3	60.4	319.4	95.5	83.4	57.1	49.4	50.5
23	50.5	54.9	51.6	73.5	80.1	68.1	129.5	299.7	79.0	56.0	49.4	49.4
24	48.3	58.2	60.4	65.9	91.1	64.8	203.1	97.7	88.9	56.0	50.5	49.4
25	47.2	62.6	54.9	60.4	129.5	58.2	1,183.2	104.3	68.1	56.0	50.5	351.2
26	98.8	60.4	60.4	54.9	91.1	61.5	612.5	87.8	61.5	54.9	50.5	972.5
27	103.2	60.4	101.0	57.1	71.3	107.6	369.9	83.4	59.3	53.8	50.5	239.3
28	73.5	62.6	106.5	61.5	71.3	114.2	289.8	74.6	58.2	52.7	50.5	116.3
29	67.0		95.5	60.4	71.3	87.8	308.4	71.3	58.2	51.6	50.5	97.7
30	60.4		75.7	67.0	70.2	77.9	506.0	80.1	58.2	50.5	50.5	88.9
31	57.1		67.0		67.0		447.8	75.7		50.5		79.0
Average	53.8	59.3	61.3	87.4	85.3	75.5	253.7	240.0	69.4	69.5	49.7	107.5
Maximum	103.2	99.9	106.5	207.5	210.7	155.9	1,183.2	1,649.7	114.2	173.4	50.5	972.5
Minimum	39.5	51.6	45.0	54.9	54.9	58.2	43.9	71.3	58.2	50.5	48.3	48.3

Average annual discharge = 102 (m^3/sec)

Annual inflow volume = 3,207 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1986

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	71.3	41.7	108.7	248.1	202.0	165.7	181.1	904.4	114.2	74.6	60.4	116.3
2	67.0	41.7	107.6	208.5	184.4	133.9	112.0	425.9	108.7	70.2	60.4	116.3
3	62.6	41.7	107.6	202.0	180.0	139.4	105.4	413.1	107.6	67.0	59.3	117.4
4	60.4	41.7	106.5	192.1	165.7	139.4	125.1	1,901.1	104.3	67.0	60.4	120.7
5	58.2	40.6	107.6	206.4	165.7	137.2	128.4	879.2	99.9	71.3	59.3	120.7
6	57.1	40.6	108.7	230.5	176.7	128.4	119.6	521.9	97.7	63.7	59.3	114.2
7	57.1	40.6	109.8	247.0	187.7	124.0	407.2	537.4	92.2	59.3	59.3	110.9
8	57.1	39.5	107.6	253.6	195.4	129.5	175.6	388.6	90.0	60.4	60.4	106.5
9	54.9	40.6	106.5	248.1	335.9	140.5	175.6	388.6	96.6	99.9	60.4	102.1
10	54.9	43.9	108.7	256.8	288.6	150.4	153.7	335.9	121.8	58.2	60.4	97.7
11	53.8	52.7	191.0	272.2	183.3	161.4	152.6	283.2	105.4	83.4	60.4	262.3
12	52.7	57.1	630.0	281.0	202.0	142.7	173.4	248.1	91.1	81.2	61.5	1,220.6
13	50.5	313.7	832.0	257.9	210.7	173.4	110.9	257.9	106.5	69.2	61.5	580.6
14	47.2	155.3	1,649.7	274.4	210.7	169.0	107.6	214.0	93.3	68.1	61.5	276.6
15	43.9	142.3	667.4	243.7	199.8	147.1	119.6	347.9	83.4	98.8	673.9	200.9
16	41.7	126.2	478.6	215.1	193.2	143.8	250.3	229.4	80.1	87.8	341.4	187.7
17	41.7	124.0	434.7	188.8	176.7	129.5	233.8	184.4	76.8	240.4	137.2	173.4
18	40.6	248.1	609.2	187.7	167.9	141.6	540.0	302.9	74.6	126.2	115.3	169.0
19	43.9	140.5	453.3	191.0	180.0	147.1	363.3	218.4	74.6	95.5	102.1	153.7
20	43.9	122.9	360.0	197.6	198.7	133.9	196.5	169.0	73.5	83.4	95.5	142.7
21	42.8	183.3	344.7	198.7	215.1	149.3	165.7	150.4	72.4	77.9	93.3	138.3
22	43.9	194.3	360.0	203.1	183.3	171.2	251.4	143.8	74.6	74.6	91.1	135.0
23	64.8	147.1	285.4	177.1	147.1	185.5	218.4	138.3	72.4	71.3	90.0	130.6
24	50.5	137.2	243.7	242.0	137.2	200.9	189.9	135.0	91.1	67.0	86.7	128.4
25	48.3	129.5	215.1	518.8	136.1	310.6	183.3	180.0	68.1	64.8	85.6	126.2
26	47.2	124.0	199.8	817.0	136.1	226.1	182.2	180.0	85.6	61.5	210.7	125.1
27	46.1	118.5	245.9	811.1	130.6	217.8	782.6	250.3	76.8	59.3	354.5	119.6
28	43.9	113.1	322.7	373.2	149.3	138.3	497.2	140.5	135.0	60.4	163.5	116.3
29	42.8		267.8	267.8	187.7	171.2	241.5	125.1	138.3	60.4	137.2	112.0
30	42.8		236.0	236.0	161.4	232.7	429.2	125.1	114.2	59.3	124.0	109.8
31	41.7		221.7		177.8		537.4	122.9		60.4		102.1
Average	50.8	108.7	333.1	281.6	186.0	162.7	245.5	349.8	94.0	78.8	124.9	188.2
Maximum	71.3	313.7	1,649.7	817.0	335.9	310.6	782.6	1,901.1	138.3	240.4	673.9	1,220.6
Minimum	40.6	39.5	106.5	177.1	130.6	124.0	105.4	122.9	68.1	58.2	59.3	97.7

Average annual discharge = 184 (m^3/sec)

Annual inflow volume = 5,818 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1987

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	86.7	65.9	113.1	193.2	166.8	210.7	109.8	104.3	132.8	37.3	46.1	37.3
2	83.4	64.8	108.7	239.3	139.4	209.6	112.0	97.7	71.3	40.7	45.0	37.3
3	83.4	64.8	102.1	281.0	120.7	288.7	107.6	84.5	61.5	54.7	46.1	38.4
4	83.4	62.6	106.5	251.4	109.8	298.6	106.5	223.9	60.4	45.0	45.0	38.4
5	88.9	60.4	112.0	192.1	114.2	223.9	112.0	214.0	76.8	39.8	45.0	38.4
6	86.7	60.4	88.9	178.9	158.1	221.7	132.8	107.6	61.5	37.6	45.0	37.3
7	83.4	60.4	149.3	175.6	125.1	205.3	132.8	122.9	70.2	36.7	43.9	37.3
8	82.3	61.5	182.2	176.7	322.7	221.7	114.2	102.1	63.7	36.7	45.0	37.3
9	81.2	64.8	144.9	369.9	283.2	444.5	112.0	113.1	137.2	36.3	45.0	37.3
10	81.2	61.5	125.1	227.2	425.9	363.3	110.9	105.4	120.7	262.8	43.9	37.3
11	80.1	58.2	114.2	177.8	265.6	222.8	120.7	112.0	90.0	186.4	43.9	37.3
12	80.1	58.2	118.5	163.5	216.2	184.4	120.7	158.1	65.9	229.9	42.8	37.3
13	80.1	59.3	125.1	144.9	194.3	158.1	108.7	170.1	60.4	162.5	41.7	37.3
14	79.0	59.3	113.1	130.6	182.2	158.1	97.7	116.3	59.3	156.9	41.7	36.2
15	77.9	60.4	115.3	130.6	169.0	166.8	95.5	102.1	58.2	109.7	40.6	36.2
16	76.8	60.4	215.1	128.4	165.7	154.8	155.9	96.6	60.4	86.4	40.6	36.2
17	80.1	171.2	165.7	130.6	155.9	133.9	109.8	99.9	53.8	71.8	40.6	36.2
18	77.9	132.8	133.9	144.9	154.8	122.9	119.6	180.0	51.6	150.7	39.5	36.2
19	73.5	144.9	130.6	142.7	163.5	120.7	104.3	96.6	50.5	151.6	39.5	35.1
20	73.5	73.5	129.5	144.9	185.5	128.4	107.6	133.9	50.5	108.1	38.4	35.1
21	71.3	70.2	214.0	158.1	228.9	136.1	98.8	255.7	50.5	87.3	38.4	35.1
22	71.3	73.5	400.6	166.8	304.4	115.3	106.5	180.0	60.4	78.0	38.4	35.1
23	69.2	76.8	444.5	173.4	882.2	112.0	118.5	150.4	54.9	69.0	38.4	35.1
24	69.2	407.2	295.3	170.1	431.8	114.2	148.2	231.6	49.4	67.1	38.4	35.1
25	69.2	338.1	247.0	133.9	274.9	112.0	165.7	131.7	46.1	62.4	38.4	34.0
26	69.2	147.1	478.6	132.8	257.5	110.9	262.3	85.6	43.9	59.0	38.4	34.0
27	69.2	143.8	309.5	132.8	234.9	112.0	133.9	77.9	41.7	56.5	37.3	34.0
28	69.2	122.9	158.1	140.5	231.6	112.0	108.7	96.6	40.6	51.9	37.3	34.0
29	69.2		222.8	157.0	212.9	113.1	98.8	104.3	39.5	50.9	37.3	34.0
30	69.2		198.7	173.4	207.5	110.9	98.8	77.9	38.4	49.4	37.3	34.0
31	68.1		184.4		206.4		126.2	115.3		48.5		35.1
Average	76.9	103.0	185.4	175.4	235.2	179.6	121.2	130.6	64.1	87.8	41.3	36.1
Maximum	88.9	407.2	478.6	369.9	882.2	444.5	262.3	255.7	137.2	262.8	46.1	38.4
Minimum	68.1	58.2	88.9	128.4	109.8	110.9	95.5	77.9	38.4	36.3	37.3	34.0

Average annual discharge = 120 (m^3/sec)

Annual inflow volume = 3,781 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1988

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	35.1	37.5	90.7	211.2	127.3	90.1	122.4	1,456.9	113.1	91.7	49.4	46.3
2	35.1	37.3	86.1	190.8	108.4	85.1	120.5	773.5	100.0	86.7	83.9	46.3
3	34.8	37.0	92.3	156.2	88.2	59.9	213.4	643.0	102.2	82.7	49.1	46.0
4	34.8	37.3	98.1	136.7	84.5	56.2	287.4	534.3	99.1	102.5	49.1	46.0
5	34.5	37.5	110.3	122.4	82.3	53.1	197.9	450.5	92.5	86.7	49.1	46.0
6	34.5	37.5	116.1	114.3	86.1	47.9	169.3	400.7	90.7	80.1	49.1	45.7
7	34.1	37.5	218.6	122.4	80.8	47.2	107.5	360.4	90.1	78.6	49.1	45.0
8	34.1	37.3	156.2	128.0	68.1	38.2	66.7	568.5	104.7	76.4	49.4	44.4
9	33.8	47.9	111.2	136.1	63.3	38.2	52.8	639.9	128.3	75.5	49.1	43.8
10	33.6	41.1	95.9	131.7	75.5	42.3	57.7	360.4	99.1	76.4	49.4	43.2
11	33.6	39.2	1,202.1	125.5	83.2	42.3	124.3	388.3	93.5	75.8	49.1	43.2
12	34.1	39.2	1,146.2	140.4	87.3	41.6	77.1	294.5	90.1	73.7	49.1	42.9
13	34.5	37.3	341.7	144.8	85.1	41.9	795.2	453.5	88.6	72.1	49.1	42.6
14	35.5	37.0	220.5	153.1	88.2	42.6	767.2	301.0	86.4	71.1	48.7	41.6
15	34.1	37.3	180.1	153.8	74.2	47.2	1,770.6	565.3	126.8	70.2	48.4	41.0
16	33.8	36.0	250.4	152.2	75.2	50.3	3,758.6	310.6	152.6	68.9	48.2	40.4
17	33.3	35.7	236.4	136.7	75.8	50.6	1,012.7	326.2	104.7	68.9	48.2	40.1
18	32.9	34.8	237.3	151.6	68.4	73.6	611.9	329.3	86.9	67.7	48.2	41.0
19	32.3	34.8	194.5	180.1	61.8	58.4	605.8	304.7	80.8	66.2	47.9	43.2
20	31.9	35.5	182.6	184.8	63.3	63.4	1,342.0	262.5	80.5	64.7	47.5	49.1
21	33.3	75.8	174.9	131.7	68.4	67.4	736.2	275.5	77.7	102.2	47.5	48.5
22	55.3	62.8	178.6	123.0	71.5	85.4	1,121.3	246.6	86.9	60.9	47.9	126.1
23	43.5	49.1	185.7	120.5	68.6	78.9	851.1	231.2	74.9	59.4	47.5	231.1
24	37.5	40.7	190.8	108.4	66.7	76.4	782.8	215.6	252.9	58.1	47.5	96.0
25	36.7	45.7	186.4	103.2	66.7	73.9	515.7	332.4	515.7	56.9	47.5	72.7
26	36.0	44.8	450.5	111.2	68.9	80.5	410.1	201.3	201.9	55.9	47.5	64.6
27	35.7	51.6	267.5	113.7	75.8	141.0	484.6	205.0	139.2	54.3	47.5	54.0
28	36.3	332.4	223.4	123.6	73.7	103.8	546.7	171.4	115.3	53.5	47.5	45.0
29	40.1	128.6	232.7	135.4	75.2	537.4	1,792.3	150.4	106.6	52.1	47.5	40.1
30	38.2		249.4	125.5	74.2	162.8	605.7	139.7	103.4	51.3	47.2	37.6
31	38.5		246.6		72.7		1,441.3	127.3		50.1		37.6
Average	35.9	54.7	256.6	139.0	77.7	82.6	695.1	387.8	122.8	70.7	49.5	55.8
Maximum	55.3	332.4	1,202.1	211.2	127.3	537.4	3,758.6	1,456.9	515.7	102.5	83.9	231.1
Minimum	31.9	34.8	86.1	103.2	61.8	38.2	52.8	127.3	74.9	50.1	47.2	37.6

Average annual discharge = 170 (m^3/sec)

Annual inflow volume = 5,389 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1989

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	36.4	49.4	67.0	649.6	96.8	105.3	125.9	711.7	115.3	59.2	44.1	40.4
2	42.3	44.2	67.2	329.3	142.1	108.2	150.5	523.6	116.1	57.3	43.6	38.7
3	45.9	44.7	65.7	252.7	211.6	114.9	97.8	334.6	110.0	55.6	43.0	37.3
4	41.3	46.8	62.8	213.5	187.6	115.8	90.2	234.0	97.8	55.1	49.7	36.3
5	51.8	53.3	65.7	184.1	131.4	175.7	125.9	273.7	94.9	55.3	117.7	35.3
6	437.8	59.4	67.1	163.7	112.1	125.7	127.1	213.6	97.2	54.7	65.5	34.4
7	170.0	51.9	67.8	162.1	101.6	107.8	96.0	172.4	92.3	54.1	51.3	33.5
8	124.9	48.8	73.7	160.0	102.7	94.0	76.9	162.2	84.1	51.9	47.9	32.5
9	110.4	48.2	80.3	295.2	101.9	99.2	90.2	242.7	81.6	49.9	46.2	33.1
10	94.6	47.6	93.1	306.5	111.4	94.0	64.3	137.3	80.9	48.1	45.7	33.9
11	85.7	47.1	82.5	192.6	114.3	108.6	90.2	153.2	79.8	46.2	45.2	38.2
12	81.1	47.0	82.8	169.3	116.1	103.7	55.8	178.1	102.6	123.0	45.0	38.6
13	77.5	47.6	81.8	154.4	122.2	109.3	139.9	177.7	86.3	190.5	44.1	37.1
14	75.4	47.5	86.5	152.5	129.1	108.8	175.5	150.9	94.1	85.2	43.2	36.8
15	73.9	47.7	111.6	149.4	131.2	94.2	373.5	133.7	85.2	59.9	42.9	36.8
16	72.3	48.8	88.7	138.2	128.3	101.9	189.6	144.8	87.7	54.0	42.9	37.2
17	70.2	52.5	87.6	145.3	128.8	95.5	109.5	141.3	82.8	51.9	42.8	37.6
18	70.2	59.1	128.4	142.7	129.3	86.8	99.0	152.9	81.8	51.6	43.1	38.0
19	68.4	54.4	150.8	139.2	128.4	85.0	99.0	176.3	95.3	51.3	43.7	39.2
20	67.0	51.5	171.8	134.8	130.6	77.7	112.2	387.6	108.8	50.3	43.4	48.2
21	65.9	49.1	137.4	133.5	133.4	76.0	75.0	203.2	104.4	49.6	42.7	74.3
22	64.8	47.3	517.8	121.7	130.4	73.8	58.1	157.5	119.5	49.0	42.3	57.1
23	63.9	44.9	506.0	122.3	115.3	70.2	88.8	187.1	138.5	48.3	42.0	83.4
24	63.0	42.7	267.4	126.6	108.3	74.2	204.8	148.0	122.8	47.9	53.5	80.5
25	60.7	49.3	228.5	177.9	95.8	75.4	174.2	171.9	84.7	47.4	64.5	65.5
26	60.2	52.2	204.8	165.1	85.8	88.6	127.3	128.6	68.5	46.9	50.7	60.8
27	59.9	57.5	247.4	131.3	93.6	96.5	110.8	270.0	64.9	46.0	43.8	56.0
28	59.8	65.7	246.7	112.6	104.7	103.2	107.0	246.7	61.2	45.3	42.9	54.7
29	58.0		227.2	116.8	115.7	95.3	1,603.5	159.9	61.8	45.0	42.4	54.9
30	56.2		199.5	113.4	107.7	125.6	1,913.5	135.7	61.1	44.8	41.7	55.6
31	54.9		278.5		92.9		2,276.9	121.8		44.5		55.9
Average	82.7	50.2	156.3	185.2	120.7	99.7	297.7	217.2	92.1	58.7	48.6	46.5
Maximum	437.8	65.7	517.8	649.6	211.6	175.7	2,276.9	711.7	138.5	190.5	117.7	83.4
Minimum	36.4	42.7	62.8	112.6	85.8	70.2	55.8	121.8	61.1	44.5	41.7	32.5

Average annual discharge = 122 (m^3/sec)

Annual inflow volume = 3,849 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1990

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	55.3	60.4	157.0	230.9	135.7	119.0	209.9	109.3	180.7	77.9	41.6	25.8
2	54.7	53.0	127.0	217.9	138.9	110.5	125.1	840.6	156.2	65.6	43.4	26.9
3	54.7	46.5	109.5	207.5	138.2	111.4	155.6	155.5	147.1	62.8	41.1	27.7
4	55.5	43.0	100.1	204.3	136.5	110.3	517.3	303.7	189.6	59.6	39.3	27.7
5	56.7	41.2	92.4	209.3	151.4	102.0	175.9	338.4	275.0	55.5	37.9	27.7
6	57.2	43.2	88.7	281.7	131.9	92.1	206.0	301.7	204.5	53.2	36.4	27.7
7	61.2	87.8	83.2	486.6	138.4	83.4	375.0	268.0	160.5	52.1	34.9	27.6
8	58.9	328.5	82.2	343.9	146.3	84.8	158.2	477.5	174.5	50.5	33.6	27.4
9	56.9	244.0	84.7	234.1	156.6	90.7	384.9	1,217.3	108.1	49.7	32.5	27.3
10	55.5	134.5	124.1	198.5	166.1	81.1	198.1	581.9	111.1	48.6	31.4	27.4
11	54.2	101.3	340.8	173.9	149.6	80.8	127.2	385.6	101.1	47.2	30.4	27.3
12	53.3	86.8	154.5	159.6	169.6	121.2	104.4	291.2	95.6	46.3	30.1	27.3
13	52.1	191.0	117.3	169.5	160.6	143.1	101.3	341.7	132.5	53.3	29.5	27.1
14	52.1	228.2	130.8	180.1	161.8	87.4	89.6	405.8	160.7	47.0	29.3	27.8
15	51.0	123.5	141.3	156.4	184.5	95.2	115.8	257.1	118.3	45.1	29.0	60.0
16	49.4	105.2	158.5	155.5	204.0	76.3	147.4	221.8	116.1	43.9	28.6	155.9
17	49.4	92.3	497.2	189.6	173.3	76.5	166.3	203.8	95.9	54.9	28.4	126.9
18	58.9	78.6	458.9	197.2	181.0	78.2	124.3	187.1	90.2	141.3	28.2	66.2
19	52.7	71.0	466.4	182.8	189.3	88.0	134.2	171.3	201.3	59.9	28.0	47.9
20	47.1	67.1	846.1	159.9	151.7	105.4	240.1	134.1	107.2	49.3	27.8	43.5
21	47.4	65.6	1,397.3	159.2	134.6	99.1	165.7	124.0	91.2	46.9	27.4	41.1
22	50.9	60.2	2,152.5	144.3	123.7	99.7	126.0	123.3	96.8	46.0	38.7	41.1
23	49.8	57.0	825.4	148.8	131.5	111.8	89.5	154.7	90.4	45.7	31.1	40.1
24	49.7	94.7	506.2	162.3	149.9	157.8	102.6	125.7	105.7	45.9	29.6	47.0
25	46.6	169.6	421.9	173.2	161.9	398.1	86.2	112.5	94.3	45.6	28.6	46.6
26	44.3	251.2	354.3	180.9	161.9	136.5	305.7	109.8	76.0	45.0	27.4	42.4
27	147.6	233.2	315.7	176.2	165.4	114.9	291.2	105.9	73.8	44.7	26.6	43.9
28	131.4	195.2	290.2	160.8	160.4	148.3	137.1	191.5	68.2	44.2	25.8	1,016.5
29	71.1		292.1	151.4	161.1	112.1	84.7	407.3	81.0	44.0	25.6	2,502.6
30	61.4		332.6	142.8	149.8	169.0	118.7	336.9	77.5	43.5	24.8	580.9
31	57.1		256.5		148.6		129.2	260.7		43.1		285.2
Average	59.5	119.8	371.1	198.0	155.3	116.2	177.2	298.3	126.0	53.5	31.6	179.7
Maximum	147.6	328.5	2,152.5	486.6	204.0	398.1	517.3	1,217.3	275.0	141.3	43.4	2,502.6
Minimum	44.3	41.2	82.2	142.8	123.7	76.3	84.7	105.9	68.2	43.1	24.8	25.8

Average annual discharge = 158 (m^3/sec)

Annual inflow volume = 4,980 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1991

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	201.9	94.3	140.9	313.9	193.1	78.0	80.2	118.1	252.7	70.5	39.7	26.9
2	177.2	101.2	169.1	447.8	196.3	89.0	80.0	96.2	212.0	68.9	38.9	26.9
3	159.9	111.2	174.5	485.9	180.4	104.4	98.4	90.2	169.2	66.8	38.2	27.0
4	147.9	123.9	810.0	331.8	161.7	99.4	90.1	116.9	158.9	65.9	37.6	27.0
5	137.0	126.3	442.6	308.9	158.2	102.8	84.7	175.1	229.2	64.3	37.0	26.8
6	132.1	138.6	298.1	315.9	158.4	109.1	161.0	103.7	206.1	63.2	36.4	26.7
7	127.0	146.9	259.7	294.9	172.9	106.7	110.6	94.9	105.4	62.1	36.4	26.6
8	123.8	139.2	348.2	525.6	164.5	108.4	103.5	120.2	92.5	60.4	36.4	26.5
9	118.1	150.4	315.9	948.8	138.7	112.0	113.6	100.9	83.9	58.5	36.3	26.4
10	112.0	428.1	231.5	590.1	130.4	144.0	133.5	121.0	81.2	57.4	36.2	26.4
11	104.9	721.2	215.8	368.7	99.9	161.4	197.1	105.3	132.8	53.7	36.0	26.2
12	104.2	758.3	229.2	328.0	83.1	121.2	238.5	83.6	122.0	55.6	35.8	26.2
13	93.5	292.1	239.5	436.7	81.1	122.2	271.8	77.7	117.9	54.8	35.1	26.0
14	83.2	233.8	225.9	1,307.2	92.1	123.1	497.4	74.2	361.4	50.6	34.4	25.8
15	75.9	268.0	217.8	724.3	102.1	168.2	291.8	71.9	478.6	51.0	33.6	25.7
16	70.0	178.4	217.3	395.3	113.8	165.1	185.2	68.1	504.2	52.4	32.7	25.6
17	65.6	157.0	215.0	322.5	117.0	161.2	129.9	106.0	434.5	52.4	31.9	25.4
18	61.9	143.9	287.0	276.8	122.4	179.2	139.9	101.6	213.9	52.4	31.0	25.4
19	58.9	135.7	413.8	253.4	127.9	231.7	159.7	98.6	171.4	52.3	30.5	25.7
20	56.3	129.9	252.5	233.5	154.7	168.2	286.1	110.2	149.3	52.3	29.1	26.2
21	53.6	123.3	249.7	221.9	205.0	153.3	456.8	107.3	123.3	52.2	28.7	40.3
22	52.3	121.5	280.4	208.4	182.6	118.3	305.8	90.7	136.6	49.6	28.2	116.8
23	49.2	122.5	371.1	228.1	147.1	132.5	202.5	196.1	113.5	51.6	27.7	50.2
24	46.2	133.6	269.3	193.7	134.7	110.6	139.3	112.3	87.6	51.0	27.5	44.4
25	43.7	268.6	226.4	189.2	139.3	109.0	241.6	106.7	81.9	48.7	27.4	41.9
26	63.2	218.2	225.9	186.8	120.3	101.0	123.2	105.1	142.7	44.9	27.4	42.1
27	133.3	190.5	238.9	184.0	91.9	94.2	112.1	109.7	98.8	43.5	27.1	42.6
28	135.7	187.0	255.3	166.7	89.5	91.5	101.2	303.2	85.2	42.8	27.0	45.1
29	138.1		275.2	180.5	84.5	87.1	121.4	438.7	79.7	41.9	27.0	45.0
30	91.0		294.8	180.3	77.0	80.4	167.0	331.4	73.0	41.2	26.9	40.4
31	90.1		305.8		69.7		126.7	292.7		40.4		33.8
Average	100.2	212.3	280.6	371.7	132.0	124.4	179.0	136.4	176.7	54.0	32.6	34.5
Maximum	201.9	758.3	810.0	1,307.2	205.0	231.7	497.4	438.7	504.2	70.5	39.7	116.8
Minimum	43.7	94.3	140.9	166.7	69.7	78.0	80.0	68.1	73.0	40.4	26.9	25.4

Average annual discharge = 152 (m^3/sec)

Annual inflow volume = 4,797 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1992

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	38.4	241.6	117.4	305.1	278.5	152.2	166.7	160.4	392.7	279.7	211.4	153.5
2	30.1	163.8	95.6	293.4	265.5	167.5	161.5	215.2	555.3	275.0	206.9	154.1
3	29.1	140.2	88.4	287.8	390.2	200.7	173.8	1,014.2	495.3	268.7	202.5	154.1
4	27.9	123.5	75.9	283.0	319.0	173.1	174.6	344.7	349.8	258.6	198.1	153.8
5	27.2	111.3	68.2	298.2	267.5	159.2	150.5	361.1	335.8	248.9	193.8	153.0
6	28.1	148.0	65.0	463.7	236.1	175.0	142.5	438.2	392.0	250.3	190.6	153.0
7	35.6	257.6	50.1	915.3	236.2	169.3	144.8	239.7	382.5	251.9	185.9	153.2
8	47.8	150.1	60.4	323.1	245.8	170.0	162.1	254.8	333.5	242.3	181.9	153.4
9	37.2	134.8	62.0	309.3	244.1	160.9	164.6	588.4	5,872.8	237.2	178.9	153.4
10	34.3	124.1	61.5	807.0	231.0	160.2	161.7	348.1	7,190.6	232.7	175.9	153.6
11	49.6	116.9	64.0	295.1	230.7	200.1	221.6	271.8	1,493.5	232.5	172.5	154.1
12	46.4	112.3	69.6	278.0	241.3	185.0	173.4	249.8	952.9	228.0	168.7	159.5
13	40.4	546.7	140.8	277.8	262.5	177.2	160.0	228.5	827.2	226.1	165.8	165.2
14	36.9	263.3	143.6	268.9	265.9	160.9	206.6	287.0	771.4	225.7	163.5	160.5
15	33.8	194.7	92.5	266.9	265.1	168.7	178.4	298.1	724.0	225.3	161.2	158.9
16	37.7	169.2	80.8	266.6	260.2	163.9	169.0	924.9	607.7	224.6	159.0	157.8
17	29.0	155.2	77.4	264.7	256.5	166.3	210.3	891.5	624.8	222.3	156.7	157.7
18	27.6	148.0	89.5	335.3	223.5	150.4	247.8	513.7	528.6	221.0	154.2	158.2
19	27.9	139.5	100.8	253.7	197.2	153.9	199.1	455.0	491.6	437.4	189.2	158.7
20	27.5	126.8	112.4	274.5	182.8	159.4	236.0	405.6	460.2	269.2	327.1	159.2
21	27.5	113.2	127.9	739.6	182.0	180.6	230.1	413.1	437.8	235.6	199.4	159.7
22	27.2	103.0	186.3	439.0	173.3	147.8	233.9	429.7	414.2	227.4	165.2	160.3
23	29.6	97.5	1,278.4	285.2	193.6	141.4	174.0	306.7	394.2	222.8	160.9	160.0
24	34.0	90.9	702.9	286.2	205.3	148.9	300.2	301.2	374.8	219.2	159.9	159.2
25	45.7	85.0	1,001.4	295.0	207.9	134.7	386.7	360.6	353.9	217.2	156.4	158.7
26	61.2	82.9	1,650.4	294.8	263.9	132.3	291.5	357.8	337.8	216.4	155.8	158.2
27	171.9	83.1	1,067.6	293.6	285.8	140.4	165.4	290.3	324.5	216.0	156.3	157.7
28	281.3	83.8	485.1	298.1	226.0	150.1	164.7	278.8	311.3	215.3	156.0	157.2
29	630.0	143.9	555.8	380.7	190.3	192.0	264.4	266.9	296.8	214.9	154.4	156.7
30	1,449.8		352.9	329.1	179.7	155.0	220.0	389.8	285.8	215.1	153.4	155.9
31	383.8		313.1		165.1		193.4	514.6		215.7		200.8
Average	123.7	153.5	304.4	357.0	237.8	163.2	200.9	400.0	910.4	241.1	178.7	158.4
Maximum	1,449.8	546.7	1,650.4	915.3	390.2	200.7	386.7	1,014.2	7,190.6	437.4	327.1	200.8
Minimum	27.2	82.9	50.1	253.7	165.1	132.3	142.5	160.4	285.8	214.9	153.4	153.0

Average annual discharge = 285 (m^3/sec)

Annual inflow volume = 9,019 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1993

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	268.3	89.4	125.7	170.7	220.2	220.3	214.5	214.0	264.6	50.9	33.5	30.5
2	200.4	88.3	114.5	165.2	236.9	151.9	181.5	166.4	189.8	49.9	33.0	30.5
3	201.4	86.1	112.0	158.2	216.9	207.8	133.8	260.6	230.5	48.9	32.5	30.3
4	194.0	86.3	107.0	157.1	202.1	166.0	138.6	196.9	140.7	47.9	31.8	29.9
5	155.0	81.3	107.8	164.8	203.4	148.2	243.2	158.6	110.3	46.9	30.0	29.6
6	193.7	79.8	109.2	177.2	202.7	150.0	184.8	175.0	130.4	45.4	226.7	29.3
7	201.7	84.9	107.3	188.6	207.1	152.6	185.3	224.8	133.7	43.4	147.9	28.9
8	201.7	96.4	106.3	185.6	198.6	159.5	395.1	132.0	195.4	42.2	52.5	28.7
9	189.3	92.0	109.9	188.1	214.0	162.9	466.5	125.3	196.1	41.4	97.4	28.3
10	155.2	86.8	117.2	208.7	251.5	158.1	887.5	174.6	156.4	40.9	42.9	27.8
11	154.5	82.2	324.7	226.8	214.6	169.4	636.1	153.4	212.0	40.8	36.2	28.0
12	150.7	81.8	644.3	243.6	166.5	174.4	458.6	158.5	129.1	40.9	35.8	28.0
13	151.7	78.8	400.2	235.8	150.7	175.6	260.7	129.3	160.3	41.1	35.5	28.0
14	142.5	72.1	273.2	243.7	149.4	184.1	206.2	120.2	89.6	41.2	33.3	28.0
15	134.2	70.5	234.0	255.7	149.8	188.7	283.3	212.8	75.6	41.5	31.9	28.1
16	166.1	78.4	196.9	201.9	191.9	196.6	346.3	133.9	68.3	40.6	32.6	28.1
17	292.3	157.5	176.7	203.9	168.4	217.6	173.1	147.7	65.5	39.5	33.2	28.0
18	192.4	118.0	174.1	207.1	158.4	215.2	322.8	118.4	63.7	38.5	33.8	27.9
19	160.1	99.5	155.9	207.6	135.7	210.3	198.2	99.4	60.4	37.6	49.6	27.8
20	141.5	98.4	143.6	207.3	125.5	153.2	154.7	211.5	57.5	36.6	38.0	27.6
21	133.8	81.9	142.0	209.5	122.8	150.6	161.1	120.2	56.7	35.5	34.7	27.8
22	125.3	76.3	135.6	213.4	143.0	167.9	340.4	81.1	58.1	34.4	33.6	28.0
23	121.1	74.6	516.3	211.7	158.7	213.7	693.4	73.1	114.0	33.4	33.0	28.3
24	115.7	71.4	1,900.0	213.3	154.1	527.6	680.0	94.7	121.0	32.4	32.7	28.4
25	112.5	158.5	540.0	219.2	160.7	384.7	1,209.6	90.9	66.7	31.5	32.2	28.5
26	109.5	278.9	264.4	231.3	164.9	251.2	480.7	81.8	61.5	32.1	31.8	28.5
27	105.0	171.3	189.1	218.2	162.8	195.8	338.3	96.4	59.0	32.7	31.6	28.6
28	102.9	147.5	222.7	233.9	157.8	156.1	285.6	79.9	56.5	33.4	31.2	28.6
29	100.7		212.2	226.6	186.4	139.1	242.5	70.5	55.7	34.0	31.0	28.5
30	98.3		202.1	232.4	183.4	126.2	265.6	68.5	53.3	34.8	30.7	28.5
31	95.4		188.8		154.8		236.1	177.3		34.2		28.5
Average	157.0	102.5	269.5	206.9	177.9	195.8	355.0	140.3	114.4	39.5	47.0	28.6
Maximum	292.3	278.9	1,900.0	255.7	251.5	527.6	1,209.6	260.6	264.6	50.9	226.7	30.5
Minimum	95.4	70.5	106.3	157.1	122.8	126.2	133.8	68.5	53.3	31.5	30.0	27.6

Average annual discharge = 153 (m^3/sec)

Annual inflow volume = 4,838 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1994

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	28.4	37.1	71.2	130.2	147.0	124.6	572.7	351.6	499.8	85.7	55.6	44.4
2	28.3	33.7	68.8	88.4	185.9	107.6	188.5	302.9	478.4	51.2	52.6	46.0
3	28.1	29.9	69.4	77.9	162.6	96.7	895.9	261.1	231.0	51.7	51.9	47.6
4	27.9	27.7	91.7	284.1	146.3	88.5	362.5	417.1	312.0	88.5	51.4	55.7
5	27.7	26.5	85.7	1,036.3	133.2	79.3	189.7	349.5	401.5	92.2	51.0	64.6
6	27.6	39.8	83.7	1,085.3	136.5	76.0	155.8	364.0	361.8	97.1	50.5	129.2
7	27.6	49.1	85.0	373.9	138.0	80.6	959.8	1,302.9	280.8	91.3	50.1	164.6
8	27.4	40.0	88.7	217.2	223.1	101.4	307.6	433.8	224.5	85.0	49.9	620.1
9	27.1	44.2	89.9	197.5	304.4	112.0	263.0	299.8	221.4	81.4	49.3	220.6
10	26.9	39.9	90.2	172.4	174.4	179.2	724.3	671.0	225.2	78.1	48.7	130.1
11	27.9	39.1	85.7	154.0	219.0	147.3	379.7	320.8	258.4	74.7	48.2	90.2
12	30.0	37.6	81.5	140.5	152.5	183.4	259.8	278.5	231.5	71.3	47.5	84.5
13	51.1	35.7	70.2	135.3	135.3	180.1	228.3	239.7	235.2	68.1	46.9	79.1
14	47.7	36.3	80.7	114.7	155.6	120.3	416.3	701.5	225.6	65.2	46.3	74.0
15	47.9	37.2	108.6	154.7	209.7	103.6	265.6	336.3	220.0	61.8	45.6	76.5
16	46.4	38.5	77.4	116.7	144.8	91.1	181.1	347.4	202.5	58.2	44.9	68.7
17	45.8	39.8	59.8	113.1	130.5	97.7	227.5	1,321.5	193.2	56.6	44.3	64.1
18	45.2	41.1	56.7	109.9	128.3	100.5	748.5	554.5	184.4	55.6	43.0	65.9
19	44.4	42.9	63.5	111.0	134.3	104.3	201.6	392.7	171.2	54.7	41.7	67.0
20	45.0	48.7	202.8	102.7	138.2	132.4	1,417.7	374.7	156.2	53.5	40.9	67.9
21	40.2	582.5	112.8	89.1	132.9	134.2	388.2	510.4	133.0	52.2	40.3	69.3
22	36.1	191.8	89.7	93.5	134.4	125.0	1,271.2	647.1	113.2	51.2	39.7	75.4
23	31.2	118.7	77.5	95.4	158.2	159.3	749.7	625.3	100.3	50.0	39.1	88.2
24	28.4	104.1	73.1	89.0	136.4	150.8	1,336.9	386.3	87.0	47.5	38.6	107.6
25	27.3	100.2	80.9	74.6	135.8	252.1	269.6	352.9	86.8	75.8	37.1	116.9
26	30.7	91.4	89.8	88.3	131.8	449.3	232.9	700.7	86.8	164.2	37.5	101.6
27	107.1	79.5	90.8	97.5	136.6	188.5	243.3	398.5	85.4	131.8	36.8	167.7
28	84.9	72.5	89.9	100.6	135.6	167.9	932.4	351.8	84.3	110.8	38.1	354.0
29	54.6		82.6	136.4	138.4	144.9	416.8	323.4	84.3	93.0	41.6	187.6
30	47.2		83.1	159.9	135.5	303.6	1,197.2	315.4	85.1	81.2	43.0	114.4
31	41.5		161.6		125.5		506.2	308.3		68.7		105.4
Average	39.9	75.2	88.5	198.0	154.9	146.1	531.9	469.1	208.7	75.7	45.1	120.9
Maximum	107.1	582.5	202.8	1,085.3	304.4	449.3	1,417.7	1,321.5	499.8	164.2	55.6	620.1
Minimum	26.9	26.5	56.7	74.6	125.5	76.0	155.8	239.7	84.3	47.5	36.8	44.4

Average annual discharge = 181 (m^3/sec)

Annual inflow volume = 5,698 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1995

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	94.3	70.5	160.3	241.3	179.2	119.4	129.6	774.4	265.2	67.1	38.2	49.9
2	99.1	70.5	158.2	210.5	164.6	121.8	102.2	789.4	215.5	66.5	37.9	43.7
3	93.7	71.1	153.1	197.9	160.6	119.8	124.0	629.5	186.9	75.0	37.6	41.1
4	89.7	72.7	154.5	174.7	151.5	121.8	125.5	752.8	151.1	71.3	36.4	39.8
5	88.5	72.4	160.1	164.5	158.6	126.2	139.6	614.9	134.7	57.6	35.2	38.0
6	87.0	71.8	159.2	156.6	148.7	132.4	155.4	522.4	129.8	56.2	34.8	35.9
7	83.8	71.4	158.3	160.0	158.6	148.6	140.6	452.0	129.7	55.2	34.6	33.4
8	81.6	71.1	147.9	156.0	159.9	143.9	203.7	364.9	130.6	54.3	34.4	35.4
9	78.7	70.9	136.3	199.8	165.7	142.7	221.3	309.6	167.6	53.7	34.2	49.4
10	85.9	71.5	134.3	280.7	175.1	146.2	168.2	359.4	138.7	53.4	34.0	49.2
11	83.7	291.6	132.7	208.8	178.0	131.3	177.8	261.0	134.9	48.6	33.8	41.4
12	78.8	467.5	125.2	269.5	179.6	134.3	138.7	239.4	133.4	36.8	33.7	40.1
13	71.0	151.9	114.0	226.2	178.4	133.3	129.5	271.0	124.6	36.5	33.5	40.7
14	71.7	198.6	120.6	222.8	177.3	132.2	139.8	328.0	108.2	36.7	33.3	40.8
15	76.5	269.9	114.4	260.1	174.0	131.1	154.2	298.8	105.9	46.3	32.8	40.2
16	78.2	179.2	114.3	322.0	160.5	140.8	181.0	259.3	98.8	73.1	32.5	40.2
17	75.1	158.6	114.3	267.2	147.2	149.4	230.8	271.4	79.8	55.5	31.8	40.1
18	71.5	199.0	114.4	248.3	159.9	156.4	218.8	244.3	77.8	58.7	31.2	39.3
19	72.5	148.4	129.0	248.4	146.5	220.3	493.2	238.5	73.8	46.9	31.0	38.7
20	76.1	148.7	144.4	234.0	132.6	226.2	483.8	620.9	72.2	46.3	30.7	38.1
21	76.5	144.0	166.1	236.9	128.3	301.7	363.6	461.9	70.6	45.7	30.7	37.2
22	72.8	120.6	172.1	241.7	139.5	225.8	515.0	394.2	69.9	45.3	30.3	36.5
23	72.8	106.8	239.5	250.7	141.0	169.0	710.5	269.2	69.1	44.9	29.8	35.9
24	73.8	104.9	261.0	271.4	126.8	147.0	642.1	328.2	97.6	44.3	29.4	35.4
25	71.9	107.4	220.5	258.8	119.8	116.6	1,175.6	217.8	78.0	43.8	30.8	34.7
26	70.6	107.4	442.2	260.9	121.8	112.6	1,691.4	204.8	68.5	43.0	32.3	34.2
27	69.8	232.6	267.9	261.9	119.9	105.2	1,921.9	266.8	68.6	41.9	33.8	33.6
28	70.1	200.6	477.8	233.1	120.2	117.2	2,650.8	244.9	68.5	40.8	40.0	34.2
29	68.7		497.9	216.8	121.5	114.8	1,327.0	272.2	68.6	39.9	75.9	32.4
30	69.2		336.4	194.2	117.8	124.8	863.7	291.4	67.8	39.0	58.8	31.8
31	70.7		279.5		117.2		753.0	422.4		38.5		29.6
Average	78.2	144.7	197.0	229.2	149.4	147.1	531.4	386.3	112.9	50.4	35.8	38.4
Maximum	99.1	467.5	497.9	322.0	179.6	301.7	2,650.8	789.4	265.2	75.0	75.9	49.9
Minimum	68.7	70.5	114.0	156.0	117.2	105.2	102.2	204.8	67.8	36.5	29.4	29.6

Average annual discharge = 176 (m^3/sec)

Annual inflow volume = 5,544 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1996

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	30.5	50.4	184.5	353.2	233.6	176.9	397.1	250.4	175.1	100.5	44.0	30.9
2	29.8	50.2	134.8	296.9	195.8	164.5	260.7	208.2	178.3	101.9	42.9	30.0
3	29.4	66.8	145.9	253.8	172.5	144.5	210.7	315.5	203.9	302.2	41.6	29.2
4	29.0	78.5	110.7	212.7	168.0	143.2	372.6	285.4	171.7	333.8	40.8	34.6
5	28.7	71.3	118.6	222.9	163.0	138.9	309.9	305.8	176.2	148.5	39.7	35.6
6	28.5	65.6	141.3	240.1	157.5	130.0	263.7	431.5	179.2	69.9	39.4	31.7
7	28.2	68.7	190.0	280.6	141.8	138.0	188.5	287.9	185.2	66.2	40.1	29.3
8	27.8	75.5	208.4	381.4	145.8	148.2	167.0	277.8	150.6	74.1	41.2	29.2
9	26.8	141.8	171.1	222.5	142.5	173.0	164.6	265.0	148.3	83.7	42.4	28.9
10	25.8	141.5	167.3	204.2	139.8	146.8	167.8	271.4	143.4	80.2	43.6	28.9
11	39.4	81.4	176.3	200.6	134.5	146.8	196.1	283.7	125.7	76.4	44.7	28.4
12	54.7	88.5	330.2	198.7	134.9	152.5	198.6	490.5	114.5	69.4	45.8	28.2
13	71.3	96.7	309.1	193.5	129.9	249.8	208.4	1,010.9	105.5	59.1	42.2	28.0
14	90.3	144.2	307.0	191.5	123.2	207.7	260.3	1,048.8	168.1	51.3	36.4	27.7
15	641.5	620.3	467.8	204.5	153.4	249.1	190.7	700.1	125.5	43.4	33.0	27.3
16	352.9	255.9	661.6	203.1	161.7	347.1	164.2	577.6	98.6	35.6	31.9	27.1
17	167.8	192.5	1,003.6	232.1	144.0	269.7	147.0	495.1	85.0	29.1	31.5	26.8
18	120.0	139.9	1,316.7	229.6	109.2	214.8	129.7	405.0	84.7	24.5	31.1	26.7
19	83.3	152.7	857.2	229.6	102.2	338.4	131.8	352.3	80.6	23.4	29.5	26.5
20	71.0	180.8	575.0	213.8	93.5	681.8	260.9	254.6	75.6	30.4	28.3	26.3
21	59.1	209.7	496.0	204.0	185.6	1,190.6	268.5	200.0	71.6	48.2	33.8	26.1
22	49.2	239.6	403.1	194.8	284.5	504.4	175.8	243.7	132.3	71.2	39.8	25.8
23	73.4	271.0	331.7	186.2	298.3	379.8	191.9	1,081.5	117.7	62.9	37.6	25.3
24	70.8	744.3	291.1	173.9	246.8	363.3	178.0	720.5	103.9	55.2	33.3	24.8
25	55.6	484.7	239.0	195.1	461.7	286.3	148.9	542.4	101.4	51.9	30.6	24.6
26	53.3	355.7	270.3	178.6	342.2	253.2	136.2	374.1	98.6	50.5	30.5	24.6
27	53.9	340.4	329.4	177.6	271.1	271.6	114.4	298.5	96.8	49.2	30.5	24.6
28	54.3	278.3	434.4	180.2	248.8	252.8	216.2	247.8	94.4	47.9	30.7	24.6
29	53.2	239.0	843.2	184.5	227.8	323.0	287.9	213.7	93.5	46.7	31.1	24.7
30	51.9		541.9	220.6	214.4	465.7	179.8	236.4	95.5	45.7	31.8	24.5
31	50.8		403.6		170.3		282.3	195.2		45.1		24.5
Average	83.9	204.3	392.3	222.0	190.3	288.4	211.9	415.2	126.1	76.7	36.7	27.6
Maximum	641.5	744.3	1,316.7	381.4	461.7	1,190.6	397.1	1,081.5	203.9	333.8	45.8	35.6
Minimum	25.8	50.2	110.7	173.9	93.5	130.0	114.4	195.2	71.6	23.4	28.3	24.5

Average annual discharge = 190 (m^3/sec)

Annual inflow volume = 6,001 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1997

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.2	25.4	35.8	373.2	107.7	108.8	144.9	212.7	382.6	112.8	97.4	106.3
2	24.3	25.1	88.3	501.3	98.9	113.2	118.9	253.6	375.3	139.7	93.0	101.0
3	24.3	29.0	104.5	427.1	121.6	115.9	104.3	182.0	336.3	128.5	89.4	97.1
4	24.2	28.5	80.7	608.0	114.2	123.5	148.9	126.8	233.9	128.3	84.5	93.2
5	24.1	41.5	64.8	325.6	112.6	108.5	134.0	123.4	244.3	176.9	80.8	89.2
6	24.0	35.0	62.2	227.9	99.3	115.8	127.5	131.8	311.0	136.7	76.8	85.4
7	23.9	33.2	57.6	153.9	211.1	132.0	160.9	161.6	364.5	125.0	73.0	81.6
8	23.5	32.1	51.0	143.1	209.8	150.4	178.1	161.1	620.5	128.8	67.9	87.5
9	23.2	30.8	59.9	143.4	179.6	183.7	358.7	170.6	363.5	121.2	112.5	265.2
10	23.0	30.0	61.0	144.1	128.3	131.8	228.6	181.3	286.2	109.2	159.5	159.2
11	22.8	40.0	52.9	142.7	118.8	117.8	185.0	247.7	225.6	134.5	99.1	133.6
12	22.5	34.8	48.5	161.8	121.9	113.1	140.5	669.0	198.7	109.3	98.2	124.4
13	22.4	26.6	40.0	146.0	112.7	121.6	138.5	383.0	229.7	112.6	101.5	120.4
14	22.2	24.6	27.5	173.4	107.2	122.5	174.3	331.6	211.5	110.8	105.8	118.4
15	22.1	22.2	27.4	257.0	101.2	125.0	158.7	260.2	182.5	101.2	98.7	117.6
16	21.9	21.1	123.4	175.9	96.3	119.6	198.2	242.9	165.1	120.8	92.3	117.1
17	21.7	20.0	93.9	146.8	95.2	119.2	173.5	212.3	147.9	106.6	86.1	108.9
18	20.9	19.8	83.9	132.6	91.4	127.1	183.3	194.7	136.9	99.8	79.3	99.7
19	21.4	19.6	326.8	118.5	88.5	117.9	481.3	175.4	130.5	94.2	72.5	92.9
20	56.2	19.7	160.5	102.1	87.1	122.4	197.7	247.6	128.2	145.2	65.3	85.1
21	68.4	19.7	123.7	100.1	100.4	133.8	205.3	203.6	155.9	209.4	59.0	77.4
22	55.8	19.9	109.2	102.4	99.3	118.4	260.4	418.1	152.4	132.0	56.3	69.8
23	29.4	18.7	77.1	90.6	87.6	131.3	206.0	293.5	128.6	106.8	57.5	62.1
24	25.1	17.6	62.9	96.4	80.9	130.9	205.7	243.2	125.6	102.2	60.2	60.3
25	24.0	35.0	54.0	113.9	80.8	133.5	207.8	268.0	117.8	94.5	78.0	58.1
26	22.4	74.8	46.1	115.7	76.4	126.4	388.3	473.5	104.7	118.1	174.2	56.6
27	22.4	42.8	70.4	117.6	89.4	196.6	808.2	6,245.5	101.6	141.0	183.7	55.6
28	27.7	32.9	157.0	109.1	103.5	217.1	288.7	1,704.6	104.3	107.3	140.4	53.6
29	25.3		571.6	103.7	98.6	258.3	367.9	832.2	138.9	121.3	120.3	60.6
30	26.7		324.7	104.8	92.7	181.8	313.5	574.8	117.3	125.5	112.6	59.7
31	26.7		301.1		88.0		270.1	481.4		109.4		56.8
Average	27.3	29.3	114.5	188.6	109.7	137.3	234.1	529.3	217.4	122.9	95.9	95.3
Maximum	68.4	74.8	571.6	608.0	211.1	258.3	808.2	6,245.5	620.5	209.4	183.7	265.2
Minimum	20.9	17.6	27.4	90.6	76.4	108.5	104.3	123.4	101.6	94.2	56.3	53.6

Average annual discharge = 160 (m^3/sec)

Annual inflow volume = 5,030 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1998

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	56.6	58.3	399.6	228.7	319.6	127.1	284.4	106.4	111.4	50.7	31.2	21.4
2	53.7	69.9	443.4	259.2	315.5	122.3	214.8	87.3	94.5	50.1	30.8	22.1
3	53.4	68.8	516.8	309.5	307.2	103.7	157.3	83.7	109.2	49.5	30.9	22.9
4	52.0	66.0	2,480.6	314.8	293.4	113.9	220.4	77.8	114.9	52.1	30.9	23.7
5	53.2	65.1	1,165.7	311.2	281.5	100.3	143.6	102.2	113.8	49.5	30.3	24.5
6	51.7	67.7	667.7	311.5	246.5	95.9	234.5	155.2	87.1	48.8	31.2	25.3
7	50.2	70.4	520.6	296.6	176.6	101.2	143.9	108.3	78.5	46.5	29.8	26.2
8	56.2	75.1	491.8	1,286.4	244.3	95.1	116.1	81.3	75.8	38.0	28.6	26.2
9	57.9	78.0	432.8	728.3	209.5	82.5	113.8	75.2	112.7	37.7	27.5	25.5
10	61.3	84.4	372.3	416.0	149.9	83.7	239.3	96.4	92.1	37.8	26.6	25.6
11	65.9	92.1	332.8	385.2	137.3	102.6	217.6	108.1	98.7	38.2	27.6	26.5
12	70.5	101.9	354.4	326.9	125.8	273.4	418.3	117.1	113.9	38.9	26.9	25.5
13	85.7	112.6	347.3	282.6	120.3	145.2	404.5	131.2	88.4	38.0	27.8	25.3
14	106.3	172.2	285.9	266.6	140.3	102.3	422.4	184.6	76.7	37.6	27.2	25.2
15	234.9	838.7	249.1	263.7	136.5	80.3	475.3	224.7	76.4	37.4	28.1	25.0
16	147.5	399.2	249.5	261.1	142.8	69.5	587.5	113.7	73.1	35.8	27.4	25.6
17	104.6	586.7	254.0	254.0	159.7	69.3	362.1	103.2	69.1	38.4	27.5	25.4
18	90.9	1,001.8	244.9	246.7	147.4	80.6	225.7	91.7	70.1	38.3	25.9	25.3
19	83.2	461.2	261.7	262.0	141.6	81.4	171.4	89.8	68.7	37.5	25.2	24.3
20	77.0	371.1	268.9	274.6	142.6	68.9	123.2	108.7	67.0	38.6	24.5	24.1
21	72.6	318.4	243.7	297.1	142.3	76.4	124.0	91.6	66.6	36.6	23.1	23.6
22	68.4	349.4	301.1	311.8	139.8	89.2	123.5	91.1	66.2	34.8	22.9	22.6
23	64.4	361.6	278.2	327.3	136.1	90.5	124.8	95.0	63.1	33.7	22.1	22.7
24	60.6	761.1	241.5	344.1	127.3	93.0	114.6	94.8	60.2	32.5	22.0	22.0
25	57.0	692.1	236.6	370.6	130.2	94.1	109.7	89.9	58.1	33.0	21.9	22.1
26	53.6	496.1	215.0	791.7	125.0	91.6	163.9	106.0	58.2	32.2	22.5	22.2
27	54.3	435.9	205.7	436.2	135.2	96.9	106.1	95.9	54.6	32.3	22.4	21.6
28	56.6	411.1	209.9	357.4	153.1	102.4	95.1	86.4	52.8	30.4	21.6	21.7
29	55.9		235.0	346.1	193.1	127.9	90.5	85.7	50.5	30.3	21.4	22.5
30	55.1		219.4	333.7	135.3	136.9	123.6	125.2	50.2	30.3	21.3	22.6
31	55.9		214.4		127.9		159.7	135.0		31.0		23.9
Average	73.1	309.5	417.4	373.4	176.9	103.3	213.3	107.9	79.1	38.6	26.2	24.0
Maximum	234.9	1,001.8	2,480.6	1,286.4	319.6	273.4	587.5	224.7	114.9	52.1	31.2	26.5
Minimum	50.2	58.3	205.7	228.7	120.3	68.9	90.5	75.2	50.2	30.3	21.3	21.4

Average annual discharge = 161 (m^3/sec)

Annual inflow volume = 5,073 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 1999

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.1	64.2	65.4	113.2	94.2	40.1	128.0	326.7	130.9	130.9	29.0	28.7
2	23.5	60.6	67.6	110.2	78.0	42.2	115.3	229.2	200.3	105.5	30.7	28.8
3	23.8	57.1	72.2	83.5	77.2	42.9	113.2	216.3	113.1	83.7	32.3	29.3
4	23.1	53.7	82.8	86.2	69.4	42.6	66.4	189.5	94.9	77.4	40.9	29.7
5	23.4	50.4	102.8	93.2	70.5	60.3	55.7	210.6	106.8	84.7	68.0	28.7
6	24.8	48.6	91.6	86.4	71.2	41.7	55.8	278.5	183.4	73.4	61.8	28.2
7	41.5	45.7	256.2	94.3	72.9	43.4	49.9	637.7	110.9	69.9	68.5	27.8
8	39.0	42.2	329.1	96.1	68.3	54.1	43.4	300.8	101.1	67.7	55.8	28.9
9	37.9	45.3	303.2	102.0	67.2	57.0	43.1	229.6	171.7	66.1	49.5	28.4
10	36.0	49.4	200.4	85.7	62.7	62.4	43.0	308.1	96.3	66.8	48.4	28.3
11	33.7	55.5	148.1	106.6	52.4	55.0	123.5	226.3	100.7	66.3	48.1	28.2
12	31.3	64.5	126.3	119.9	59.3	67.3	113.9	233.9	87.8	66.3	43.6	28.5
13	27.8	66.0	105.3	132.8	63.5	60.2	105.0	285.6	82.8	63.6	43.6	27.8
14	24.1	73.7	92.0	106.3	52.1	53.4	78.2	185.2	82.6	61.9	42.8	27.4
15	22.1	67.7	82.1	91.1	44.2	52.5	56.5	145.1	179.5	59.4	42.5	27.2
16	20.5	59.9	72.5	82.7	40.7	52.1	56.5	117.8	148.1	59.5	42.6	27.1
17	21.8	58.6	65.0	83.4	50.8	50.9	219.2	98.0	159.6	58.5	42.5	27.0
18	23.3	83.9	57.9	94.8	63.7	74.6	393.2	88.1	111.4	54.9	42.5	26.3
19	24.8	140.2	52.5	88.5	62.4	83.2	327.6	86.0	263.5	52.0	42.5	26.0
20	30.4	114.9	63.8	84.1	61.8	126.6	237.6	116.9	186.5	49.7	40.0	26.0
21	136.8	69.8	73.7	79.6	79.9	122.2	170.8	91.3	105.0	48.2	39.5	25.9
22	138.1	67.7	48.2	73.4	84.7	72.0	138.4	82.4	80.2	42.8	38.6	26.0
23	98.1	66.9	42.8	80.6	71.4	62.2	100.2	120.0	115.7	38.9	37.9	26.1
24	281.8	69.7	44.1	79.8	69.4	59.7	84.8	77.0	164.2	35.8	37.5	25.9
25	187.4	75.3	52.1	82.2	76.9	97.0	109.4	91.8	130.9	35.1	37.0	26.2
26	110.1	71.6	61.7	80.6	59.7	65.3	67.7	144.8	99.9	34.8	41.2	26.1
27	80.9	72.6	63.9	93.5	64.6	68.2	56.4	166.1	87.2	27.3	34.7	26.1
28	68.3	66.2	68.2	81.7	55.1	61.0	55.0	122.4	107.1	26.3	30.2	26.2
29	64.6		73.4	80.7	56.1	70.4	145.1	82.9	153.9	25.5	29.2	26.3
30	62.5		80.9	94.9	52.7	73.2	152.4	92.6	256.6	27.5	29.1	25.5
31	65.2		98.1		46.7		182.4	119.9		27.6		25.6
Average	59.7	66.5	101.4	92.3	64.5	63.8	119.0	183.9	133.8	57.7	42.3	27.2
Maximum	281.8	140.2	329.1	132.8	94.2	126.6	393.2	637.7	263.5	130.9	68.5	29.7
Minimum	20.5	42.2	42.8	73.4	40.7	40.1	43.0	77.0	80.2	25.5	29.0	25.5

Average annual discharge = 84 (m^3/sec)

Annual inflow volume = 2,665 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2000

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.2	232.3	54.9	102.9	65.9	52.1	168.5	1,890.1	166.8	63.7	46.6	29.9
2	24.0	176.3	53.6	102.0	78.8	50.2	210.2	949.7	163.8	61.4	45.4	31.3
3	23.1	109.9	49.9	110.0	85.6	47.9	193.2	492.6	122.5	62.4	46.4	30.8
4	21.3	90.7	52.6	102.7	84.3	51.0	151.7	373.1	129.8	61.4	45.4	29.5
5	19.6	80.8	109.5	80.1	70.5	53.1	74.6	306.2	113.8	60.2	42.4	30.7
6	19.5	76.0	73.5	81.2	70.0	42.4	64.1	287.8	119.3	56.5	39.7	29.0
7	19.5	67.6	68.9	84.0	66.2	56.0	70.1	284.7	147.5	55.6	39.0	30.3
8	18.9	58.7	69.9	68.0	70.8	58.0	144.9	257.0	112.9	54.5	38.4	28.6
9	19.4	56.3	72.0	66.0	79.3	119.5	182.2	399.5	162.7	54.5	37.8	31.0
10	19.1	134.1	77.6	77.7	83.4	70.2	109.8	350.1	120.8	54.5	36.5	30.7
11	19.5	128.9	74.2	86.1	90.5	76.0	115.5	303.8	123.7	52.6	33.1	33.3
12	185.2	117.0	68.4	93.7	93.2	57.4	96.6	269.1	88.5	50.5	33.4	32.9
13	261.8	87.9	65.8	101.9	167.8	42.8	114.3	226.8	72.5	52.0	29.8	35.4
14	187.0	72.3	61.0	88.9	109.7	37.0	146.1	239.7	62.1	49.9	29.9	33.5
15	88.3	70.5	60.0	96.5	101.5	89.8	153.2	250.9	61.3	47.6	30.0	36.0
16	65.7	68.3	60.1	76.4	125.5	72.1	89.8	260.6	59.0	47.3	29.9	37.1
17	50.7	64.4	59.7	79.7	95.7	63.1	164.5	204.2	55.1	48.8	28.3	39.9
18	47.5	62.6	55.1	82.2	94.6	76.0	85.9	196.5	46.4	46.1	29.7	52.1
19	50.7	60.9	49.7	79.7	116.3	78.6	72.9	156.5	57.1	43.2	28.0	51.4
20	62.1	56.1	46.1	79.0	88.6	132.0	145.5	158.9	224.8	41.0	29.6	41.4
21	55.7	56.1	43.0	82.1	78.6	93.8	141.5	159.3	147.9	41.3	28.3	35.5
22	50.0	55.5	44.8	94.8	79.5	69.3	676.8	138.6	133.0	41.6	27.3	31.0
23	46.3	54.3	44.9	74.6	83.6	98.4	799.5	137.9	95.1	40.0	28.6	28.9
24	43.7	48.6	47.2	73.3	72.9	74.3	397.7	126.6	86.3	38.3	30.0	25.4
25	41.2	46.4	50.2	87.7	68.9	72.0	288.8	118.5	95.2	38.4	29.0	26.1
26	42.7	48.4	81.5	87.5	63.1	80.1	286.9	111.7	215.2	38.8	29.0	24.9
27	41.8	49.4	123.5	85.9	57.1	134.3	200.6	109.1	122.4	37.6	31.0	26.5
28	39.6	48.9	107.1	66.9	51.0	229.1	212.3	125.1	95.6	38.3	29.5	26.0
29	38.4	48.9	128.8	63.0	48.7	105.1	205.4	185.7	78.9	41.3	29.9	24.7
30	38.0		123.0	63.1	55.2	347.0	176.8	201.6	69.7	46.5	31.8	25.2
31	38.9		97.3		68.3		701.5	152.2		47.5		24.0
Average	55.0	80.3	70.1	83.9	82.8	87.6	214.2	304.0	111.7	48.8	33.8	32.0
Maximum	261.8	232.3	128.8	110.0	167.8	347.0	799.5	1,890.1	224.8	63.7	46.6	52.1
Minimum	18.9	46.4	43.0	63.0	48.7	37.0	64.1	109.1	46.4	37.6	27.3	24.0

Average annual discharge = 101 (m^3/sec)

Annual inflow volume = 3,184 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2001

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	24.5	21.7	26.5	50.8	55.4	54.1	113.4	318.6	129.4	48.5	27.7	20.6
2	25.4	23.4	26.1	41.0	55.5	132.0	78.4	282.2	142.9	50.6	30.3	21.8
3	28.1	22.5	25.2	42.7	55.3	182.1	93.2	291.5	126.7	56.0	37.4	20.8
4	28.3	21.6	24.8	53.0	54.5	124.0	79.7	497.4	138.6	71.1	48.9	19.8
5	27.8	22.9	24.3	45.6	56.1	148.9	83.5	347.3	104.4	60.1	40.9	20.8
6	27.2	21.6	24.3	44.1	65.5	134.7	56.8	360.5	113.8	54.0	45.5	19.8
7	25.7	20.4	23.1	46.6	73.9	147.9	65.4	427.7	92.6	51.0	45.4	21.0
8	23.9	20.6	22.9	50.7	76.0	134.3	113.3	276.1	111.8	47.6	40.3	20.0
9	23.9	20.7	22.7	55.0	71.9	147.1	94.9	245.6	88.9	47.9	36.6	20.9
10	22.8	20.5	22.6	55.3	74.7	154.1	86.0	255.7	86.3	48.1	35.6	19.8
11	24.3	21.5	20.8	52.1	77.6	89.8	689.1	212.4	89.0	47.9	36.5	18.8
12	23.4	22.8	20.7	55.0	80.9	78.7	170.1	176.9	169.3	49.1	34.0	19.1
13	23.1	21.8	23.2	57.2	78.7	71.5	232.1	162.4	125.0	47.0	33.3	19.8
14	25.0	20.8	25.3	53.1	75.3	128.1	147.0	402.1	223.3	48.2	32.1	19.7
15	24.1	22.0	24.4	56.9	85.4	127.7	156.5	371.2	205.0	45.1	31.0	19.0
16	24.8	23.4	27.1	65.5	68.6	195.3	415.5	309.2	123.0	43.9	31.3	21.0
17	23.4	22.4	26.0	119.1	91.8	486.6	292.1	205.7	108.4	44.6	30.2	22.2
18	22.6	22.6	22.7	166.6	66.7	188.9	184.4	179.5	97.3	41.1	27.6	23.1
19	23.2	22.1	21.6	93.1	67.1	117.7	152.9	176.4	89.0	40.4	25.7	27.4
20	23.6	23.0	26.1	97.3	158.6	94.1	143.8	179.7	82.9	38.7	27.1	25.4
21	23.2	24.4	50.9	69.4	116.9	151.6	142.7	202.5	77.8	37.5	27.6	24.9
22	24.1	23.1	41.5	58.9	83.8	196.6	445.7	193.3	70.8	36.7	25.3	23.9
23	23.7	22.9	32.9	48.1	80.9	164.0	697.3	235.2	66.6	34.8	23.7	23.2
24	22.7	25.4	28.9	50.0	66.4	175.8	571.8	176.8	63.4	34.6	24.7	23.1
25	23.8	29.6	27.5	52.2	58.2	112.6	329.3	151.1	60.5	32.0	23.1	22.0
26	23.8	29.5	27.7	49.0	53.1	132.9	214.9	144.2	64.5	32.1	22.2	21.8
27	23.7	29.7	26.1	49.6	47.9	118.2	203.0	135.4	59.9	30.5	22.9	21.7
28	22.4	29.0	29.5	46.6	49.6	70.8	170.5	138.9	55.0	28.5	21.9	21.5
29	22.4		50.8	56.3	68.7	62.3	663.1	128.3	51.6	26.8	20.7	20.0
30	22.6		65.1	50.9	53.1	255.7	579.1	122.7	49.1	26.6	21.7	21.0
31	21.5		48.9		59.3		393.6	157.3		26.9		20.3
Average	24.2	23.3	29.4	61.1	71.9	145.9	253.5	240.8	102.2	42.8	31.0	21.4
Maximum	28.3	29.7	65.1	166.6	158.6	486.6	697.3	497.4	223.3	71.1	48.9	27.4
Minimum	21.5	20.4	20.7	41.0	47.9	54.1	56.8	122.7	49.1	26.6	20.7	18.8

Average annual discharge = 88 (m^3/sec)

Annual inflow volume = 2,770 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2002

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.5	29.4	47.3	100.1	51.3	61.5	88.5	90.4	208.0	47.0	31.4	23.2
2	20.7	30.6	49.4	97.8	52.5	53.4	72.7	110.8	266.0	46.6	30.6	23.1
3	21.3	28.8	55.5	90.4	54.3	78.7	63.8	84.9	180.1	46.2	30.4	22.8
4	20.4	28.4	44.8	89.9	65.1	60.5	68.4	109.9	343.4	45.5	29.2	23.5
5	19.4	27.5	42.8	89.8	94.7	56.8	62.1	134.3	239.2	46.1	29.8	22.4
6	18.7	28.2	41.5	89.2	99.5	64.0	55.8	255.7	170.9	47.7	31.2	22.3
7	19.1	31.5	42.6	132.8	92.9	57.4	45.6	192.1	142.9	47.8	30.2	21.2
8	19.3	36.7	41.9	119.0	84.3	55.1	43.4	149.2	173.6	46.8	29.8	21.1
9	18.9	33.1	57.2	100.9	88.8	61.5	37.8	125.5	129.7	46.1	28.6	21.3
10	19.5	29.8	235.0	91.6	90.4	87.4	46.6	101.4	114.5	45.4	28.5	22.0
11	18.5	28.1	158.2	87.1	101.0	86.2	47.5	109.9	100.0	44.5	28.9	21.8
12	18.5	27.9	119.3	88.2	103.5	82.2	38.9	629.9	115.4	44.7	29.1	20.8
13	17.3	27.9	111.4	93.4	98.3	88.8	37.7	952.1	105.7	50.2	27.7	21.9
14	21.2	27.7	104.4	100.3	95.3	195.9	36.3	569.5	168.9	50.8	26.8	23.1
15	59.0	27.8	98.3	95.4	105.1	139.1	41.7	444.2	171.7	46.5	26.8	22.6
16	132.4	29.2	93.1	93.2	115.4	128.6	44.4	258.2	144.2	44.1	27.2	22.3
17	95.8	33.2	99.2	88.4	103.6	211.7	71.6	190.8	212.5	42.3	25.7	21.4
18	64.7	38.0	96.5	87.8	103.2	173.5	91.2	152.0	169.5	41.0	25.8	22.3
19	52.9	40.7	100.6	90.1	96.4	134.1	88.9	131.1	132.6	40.5	25.4	21.8
20	44.6	36.8	108.5	92.7	83.3	107.3	162.3	144.3	106.6	45.4	25.1	24.9
21	41.3	56.2	107.0	91.1	77.6	125.1	294.8	126.1	91.9	42.1	24.7	25.6
22	41.5	88.3	117.4	81.8	75.9	89.9	135.9	170.6	76.3	41.2	24.4	25.3
23	38.7	588.7	94.2	79.3	77.3	99.0	201.4	154.2	63.9	40.0	24.5	23.8
24	38.8	219.1	111.1	79.6	73.5	264.1	115.1	197.4	79.3	39.0	25.5	23.6
25	36.4	149.4	239.8	80.2	72.2	206.5	125.0	257.7	64.0	37.2	24.6	24.4
26	36.7	98.4	164.4	79.1	65.8	119.4	101.1	236.5	60.7	35.7	24.3	24.1
27	34.1	68.0	133.4	66.0	70.9	97.2	124.0	230.1	55.7	34.7	25.2	22.9
28	32.6	49.2	116.0	58.6	75.4	122.3	102.9	166.8	51.8	34.1	24.3	23.4
29	33.1		113.4	51.7	104.6	169.8	100.1	139.9	48.4	32.6	23.0	23.5
30	30.8		110.2	47.4	79.6	110.1	123.8	311.2	48.0	31.2	23.4	23.1
31	30.5		104.0		61.0		80.8	213.5		30.6		22.2
Average	36.0	69.2	101.9	87.8	84.3	112.9	88.7	230.3	134.5	42.4	27.1	22.8
Maximum	132.4	588.7	239.8	132.8	115.4	264.1	294.8	952.1	343.4	50.8	31.4	25.6
Minimum	17.3	27.5	41.5	47.4	51.3	53.4	36.3	84.9	48.0	30.6	23.0	20.8

Average annual discharge = 87 (m^3/sec)

Annual inflow volume = 2,731 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2003

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	20.8	28.6	494.9	184.7	324.2	30.6	83.4	215.6	83.8	79.7	30.3	20.2
2	20.8	29.1	1,270.0	179.1	167.2	37.4	74.3	311.9	89.1	66.1	28.9	22.6
3	20.9	25.7	643.6	171.0	107.8	32.7	74.3	227.1	117.8	60.5	28.5	21.1
4	21.1	22.7	459.7	179.6	95.7	28.4	80.9	138.9	192.7	52.3	30.0	23.3
5	20.4	23.7	366.4	156.9	82.1	28.4	158.5	99.2	144.6	48.0	28.8	25.5
6	20.0	22.9	332.5	138.9	69.0	28.8	172.9	80.0	123.0	47.8	28.7	23.4
7	19.5	23.8	310.3	153.9	71.1	102.4	189.1	74.4	97.1	46.2	26.0	25.4
8	20.5	24.0	271.3	170.1	67.1	104.2	100.9	88.4	111.6	42.8	27.0	23.6
9	22.0	23.3	244.7	182.1	64.8	121.0	190.1	68.0	138.1	48.0	26.6	23.9
10	20.5	22.3	221.5	192.2	60.7	114.0	123.8	61.1	102.6	45.5	25.2	26.6
11	19.2	21.7	195.0	199.8	57.7	92.7	139.2	60.8	93.7	41.8	26.4	27.9
12	18.6	21.5	178.6	206.5	57.1	84.8	114.8	60.6	89.8	43.1	24.8	26.9
13	17.2	20.5	183.5	208.3	53.5	75.2	115.9	56.4	122.9	38.7	27.2	31.1
14	17.0	20.1	194.8	212.5	54.6	74.9	93.2	50.5	98.9	37.0	25.6	62.0
15	16.6	21.0	194.9	205.8	55.2	76.2	122.3	47.9	102.7	36.8	28.3	80.7
16	17.2	25.9	220.8	304.5	56.3	77.4	180.5	46.3	82.3	35.9	26.6	60.1
17	16.5	381.8	208.8	246.3	57.4	79.5	93.9	58.8	75.8	33.5	41.0	49.2
18	17.3	3,831.8	191.6	219.5	61.5	75.4	90.4	141.0	73.6	32.3	53.3	41.3
19	17.0	1,780.4	192.3	224.7	53.2	76.3	78.3	224.1	67.7	32.5	35.2	37.9
20	17.0	454.2	198.6	248.9	61.7	99.3	125.3	255.6	66.3	32.3	30.1	33.6
21	16.7	307.4	217.4	190.5	61.4	137.5	154.1	208.2	62.8	32.0	27.9	35.6
22	17.1	263.1	236.8	173.5	59.1	104.7	141.8	132.4	59.4	29.6	27.5	33.7
23	16.5	280.7	212.4	186.3	53.8	94.1	133.0	125.7	70.4	29.9	24.9	34.6
24	17.2	261.8	213.8	201.6	44.5	90.4	265.3	97.7	203.3	29.3	26.8	32.4
25	16.1	234.6	231.1	193.7	41.7	105.1	153.0	81.7	402.7	26.8	24.6	29.9
26	15.2	229.8	217.1	192.3	40.4	102.1	156.9	82.1	300.1	28.1	22.3	31.8
27	15.7	227.4	221.8	194.8	43.0	95.3	175.5	83.8	173.0	27.7	20.0	29.5
28	14.8	377.8	221.6	160.8	41.4	87.8	137.4	82.0	127.3	26.4	22.2	31.4
29	23.0		308.5	152.7	30.8	81.3	130.7	93.7	102.1	26.2	24.5	29.4
30	24.3		255.5	169.8	29.2	72.7	172.0	142.9	87.0	28.1	22.2	30.2
31	30.3		202.6		30.0		122.6	91.6		28.7		27.4
Average	18.9	321.7	294.0	193.4	69.5	80.3	133.7	115.8	122.1	39.2	28.0	33.3
Maximum	30.3	3,831.8	1,270.0	304.5	324.2	137.5	265.3	311.9	402.7	79.7	53.3	80.7
Minimum	14.8	20.1	178.6	138.9	29.2	28.4	74.3	46.3	59.4	26.2	20.0	20.2

Average annual discharge = 119 (m^3/sec)

Annual inflow volume = 3,763 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2004

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	27.5	137.3	81.2	39.9	367.8	49.0	62.6	186.3	63.0	39.4	38.9	94.6
2	31.6	105.5	69.6	38.5	200.3	57.1	76.9	106.9	96.5	40.4	37.2	70.6
3	31.3	102.6	61.4	37.2	136.8	51.1	66.1	218.2	65.5	42.0	37.2	57.5
4	31.4	87.9	58.2	38.5	124.3	45.2	88.8	142.3	56.3	43.9	36.0	49.6
5	31.4	75.8	55.5	42.3	110.0	44.9	73.8	94.0	50.7	42.8	32.7	46.5
6	31.1	67.4	57.4	47.8	96.5	43.7	70.6	114.3	57.1	41.0	32.6	45.1
7	31.1	59.3	55.7	48.4	94.8	92.6	67.1	331.7	49.2	41.3	34.7	40.4
8	30.4	56.9	56.7	43.2	90.3	70.2	101.1	254.3	49.8	45.5	32.9	39.7
9	29.4	83.7	72.5	54.9	87.9	91.0	222.7	168.6	48.6	49.9	35.5	37.1
10	27.9	113.8	77.7	53.1	83.4	73.0	115.0	125.2	47.1	55.8	32.6	36.9
11	29.0	93.6	73.2	46.8	80.0	56.2	95.8	146.5	44.4	132.4	35.8	36.5
12	30.2	86.2	67.2	45.5	79.6	56.7	162.4	96.3	46.3	107.2	33.0	35.4
13	32.0	90.5	63.2	43.3	76.0	54.0	94.5	69.2	51.5	86.8	30.6	35.5
14	33.4	85.6	63.5	40.2	77.2	56.7	165.4	64.1	55.4	76.1	33.3	34.9
15	34.6	92.0	63.9	42.3	78.0	84.7	93.1	79.9	105.0	64.9	30.9	33.5
16	35.5	85.1	71.5	44.9	79.5	67.6	88.5	87.8	161.8	61.7	33.5	30.4
17	70.0	83.1	73.5	41.8	79.9	64.9	54.0	242.2	98.1	54.1	30.9	31.1
18	124.5	133.4	72.4	40.1	83.9	106.3	96.3	175.4	74.5	52.9	33.5	30.4
19	66.5	116.8	71.1	40.4	73.7	76.2	64.2	118.9	63.3	52.0	30.9	30.6
20	52.4	94.0	64.2	44.9	82.4	86.8	52.9	109.7	61.3	51.5	31.7	114.9
21	50.6	91.9	63.3	41.4	81.0	97.9	57.4	84.8	106.1	52.7	32.3	65.8
22	210.7	83.5	52.8	37.6	77.4	116.5	49.6	79.5	73.7	54.2	30.9	47.1
23	261.0	83.4	49.5	46.1	71.2	83.8	44.9	92.0	58.5	57.9	29.1	41.4
24	170.8	88.5	47.7	44.6	60.5	117.3	38.4	91.7	53.4	55.1	31.1	43.2
25	115.4	88.5	40.3	45.2	57.9	170.2	32.2	104.7	55.7	56.6	35.4	42.7
26	97.7	87.4	41.4	47.9	57.1	107.1	29.7	100.7	59.1	59.7	34.8	40.3
27	84.7	86.3	38.8	54.7	61.3	99.6	51.4	67.2	62.8	69.3	34.3	41.8
28	77.2	96.3	37.0	80.5	60.2	69.3	70.8	79.3	53.9	59.9	39.4	39.4
29	78.3	86.5	36.2	98.4	48.2	59.7	86.0	62.7	46.7	51.6	43.4	40.4
30	126.3		35.7	370.3	46.8	51.9	171.7	70.0	40.6	44.0	202.7	41.0
31	189.5		37.1		48.5		162.3	64.0		42.6		47.8
Average	73.3	91.1	58.4	58.0	92.0	76.7	87.3	123.5	65.2	57.6	39.6	45.9
Maximum	261.0	137.3	81.2	370.3	367.8	170.2	222.7	331.7	161.8	132.4	202.7	114.9
Minimum	27.5	56.9	35.7	37.2	46.8	43.7	29.7	62.7	40.6	39.4	29.1	30.4

Average annual discharge = 72 (m^3/sec)

Annual inflow volume = 2,290 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2005

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	379.3	71.3	210.0	213.8	179.2	90.9	250.1	108.7	51.5	43.0	56.1	41.9
2	160.5	70.0	211.6	226.7	174.9	83.7	255.6	105.0	48.0	43.2	53.6	44.2
3	107.2	69.2	214.3	231.7	207.8	81.6	211.1	112.2	47.8	44.4	50.4	40.7
4	92.1	63.0	225.8	237.1	194.5	80.9	172.2	104.5	46.2	44.5	54.2	43.0
5	79.7	76.4	247.5	247.0	205.0	85.5	183.3	127.5	52.0	45.9	51.1	39.6
6	69.8	77.9	250.9	237.5	200.3	82.0	178.4	102.0	61.6	45.4	48.3	35.9
7	59.8	187.3	243.8	243.3	189.2	87.1	130.9	104.6	142.1	46.7	51.5	38.2
8	50.8	172.5	229.6	247.5	194.4	90.9	170.5	107.3	106.3	45.7	49.0	34.8
9	48.0	666.0	238.7	233.7	193.3	86.8	198.9	115.7	116.2	53.0	51.7	37.5
10	45.9	411.9	223.0	194.7	173.8	87.0	204.9	117.3	78.3	54.6	48.7	35.1
11	43.1	706.8	230.3	170.9	151.6	94.9	328.8	114.9	73.7	61.9	45.5	35.4
12	44.0	763.6	225.3	171.3	140.4	96.6	457.4	109.3	86.2	110.5	48.4	34.0
13	43.7	440.8	236.9	172.3	140.6	95.7	439.2	169.4	74.9	69.4	45.3	36.8
14	45.0	353.3	229.8	180.2	129.0	81.9	323.0	107.2	58.4	60.6	48.1	33.7
15	42.4	330.6	252.5	185.5	114.2	81.0	304.4	94.7	58.9	55.8	45.0	36.4
16	43.3	332.7	293.5	192.7	120.2	94.2	361.7	136.5	53.5	67.0	47.9	33.7
17	39.7	272.9	334.7	181.2	115.0	97.1	236.3	131.2	77.8	83.5	44.8	31.8
18	42.1	293.6	386.5	188.0	110.9	111.6	195.6	109.9	331.3	70.1	41.6	34.0
19	38.8	402.8	663.8	206.4	114.8	120.5	185.8	90.2	174.0	65.1	44.4	31.8
20	41.2	284.4	529.1	210.9	103.7	133.7	192.0	92.2	103.0	64.4	41.4	32.4
21	37.8	233.7	474.6	198.1	106.4	139.2	219.4	81.1	77.2	60.0	44.1	32.2
22	55.4	236.2	610.4	213.8	94.1	151.6	212.0	76.2	62.5	60.5	41.1	34.8
23	93.4	240.1	460.6	245.3	94.2	166.8	170.6	71.9	85.4	56.1	43.9	33.5
24	66.5	229.6	414.1	222.6	102.5	180.1	165.6	66.2	59.0	57.3	40.9	32.1
25	49.5	215.5	342.4	227.5	95.7	181.5	153.3	84.2	54.8	53.4	44.0	35.1
26	43.5	208.7	311.7	257.3	89.4	197.8	149.2	71.2	50.4	54.1	41.4	32.0
27	39.1	208.2	323.0	223.5	89.7	198.2	205.3	100.2	55.4	53.9	44.6	34.9
28	73.0	203.7	314.9	209.5	85.2	184.1	131.1	79.1	49.9	54.0	44.2	32.5
29	74.0		274.1	179.4	92.7	202.7	123.9	66.7	43.9	56.1	45.2	32.4
30	65.5		242.2	169.3	105.2	208.0	160.0	56.8	43.1	53.3	45.5	33.2
31	60.6		226.0		105.4		108.3	50.3		54.6		30.2
Average	70.2	279.4	312.0	210.6	135.9	122.5	218.7	98.8	80.8	57.7	46.7	35.3
Maximum	379.3	763.6	663.8	257.3	207.8	208.0	457.4	169.4	331.3	110.5	56.1	44.2
Minimum	37.8	63.0	210.0	169.3	85.2	80.9	108.3	50.3	43.1	43.0	40.9	30.2

Average annual discharge = 138 (m^3/sec)

Annual inflow volume = 4,357 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2006

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	31.3	55.1	153.1	135.8	118.1	72.3	95.2	273.5	297.6	68.3	33.8	62.1
2	65.0	56.1	133.1	138.3	114.6	68.7	58.7	245.0	412.3	63.4	32.5	53.6
3	84.9	56.0	114.4	136.8	109.1	67.2	91.4	295.7	525.0	59.5	33.9	48.1
4	75.5	57.2	99.1	113.6	112.4	108.7	69.4	1,226.1	446.2	56.7	31.4	82.4
5	58.7	56.9	85.0	126.9	134.2	96.2	84.2	1,054.7	313.7	51.5	30.0	1,530.1
6	50.1	56.5	69.8	131.4	132.7	97.0	82.6	766.3	248.5	52.3	30.7	673.1
7	46.5	56.0	68.9	136.2	143.2	68.8	158.2	562.0	214.6	50.5	30.2	327.8
8	47.9	59.9	68.1	130.8	143.0	55.3	157.2	752.1	190.1	48.2	30.4	260.0
9	43.3	61.1	68.3	129.1	155.1	56.7	155.6	526.4	184.8	48.1	32.9	233.1
10	38.7	60.3	68.7	261.2	142.1	58.8	203.0	439.9	170.0	48.6	35.5	232.4
11	40.1	57.7	70.0	143.5	139.0	61.8	178.8	323.8	175.9	47.1	35.7	231.9
12	36.6	58.8	73.2	114.8	135.6	64.1	304.6	273.9	180.1	46.7	54.1	207.3
13	37.0	57.3	97.7	94.8	139.5	66.7	509.0	271.6	173.6	50.3	157.8	190.4
14	32.5	70.5	136.1	92.1	139.9	65.8	261.3	293.6	141.6	48.6	100.6	177.9
15	36.1	188.0	138.2	86.6	120.2	73.0	185.4	327.0	128.5	49.2	75.5	169.4
16	175.9	160.8	154.8	80.8	137.9	167.6	131.4	278.6	135.2	44.9	79.0	157.3
17	280.1	112.2	106.8	78.3	181.8	183.9	98.3	266.3	126.0	41.0	99.0	146.4
18	214.8	84.5	97.1	82.3	130.0	125.7	78.1	240.8	120.0	41.5	219.2	147.0
19	105.7	95.4	96.6	78.0	117.1	96.7	70.4	210.7	109.4	49.9	186.9	137.4
20	75.4	71.1	172.3	79.3	112.8	76.6	80.1	374.4	136.3	83.3	127.2	134.2
21	68.7	71.2	228.5	81.4	141.3	69.2	88.2	289.2	109.0	58.7	99.1	133.7
22	62.0	68.3	150.8	89.7	123.3	68.6	129.0	244.2	101.6	50.5	94.1	155.5
23	57.8	70.5	144.4	111.2	136.3	65.2	346.7	267.7	92.8	46.6	106.9	120.2
24	52.9	70.6	132.7	99.0	131.7	71.0	540.0	222.3	90.9	43.7	87.0	105.4
25	51.1	90.8	140.6	106.6	134.7	81.2	260.5	227.6	84.8	40.5	71.7	94.1
26	47.7	382.3	165.1	120.0	121.4	112.7	336.0	219.4	80.5	38.5	68.1	95.6
27	48.3	279.3	144.6	133.8	122.5	142.5	556.6	258.2	81.8	41.2	69.4	107.5
28	50.8	182.5	136.0	134.6	113.8	208.5	669.9	297.0	80.0	37.4	66.7	98.3
29	51.7		126.3	123.2	100.3	175.8	427.1	245.2	76.6	36.4	68.2	89.3
30	51.6		124.4	127.2	89.8	195.4	348.6	263.1	70.0	34.4	65.3	83.9
31	53.1		125.3		82.4		268.9	228.1		31.5		80.2
Average	70.1	98.1	119.0	116.6	127.6	97.4	226.6	379.5	176.6	48.7	75.1	205.3
Maximum	280.1	382.3	228.5	261.2	181.8	208.5	669.9	1,226.1	525.0	83.3	219.2	1,530.1
Minimum	31.3	55.1	68.1	78.0	82.4	55.3	58.7	210.7	70.0	31.5	30.0	48.1

Average annual discharge = 146 (m^3/sec)

Annual inflow volume = 4,596 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2007

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	74.3	40.1	225.2	450.5	178.8	116.7	243.5	129.2	92.3	51.5	25.0	23.0
2	70.9	39.1	185.7	401.6	176.2	125.2	322.7	121.1	87.5	50.7	28.9	23.1
3	66.4	38.2	161.0	364.1	173.8	139.1	224.9	102.1	80.8	50.1	25.4	23.1
4	68.8	38.9	164.2	318.8	177.3	160.3	181.1	106.5	72.3	47.5	27.7	22.6
5	73.1	41.8	185.3	294.5	179.5	170.1	136.1	103.6	91.8	46.9	25.5	20.6
6	70.5	38.3	172.4	280.9	172.7	139.2	158.6	135.7	81.4	43.3	26.0	20.5
7	68.5	38.3	171.8	273.3	163.9	141.8	159.2	113.3	80.5	43.1	26.1	20.8
8	69.4	39.7	174.4	257.9	185.7	145.2	442.0	95.6	91.0	40.9	26.2	21.1
9	65.3	38.8	175.8	255.4	192.5	158.2	236.1	84.3	94.7	39.4	28.7	20.6
10	67.7	43.5	166.9	247.8	185.1	162.1	166.4	77.1	84.9	38.9	25.7	20.9
11	61.9	139.6	162.0	243.7	170.9	166.0	136.2	73.6	95.8	39.3	23.6	21.1
12	59.9	208.7	540.7	243.0	156.1	173.2	200.4	74.0	81.3	34.6	25.3	21.1
13	57.0	133.5	688.1	242.4	166.9	184.3	147.3	117.4	68.3	35.9	23.6	22.9
14	51.3	109.2	421.4	240.6	176.3	223.1	97.5	521.8	69.0	34.3	23.7	25.2
15	50.5	104.4	330.2	246.5	192.3	223.0	181.5	314.9	74.1	30.8	24.8	21.4
16	46.1	88.8	297.1	245.4	214.0	184.0	127.5	180.5	75.9	34.2	24.0	21.8
17	45.8	87.3	277.6	244.7	210.5	187.7	93.6	154.7	90.0	32.1	23.1	21.6
18	43.9	82.2	278.0	267.5	203.7	182.5	95.8	139.2	83.8	33.2	22.2	21.2
19	43.4	71.5	300.8	249.6	281.7	143.1	98.5	98.2	70.9	29.9	23.0	21.7
20	43.2	66.3	2,530.0	250.5	257.0	139.5	204.6	148.4	99.3	28.9	22.3	20.3
21	42.0	62.8	1,401.7	239.3	212.8	127.1	253.8	125.1	129.0	29.1	21.3	22.8
22	43.5	105.4	727.1	223.1	180.5	128.9	228.9	139.1	102.7	28.8	22.1	20.3
23	44.2	81.1	509.3	220.5	171.9	167.5	211.0	147.5	92.2	25.5	21.0	22.7
24	44.5	65.6	454.0	226.3	160.8	142.6	252.2	237.3	90.8	27.5	23.0	21.4
25	41.3	65.1	429.1	199.0	144.0	164.1	172.2	129.5	67.3	27.5	20.7	20.1
26	44.8	63.5	415.9	182.6	134.0	177.9	140.3	155.3	64.1	26.1	21.3	21.2
27	44.9	188.7	412.4	199.0	133.3	149.1	143.9	117.3	62.2	27.2	21.7	21.6
28	40.5	327.9	414.6	199.0	138.0	236.2	122.2	96.7	62.1	25.9	20.8	19.2
29	41.7		427.3	191.1	138.4	340.5	220.7	107.6	61.4	27.3	21.5	18.6
30	38.6		439.1	191.3	121.6	246.9	163.0	97.5	53.4	27.3	22.5	18.8
31	40.1		442.6		125.3		131.8	91.6		27.3		18.6
Average	53.7	87.4	441.3	256.3	176.6	171.5	183.7	139.9	81.7	35.0	23.9	21.3
Maximum	74.3	327.9	2,530.0	450.5	281.7	340.5	442.0	521.8	129.0	51.5	28.9	25.2
Minimum	38.6	38.2	161.0	182.6	121.6	116.7	93.6	73.6	53.4	25.5	20.7	18.6

Average annual discharge = 140 (m^3/sec)

Annual inflow volume = 4,410 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2008

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	19.2	38.4	140.7	86.1	91.8	90.4	217.0	311.4	152.7	48.2	40.6	31.6
2	18.6	38.4	144.6	92.8	101.0	128.1	175.1	325.2	149.6	45.0	38.7	34.5
3	19.6	42.4	134.3	110.2	105.5	124.3	141.9	995.8	163.7	46.2	36.7	34.7
4	16.7	51.5	112.4	134.3	120.2	120.7	154.8	599.0	182.3	41.0	36.4	31.5
5	18.4	77.1	116.1	215.7	106.5	119.1	139.1	550.7	163.5	40.5	37.3	32.5
6	16.9	75.4	113.7	436.7	103.4	152.7	337.6	438.1	152.1	68.7	31.5	32.4
7	19.6	59.0	129.0	176.2	98.5	199.9	275.7	361.9	189.0	55.9	36.5	34.5
8	33.2	90.2	114.4	139.9	92.1	185.4	211.7	357.2	163.0	69.3	39.3	37.6
9	142.9	72.7	116.8	133.0	93.1	206.2	171.0	411.2	159.6	53.0	34.2	277.9
10	197.5	62.4	115.6	142.5	86.0	162.6	149.2	317.7	133.8	52.1	35.6	112.2
11	125.5	55.4	107.8	232.3	91.9	198.8	181.9	362.4	127.1	46.6	31.0	76.9
12	66.4	56.1	106.9	259.3	84.4	286.9	218.0	358.3	129.6	43.0	30.4	63.5
13	54.0	58.5	107.6	191.5	96.3	202.8	208.2	322.8	131.2	42.3	36.8	51.2
14	44.1	60.7	105.6	147.6	91.9	281.3	230.0	315.7	119.1	40.5	44.4	47.7
15	35.4	62.1	101.7	175.1	99.3	697.3	183.4	328.7	89.5	113.6	52.0	46.5
16	30.7	63.3	109.7	306.9	123.3	423.7	165.1	325.2	86.3	102.3	42.8	48.3
17	231.4	71.5	114.5	206.4	137.9	267.2	153.8	274.3	108.8	79.6	35.2	50.1
18	665.3	67.8	112.0	163.7	108.3	220.5	214.9	227.3	99.2	60.7	34.4	53.2
19	165.6	71.9	104.0	146.4	107.0	263.5	173.5	218.6	90.3	46.9	34.1	54.8
20	108.9	77.0	96.5	133.5	127.0	242.6	282.2	229.0	89.5	53.4	37.3	378.4
21	85.3	85.3	81.4	128.4	111.7	197.7	255.1	221.1	82.9	48.9	42.5	377.3
22	71.9	83.9	77.7	131.9	134.8	251.9	265.8	259.4	93.4	48.8	36.6	197.7
23	64.1	163.2	72.3	126.8	186.0	181.4	186.0	211.8	102.6	41.3	39.0	140.6
24	58.8	172.0	73.4	112.3	152.5	203.9	174.0	213.8	81.1	45.6	34.1	108.6
25	52.5	120.3	74.0	113.4	208.2	169.6	170.5	172.4	72.7	40.5	36.2	93.4
26	50.9	105.0	74.6	115.9	159.4	170.5	248.4	171.2	61.5	42.8	31.0	84.7
27	47.5	106.3	74.9	108.7	115.1	185.3	191.6	148.8	54.9	40.4	35.9	77.5
28	46.6	115.6	72.7	104.0	124.8	282.0	183.0	141.7	51.6	41.9	33.8	69.4
29	43.3	128.9	67.2	100.9	97.2	232.0	198.7	135.2	51.8	39.4	34.7	62.8
30	41.5		75.2	96.3	96.8	226.9	454.9	150.2	51.1	41.1	35.6	54.1
31	41.6		80.3		88.1		246.5	156.6		42.6		46.5
Average	85.0	80.4	100.9	159.0	114.2	222.5	211.6	310.1	112.8	52.3	36.8	91.7
Maximum	665.3	172.0	144.6	436.7	208.2	697.3	454.9	995.8	189.0	113.6	52.0	378.4
Minimum	16.7	38.4	67.2	86.1	84.4	90.4	139.1	135.2	51.1	39.4	30.4	31.5

Average annual discharge = 132 (m^3/sec)

Annual inflow volume = 4,165 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2009

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	45.9	75.3	113.3	82.3	132.5	100.6	88.8	120.4	177.3	48.5	28.5	25.0
2	45.3	71.2	105.2	119.1	138.2	95.9	96.9	126.4	186.8	51.6	28.9	27.1
3	45.3	71.7	107.0	203.9	128.8	102.2	96.4	158.4	235.2	48.7	28.0	25.0
4	48.9	70.9	210.3	177.3	154.2	100.8	94.6	112.7	234.0	76.2	25.7	27.1
5	53.2	76.3	152.9	161.2	159.8	100.3	85.7	124.6	154.3	59.4	28.1	25.6
6	47.1	167.7	146.6	190.2	140.2	91.0	81.0	132.3	126.3	54.2	28.2	27.2
7	41.9	132.2	129.3	377.5	113.1	66.0	60.7	179.4	109.8	50.1	28.3	28.1
8	41.9	106.3	112.2	313.7	114.0	66.8	59.1	128.3	101.3	48.1	28.4	24.2
9	45.0	102.7	96.6	336.6	113.9	56.4	64.9	108.7	97.3	47.8	34.7	23.7
10	45.1	110.0	85.4	243.6	113.3	56.6	86.3	156.2	97.9	47.4	96.4	25.6
11	45.8	140.6	86.9	212.1	111.6	59.5	85.3	123.5	123.5	44.6	50.7	26.1
12	43.0	134.9	79.3	187.8	104.0	61.0	101.4	114.8	120.0	43.8	35.7	26.7
13	43.3	130.1	81.5	173.5	99.2	61.7	206.6	145.1	97.6	42.1	32.1	26.6
14	43.4	456.8	82.2	164.1	108.6	62.1	131.4	145.5	93.0	41.4	32.4	25.9
15	44.0	237.5	86.0	148.7	117.9	60.2	100.9	377.7	87.6	39.9	33.3	24.1
16	47.8	196.9	87.2	142.8	112.4	135.3	87.1	359.3	102.6	37.2	30.8	24.0
17	54.9	172.9	83.3	150.4	115.6	127.1	82.3	290.4	88.9	36.7	31.4	23.9
18	80.8	170.9	87.2	148.7	135.6	92.4	198.9	187.7	66.7	34.8	33.1	24.1
19	164.3	152.0	87.5	150.0	146.1	75.4	122.6	146.3	64.9	34.3	30.9	22.2
20	115.6	174.1	85.0	144.8	139.3	61.9	103.8	159.9	62.1	34.5	33.0	21.6
21	82.5	149.8	85.6	146.8	147.2	56.3	134.5	116.1	60.3	34.0	28.8	23.0
22	73.7	135.1	78.1	157.2	116.6	56.7	237.6	130.6	59.0	35.0	28.5	23.2
23	66.8	142.1	76.1	135.2	105.6	58.9	218.1	108.8	54.8	34.6	28.4	22.4
24	68.7	205.1	77.5	123.2	101.5	60.7	208.8	125.8	54.3	33.9	28.3	23.4
25	74.3	160.6	112.4	113.2	102.4	67.6	135.1	107.4	50.5	33.8	28.5	23.0
26	98.2	144.9	127.5	110.8	99.2	61.1	106.1	200.3	50.1	31.8	28.5	23.1
27	133.7	131.8	88.0	115.1	93.9	70.9	126.8	135.6	48.7	30.6	29.4	23.9
28	110.6	119.8	123.9	115.3	96.9	77.3	273.9	99.1	51.4	30.4	27.2	21.5
29	85.1		112.6	128.4	94.6	83.6	280.7	95.4	50.9	30.7	29.4	21.7
30	74.1		139.8	124.9	91.4	100.9	237.1	88.6	54.5	29.4	27.2	20.3
31	74.3		97.8		93.4		131.6	140.2		29.3		21.0
Average	67.2	147.9	104.0	169.9	117.4	77.6	133.1	153.1	98.7	41.1	32.8	24.2
Maximum	164.3	456.8	210.3	377.5	159.8	135.3	280.7	377.7	235.2	76.2	96.4	28.1
Minimum	41.9	70.9	76.1	82.3	91.4	56.3	59.1	88.6	48.7	29.3	25.7	20.3

Average annual discharge = 97 (m^3/sec)

Annual inflow volume = 3,055 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2010

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	21.9	19.7	295.5	111.7	102.1	131.4	99.7	539.5	283.4	85.2	42.4	28.1
2	21.3	19.1	229.3	108.1	102.3	120.1	112.0	801.4	193.4	80.9	42.6	28.1
3	21.4	18.4	180.5	97.7	108.4	123.7	102.4	624.3	215.5	71.6	42.5	27.3
4	21.3	18.4	169.3	92.5	114.0	131.6	100.5	439.3	166.9	70.6	39.1	27.0
5	21.3	19.3	199.3	91.1	133.1	137.6	108.6	581.9	167.8	70.6	38.9	27.7
6	21.6	21.7	156.3	91.2	209.3	102.1	115.0	746.2	151.7	62.4	39.9	24.8
7	21.5	79.3	142.7	90.7	142.4	93.0	106.0	562.4	136.4	63.9	39.4	24.2
8	21.6	661.8	136.3	97.8	169.4	114.5	101.1	403.7	145.2	62.9	38.4	24.6
9	21.7	1,286.4	130.1	96.4	130.5	87.4	101.3	357.6	147.1	65.4	38.5	25.1
10	21.9	377.8	133.1	98.6	113.8	94.8	122.4	304.9	137.4	64.5	33.4	25.6
11	21.9	249.3	130.7	114.9	126.0	90.6	128.1	331.3	140.2	62.2	32.9	25.9
12	22.3	201.2	129.4	109.6	106.9	79.8	149.6	379.3	142.1	61.9	32.6	26.3
13	22.4	167.8	129.3	121.3	108.7	100.6	114.2	388.9	176.8	60.4	33.1	26.7
14	22.2	137.8	129.0	109.7	116.3	96.5	101.6	368.1	165.1	61.0	29.3	27.3
15	22.3	113.8	132.0	107.8	107.7	121.3	92.6	548.0	155.5	60.3	30.1	27.6
16	22.3	107.6	136.3	107.5	100.9	100.2	97.8	454.2	135.0	60.5	29.9	27.8
17	20.6	98.1	141.7	113.4	102.3	99.5	95.8	356.5	117.8	60.6	28.6	26.9
18	19.5	90.5	145.7	114.4	120.1	101.9	162.4	348.6	124.7	58.4	31.4	26.7
19	20.0	89.1	145.0	144.0	156.3	98.5	150.8	331.7	122.6	56.1	30.4	24.2
20	19.5	86.2	151.3	140.7	124.0	88.1	300.4	391.9	109.5	55.8	27.6	24.2
21	19.8	89.2	147.6	136.8	108.2	92.8	321.6	325.1	102.6	50.1	28.0	23.9
22	19.2	105.4	150.5	125.3	126.7	99.6	356.9	285.3	112.6	182.1	28.0	23.6
23	19.6	112.6	151.6	108.8	115.6	105.8	276.8	279.6	127.3	116.2	28.4	23.2
24	16.8	111.8	155.4	98.9	113.1	123.4	160.9	319.0	141.6	76.8	28.0	23.2
25	17.3	105.4	147.2	83.6	118.4	125.8	126.4	317.7	126.1	61.4	28.4	23.2
26	16.6	107.1	139.2	75.7	121.3	138.3	267.1	298.8	103.5	54.5	28.6	23.1
27	16.3	173.1	141.5	91.3	122.3	116.5	478.2	244.0	91.8	50.1	28.5	23.1
28	16.9	167.7	142.0	112.4	240.9	109.4	1,605.8	212.3	92.7	50.2	28.5	23.1
29	20.4		134.1	111.0	243.6	111.2	871.7	196.1	87.2	45.9	28.7	23.1
30	35.9		164.4	105.1	166.0	99.8	755.4	180.0	85.5	46.3	28.4	26.6
31	25.5		139.7		136.3		500.4	169.4		45.8		41.4
Average	21.1	172.7	153.4	106.9	132.5	107.9	264.0	389.9	140.2	66.9	32.8	25.9
Maximum	35.9	1,286.4	295.5	144.0	243.6	138.3	1,605.8	801.4	283.4	182.1	42.6	41.4
Minimum	16.3	18.4	129.0	75.7	100.9	79.8	92.6	169.4	85.5	45.8	27.6	23.1

Average annual discharge = 135 (m^3/sec)

Annual inflow volume = 4,245 (Mm^3)

River: Poonch **Station:** EFlow Site 4 **Year:** 2011

Synthetic Mean Daily Discharges (without Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	27.8	22.7	95.5	167.4	188.8	135.6	146.3	76.4	361.1	154.3	94.9	65.1
2	21.8	21.2	116.0	168.2	207.1	103.5	98.5	50.7	233.8	156.5	94.2	60.2
3	23.1	19.8	274.1	146.3	208.0	108.4	102.0	97.0	176.9	142.4	88.3	58.3
4	24.9	18.3	478.1	132.4	206.0	88.5	97.5	139.7	230.7	137.5	85.9	56.1
5	27.0	17.1	298.3	134.3	187.1	101.6	86.4	96.5	219.5	132.9	84.8	53.9
6	29.4	15.6	229.0	125.6	212.5	113.2	72.4	58.4	204.5	141.8	85.0	51.8
7	29.8	491.0	206.5	112.3	188.1	103.8	98.2	295.6	227.3	138.9	85.3	50.1
8	28.4	289.6	212.3	102.6	157.4	106.5	105.5	199.8	404.9	128.4	84.5	48.4
9	27.3	140.1	201.7	104.5	160.6	102.7	115.3	217.4	364.0	132.0	85.8	48.0
10	25.6	80.0	194.7	112.3	163.8	131.4	127.7	191.3	376.2	129.4	84.8	47.7
11	25.3	60.7	187.8	258.1	182.3	125.8	85.9	290.4	259.4	114.9	85.4	47.3
12	24.2	61.0	180.5	260.8	154.4	171.4	66.2	333.1	199.9	114.3	79.1	46.9
13	22.0	257.6	173.3	221.4	168.2	130.9	66.8	266.4	198.1	113.3	82.0	46.4
14	19.8	758.7	169.1	193.3	155.6	108.5	160.5	208.0	233.8	114.3	75.2	46.4
15	34.8	319.4	177.0	181.5	155.0	111.2	107.7	210.2	406.2	110.4	76.0	46.0
16	34.9	214.1	203.3	174.6	172.5	101.6	293.1	213.7	1,313.9	105.4	80.8	45.9
17	29.8	199.5	215.7	638.9	169.8	125.9	137.2	205.3	466.3	103.6	76.3	45.6
18	30.5	159.8	220.4	493.7	155.6	128.1	119.2	183.7	330.1	101.1	78.6	42.5
19	33.0	128.5	627.2	347.5	157.4	123.5	83.9	174.1	283.8	102.2	79.4	43.2
20	28.9	111.1	439.5	292.1	168.9	117.2	72.3	213.3	260.2	98.3	83.3	46.3
21	29.8	104.3	261.0	265.1	167.5	98.2	82.4	181.5	246.5	98.2	77.9	46.0
22	31.4	95.5	207.8	230.4	131.8	91.7	98.0	158.9	242.9	99.0	72.8	43.4
23	28.3	97.0	201.5	235.7	140.6	116.8	76.4	145.0	246.2	106.0	77.0	42.1
24	30.5	114.5	196.8	239.8	121.5	79.2	234.8	265.1	230.8	110.3	77.8	43.1
25	30.1	113.2	195.8	234.1	134.9	149.5	201.6	351.6	195.5	108.1	77.3	42.8
26	29.0	110.1	195.4	231.9	138.5	190.5	149.9	191.9	198.2	96.7	77.0	42.9
27	28.2	113.8	181.2	227.3	136.4	128.5	113.6	322.5	174.4	94.1	76.7	43.0
28	26.6	97.8	201.3	226.6	131.3	198.0	98.5	345.3	165.5	92.3	73.6	42.6
29	21.5		227.9	221.2	123.8	141.2	186.2	281.7	163.5	93.4	70.9	42.6
30	24.5		206.4	202.4	131.1	134.0	116.8	218.1	154.8	94.5	70.4	38.2
31	24.3		170.2		132.8		92.7	182.6		95.5		38.7
Average	27.5	151.1	230.5	222.7	161.6	122.2	119.1	205.3	292.3	114.8	80.7	47.1
Maximum	34.9	758.7	627.2	638.9	212.5	198.0	293.1	351.6	1,313.9	156.5	94.9	65.1
Minimum	19.8	15.6	95.5	102.6	121.5	79.2	66.2	50.7	154.8	92.3	70.4	38.2

Average annual discharge = 148 (m^3/sec)

Annual inflow volume = 4,653 (Mm^3)

APPENDIX F

SYNTHETIC MEAN DAILY DISCHARGE OF POONCH RIVER
AT EFLOW SITE 2
(WITH PROJECT)

River: Poonch **Station:** EFlow Site 2 **Year:** 1960

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.1	4.3	4.2	4.1	4.2	4.1	4.3	4.1	4.0	4.0
2	4.1	4.1	4.1	4.3	4.2	4.1	4.2	4.1	4.3	4.1	4.0	4.0
3	4.1	4.1	4.1	4.3	4.3	4.1	4.2	4.2	39.5	4.1	4.0	4.0
4	4.1	4.1	4.1	4.3	4.3	4.1	4.1	4.1	4.2	4.1	4.0	4.0
5	4.1	4.1	4.1	4.3	4.2	4.1	4.1	4.1	4.3	4.1	4.0	4.0
6	4.1	4.1	4.1	4.3	4.2	4.1	4.3	4.1	4.2	4.1	4.0	4.0
7	4.1	4.1	4.1	4.2	4.1	4.2	4.3	342.2	4.2	4.1	4.0	4.0
8	4.1	4.1	4.2	4.2	4.1	4.2	118.0	203.1	4.2	4.1	4.0	4.0
9	4.1	4.1	4.3	4.2	4.2	4.2	4.3	163.4	4.1	4.1	4.0	4.0
10	4.1	4.1	16.5	4.2	4.2	4.1	1,334.7	186.0	4.1	4.1	4.0	4.0
11	4.1	4.1	594.7	4.2	4.2	4.1	2,233.7	4.3	4.2	4.1	4.0	4.0
12	4.1	4.1	20.5	4.2	4.2	4.1	379.2	4.3	4.1	4.1	4.0	4.0
13	4.1	4.1	4.4	4.2	4.2	4.1	134.7	109.7	4.1	4.1	4.0	4.0
14	4.1	4.1	4.3	4.2	4.2	4.1	1,167.3	4.3	4.1	4.1	4.0	4.0
15	4.1	4.1	4.3	4.2	4.2	4.1	469.4	246.0	4.1	4.1	4.0	4.0
16	4.1	4.1	123.7	4.3	4.2	4.1	103.6	804.3	4.1	4.1	4.0	4.0
17	4.1	4.1	54.5	4.3	4.2	4.1	4.4	4.4	4.2	4.1	4.0	4.1
18	4.1	4.1	4.4	4.3	4.3	4.1	129.7	185.8	4.1	4.1	4.0	4.0
19	4.1	4.1	4.3	56.5	4.2	4.1	4.3	4.4	4.1	4.1	4.0	4.0
20	4.3	4.1	16.5	4.3	4.2	4.1	17.5	123.7	4.1	4.1	4.0	4.0
21	4.2	4.1	4.3	4.2	4.2	4.1	4.3	18.5	4.1	4.1	4.0	4.0
22	4.1	4.1	4.4	4.2	4.2	4.1	4.2	4.4	4.1	4.1	4.0	4.0
23	4.1	4.1	4.4	4.2	4.1	4.1	4.2	103.6	4.1	4.1	4.0	4.0
24	4.1	4.1	4.3	4.2	4.1	4.1	4.2	4.3	4.2	4.1	4.0	4.0
25	4.1	4.1	4.3	4.2	4.1	4.1	4.2	4.3	4.2	4.1	4.0	4.0
26	4.1	4.1	4.3	4.2	4.1	4.1	4.4	4.4	4.1	4.1	4.0	4.0
27	4.1	4.1	4.3	4.2	4.1	4.1	4.2	4.3	4.1	4.1	4.0	4.0
28	4.1	4.1	51.5	4.2	4.1	4.1	4.2	4.4	4.1	4.1	4.0	4.0
29	4.1	4.1	4.4	4.2	4.1	4.1	4.2	4.3	4.1	4.1	4.0	4.0
30	4.1		4.3	4.2	4.1	4.1	4.2	4.3	4.1	4.0	4.0	4.0
31	4.1		4.3		4.1		4.2	4.4		4.0		4.1
Average	4.1	4.1	31.6	6.0	4.2	4.1	199.2	83.0	5.3	4.1	4.0	4.0
Maximum	4.3	4.1	594.7	56.5	4.3	4.2	2,233.7	804.3	39.5	4.1	4.0	4.1
Minimum	4.1	4.1	4.1	4.2	4.1	4.1	4.1	4.1	4.1	4.0	4.0	4.0

Average annual discharge = 30 (m^3/sec)

Annual inflow volume = 945 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1961

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.3	4.2	4.2	4.2	4.1	4.4	92.6	197.8	4.4	4.1	4.1
2	4.0	79.6	4.2	4.2	4.2	4.1	4.2	294.1	336.1	4.2	4.1	4.1
3	4.0	4.4	4.2	4.2	4.2	4.2	4.3	77.6	4.3	4.2	4.1	4.1
4	4.0	4.4	4.1	4.2	4.2	4.2	4.3	4.4	4.4	4.2	4.1	4.1
5	4.0	4.3	4.1	4.3	4.2	4.2	22.5	4.3	4.2	4.2	4.1	4.1
6	4.0	4.3	4.1	4.2	4.2	4.3	42.5	4.3	22.5	4.2	4.1	4.1
7	4.0	4.3	4.1	4.2	4.2	21.5	6.4	4.2	348.2	4.2	4.1	4.1
8	4.0	4.2	4.1	4.2	4.2	69.6	143.7	4.2	1,062.7	4.2	4.1	4.1
9	4.0	4.2	4.1	4.2	4.2	4.4	27.5	585.7	748.0	4.2	4.1	4.1
10	4.0	4.2	4.1	18.5	4.2	4.3	4.3	430.4	342.2	4.2	4.1	4.1
11	4.0	4.2	4.1	750.0	4.2	4.3	4.3	73.6	151.7	4.2	4.1	4.1
12	4.0	4.1	4.2	311.1	4.2	4.3	4.2	4.4	89.6	4.2	4.1	4.1
13	4.0	4.1	4.2	714.0	4.2	4.2	4.2	4.3	106.7	4.1	4.1	4.1
14	4.0	4.1	4.2	165.8	4.2	4.2	4.2	4.3	59.5	4.1	4.1	4.1
15	4.0	4.1	4.2	73.6	7.4	4.2	11.4	4.4	302.1	4.1	4.1	4.1
16	4.0	4.1	4.2	14.5	4.2	4.1	373.2	52.5	146.7	4.1	4.1	4.1
17	4.0	4.2	4.2	4.4	4.1	4.1	146.7	4.4	64.6	4.1	4.1	4.2
18	4.0	4.2	4.2	4.4	4.1	4.1	4.3	4.4	23.5	4.1	4.1	4.1
19	4.0	4.2	4.3	4.3	4.1	4.2	4.2	4.2	4.4	4.1	4.1	4.1
20	4.0	4.2	4.3	37.5	4.1	4.2	4.2	163.8	4.4	4.1	4.1	4.1
21	4.0	4.2	4.2	50.5	4.1	4.1	4.3	4.3	4.4	4.1	4.1	4.1
22	4.0	4.2	4.2	4.4	4.2	4.2	971.5	4.2	4.4	4.1	4.1	4.1
23	4.0	4.2	4.2	4.3	4.2	4.2	673.9	4.3	4.4	4.1	4.1	4.1
24	4.0	4.2	4.3	4.2	4.1	4.2	163.8	61.6	79.6	4.1	4.1	4.1
25	4.0	4.1	4.3	4.2	4.1	4.2	188.8	146.7	171.8	4.1	4.1	4.1
26	4.1	4.1	4.2	4.2	4.1	4.4	319.1	4.4	160.8	4.1	4.1	4.1
27	4.1	4.2	4.2	4.2	4.1	4.3	106.7	4.4	4.4	4.1	4.3	4.1
28	4.0	4.2	4.2	4.2	4.1	4.2	35.5	4.3	4.2	4.1	4.2	4.1
29	336.1		4.2	4.2	4.1	4.3	231.9	4.2	4.2	4.2	4.1	4.1
30	248.0		4.2	4.3	4.1	4.4	461.4	8.4	4.2	4.3	4.1	4.1
31	51.5		4.2		4.1		225.9	299.1		4.3		4.1
Average	24.1	6.9	4.2	74.2	4.3	7.0	135.7	76.4	148.9	4.2	4.1	4.1
Maximum	336.1	79.6	4.3	750.0	7.4	69.6	971.5	585.7	1,062.7	4.4	4.3	4.2
Minimum	4.0	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.2	4.1	4.1	4.1

Average annual discharge = 41 (m^3/sec)

Annual inflow volume = 1,301 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1962

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.0	4.1	4.3	4.3	4.1	4.1	4.2	4.2	4.1	4.1	4.0
2	4.1	4.0	4.1	4.2	4.2	4.1	4.1	4.2	4.1	4.2	4.1	4.0
3	4.0	4.0	4.2	4.2	4.2	4.1	4.1	4.2	4.2	4.1	4.1	4.1
4	4.0	4.0	4.4	4.2	4.2	4.1	4.1	4.2	4.3	4.1	4.1	4.0
5	4.0	4.0	4.3	4.2	4.1	4.1	4.1	4.3	4.4	4.1	4.1	4.0
6	4.0	4.0	4.3	4.2	4.1	4.1	4.1	29.5	4.2	4.1	4.1	4.0
7	4.0	4.1	4.2	4.3	4.1	4.1	4.1	4.4	4.1	4.1	4.1	4.0
8	4.0	4.1	4.2	4.4	4.1	4.2	4.2	4.2	4.1	4.1	4.1	4.0
9	4.0	4.1	4.2	387.3	4.2	4.2	4.1	4.4	4.1	4.1	4.0	4.0
10	4.0	4.1	4.2	126.7	4.3	4.1	4.2	28.5	4.1	4.1	4.0	4.0
11	4.0	4.1	4.2	4.4	4.2	4.2	4.1	4.2	86.6	4.1	4.0	4.0
12	4.1	4.1	4.1	4.4	4.2	4.1	4.2	4.1	44.5	4.1	4.0	4.0
13	4.1	4.1	4.1	4.3	4.3	31.5	4.2	4.2	4.2	4.1	4.0	4.0
14	4.0	4.1	4.1	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.0	4.1
15	4.0	4.1	4.1	4.3	4.2	4.1	4.1	4.3	4.1	4.1	4.0	4.0
16	4.0	4.1	4.1	4.3	4.2	4.1	4.4	398.8	4.2	4.1	4.0	4.0
17	4.0	4.3	4.1	4.3	4.2	4.1	65.6	4.3	4.2	4.1	4.0	4.1
18	4.0	4.1	4.1	4.3	4.2	4.1	9.4	4.3	4.2	4.1	4.0	4.1
19	4.0	4.1	4.1	4.3	4.1	4.1	4.3	4.2	4.2	4.1	4.1	4.1
20	4.0	4.1	4.1	4.3	4.1	4.1	4.4	4.2	12.4	4.1	4.1	4.1
21	4.0	4.1	4.2	4.3	4.2	4.1	1,053.9	57.5	4.2	4.1	4.3	4.1
22	4.0	4.1	4.2	4.3	4.2	4.1	143.7	4.3	197.8	4.1	4.2	4.1
23	4.0	4.1	4.1	4.4	4.2	4.1	4.4	4.2	71.6	4.1	4.1	4.1
24	4.0	21.5	4.2	4.4	4.2	4.1	4.3	4.2	4.2	4.1	4.1	4.0
25	4.0	4.4	4.2	4.3	4.2	4.2	4.3	4.1	4.2	4.1	4.1	4.1
26	4.0	4.3	4.2	4.3	4.2	4.2	4.3	4.3	4.3	4.1	4.1	4.1
27	4.0	4.2	4.2	4.3	4.2	4.2	40.5	4.3	4.3	4.1	4.1	4.4
28	4.0	4.2	4.2	4.3	4.2	4.1	4.4	70.6	4.4	4.1	4.1	4.1
29	4.0		4.2	4.3	4.2	4.1	4.2	4.3	4.2	4.1	4.1	4.1
30	4.0		4.2	4.3	4.1	4.2	4.3	4.4	4.2	4.1	4.1	4.1
31	4.0		4.2		4.1		4.2	4.2		4.1		4.1
Average	4.0	4.7	4.2	21.1	4.2	5.1	45.9	22.4	17.3	4.1	4.1	4.1
Maximum	4.1	21.5	4.4	387.3	4.3	31.5	1,053.9	398.8	197.8	4.2	4.3	4.4
Minimum	4.0	4.0	4.1	4.2	4.1	4.1	4.1	4.1	4.1	4.1	4.0	4.0

Average annual discharge = 12 (m^3/sec)

Annual inflow volume = 373 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1963

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.0	4.1	4.2	4.1	47.5	22.5	685.2	208.9	4.1	4.0	4.0
2	4.0	4.0	4.1	4.2	4.4	4.2	4.4	72.6	4.3	4.1	4.0	4.0
3	4.0	4.0	4.1	4.4	4.3	4.2	4.3	4.3	4.2	4.1	4.0	4.0
4	4.1	4.0	4.1	4.4	4.2	4.2	4.2	4.3	4.2	4.0	4.0	4.0
5	4.1	4.0	8.4	4.1	4.4	4.2	4.2	148.7	4.3	4.0	4.0	4.0
6	4.1	4.0	53.5	4.2	11.4	4.2	4.2	33.5	4.3	4.0	4.0	4.0
7	4.1	4.0	4.3	4.2	4.3	4.2	4.2	4.4	4.2	4.1	4.0	4.0
8	4.1	4.0	4.3	4.2	4.3	4.2	4.2	117.7	4.1	4.1	4.0	4.0
9	4.1	4.0	4.3	4.2	14.5	4.2	4.2	73.6	4.3	4.1	4.0	4.0
10	4.1	4.0	46.5	4.2	21.5	4.1	4.2	4.3	4.3	4.1	4.0	4.0
11	4.1	4.0	4.3	4.2	4.3	4.2	4.4	82.6	4.2	4.1	4.0	4.0
12	4.0	4.0	4.2	4.2	4.3	4.2	67.6	120.7	4.1	4.1	4.0	4.0
13	4.1	4.0	4.2	4.2	4.4	4.2	4.4	17.5	4.1	4.0	4.0	4.3
14	4.1	4.0	4.1	4.2	123.7	4.2	16.5	4.3	4.1	4.0	4.0	4.2
15	4.1	4.1	4.2	4.2	4.4	4.2	4.2	4.3	4.1	4.0	4.0	4.1
16	4.1	4.3	4.4	4.2	7.4	4.2	4.1	4.3	4.1	4.0	4.1	4.1
17	4.0	4.2	4.4	4.3	4.4	4.2	4.1	80.6	4.2	4.0	4.1	4.1
18	4.0	4.1	4.3	4.3	4.3	4.2	185.8	254.0	4.1	4.0	4.1	4.1
19	4.0	4.1	4.2	4.3	4.3	37.5	8.4	4.4	4.1	4.0	4.1	4.1
20	4.0	4.1	4.2	4.2	4.3	4.3	4.4	197.8	4.2	4.0	4.1	4.1
21	4.0	4.1	4.1	4.2	4.3	4.2	299.1	367.2	4.2	4.0	4.1	4.1
22	4.0	4.1	4.2	4.3	4.2	4.2	30.5	285.0	4.1	4.0	4.1	4.1
23	4.0	4.1	39.5	4.3	4.2	4.2	4.3	123.7	4.1	4.0	4.1	4.1
24	4.0	4.1	163.8	4.4	4.2	4.2	4.2	106.7	4.1	4.0	4.0	4.1
25	4.0	4.1	4.2	4.3	4.2	4.2	4.1	6.4	4.1	4.0	4.0	4.1
26	4.0	4.1	4.2	4.2	4.2	4.2	4.1	48.5	4.1	4.0	4.0	4.1
27	4.0	4.1	4.2	36.5	4.2	4.2	4.1	15.5	4.2	4.0	4.0	4.0
28	4.0	4.1	4.2	274.0	4.2	31.5	11.4	4.3	4.2	4.0	4.1	4.0
29	4.0		4.2	101.6	4.2	34.5	95.6	4.3	4.1	4.0	4.1	4.0
30	4.0		4.2	30.5	4.2	4.4	1,110.8	4.2	4.1	4.0	4.1	4.0
31	4.0		4.2		4.2		512.5	51.5		4.0		4.1
Average	4.1	4.1	13.6	18.4	9.3	8.7	78.9	94.7	11.0	4.0	4.0	4.1
Maximum	4.1	4.3	163.8	274.0	123.7	47.5	1,110.8	685.2	208.9	4.1	4.1	4.3
Minimum	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.2	4.1	4.0	4.0	4.0

Average annual discharge = 22 (m^3/sec)

Annual inflow volume = 678 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1964

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.2	4.2	4.2	4.2	4.1	4.2	4.3	151.7	4.1	4.1	4.0
2	4.0	4.2	4.2	4.2	4.3	4.1	4.3	4.3	25.5	4.1	4.1	4.0
3	4.0	4.2	4.2	148.7	4.3	4.1	86.6	4.3	4.4	4.1	4.1	4.0
4	4.0	4.1	4.2	4.4	4.3	4.1	4.3	4.3	4.3	4.1	4.1	4.0
5	4.1	4.1	4.2	4.3	4.2	4.1	4.3	4.3	4.3	4.1	4.1	4.0
6	4.2	4.1	4.2	4.3	4.2	4.1	4.3	4.4	4.2	4.1	4.0	4.0
7	225.9	4.1	4.2	4.3	4.2	4.1	4.4	4.4	4.2	4.1	4.0	4.0
8	1,320.3	4.1	4.2	4.3	4.2	4.1	4.4	4.4	4.2	4.1	4.0	4.0
9	410.3	4.1	4.2	4.2	4.2	4.1	4.2	34.5	4.2	4.1	4.0	4.0
10	4.3	4.2	4.2	4.2	4.2	4.1	4.2	452.4	73.6	4.1	4.0	4.2
11	4.3	4.2	4.2	4.3	4.2	4.1	4.2	4.4	4.3	4.1	4.0	4.3
12	4.3	4.2	4.2	4.3	4.2	4.1	4.2	30.5	4.3	4.1	4.0	4.1
13	4.2	4.1	4.2	4.3	4.2	4.1	69.6	4.3	4.4	4.1	4.0	4.1
14	4.2	4.2	4.2	4.3	4.3	4.3	70.6	4.4	4.4	4.1	4.0	4.1
15	4.1	4.2	4.2	4.3	4.2	4.3	1,351.3	1,115.8	4.3	4.1	4.0	4.1
16	4.1	4.2	4.2	76.6	4.2	4.3	353.2	588.7	4.3	4.1	4.0	4.1
17	4.1	4.2	4.2	4.4	4.2	4.2	314.1	452.4	4.3	4.1	4.0	4.1
18	4.1	6.4	4.3	4.3	4.2	4.2	146.7	390.3	4.2	4.1	4.0	4.1
19	4.1	4.3	59.5	4.2	4.2	4.2	4.4	202.9	4.2	4.1	4.0	4.1
20	4.1	4.3	4.4	4.2	4.2	4.2	4.3	299.1	4.2	4.1	4.0	4.1
21	4.2	4.2	4.3	4.2	4.2	4.2	4.2	585.7	4.2	4.1	4.0	4.1
22	4.4	4.2	4.3	4.2	4.2	4.2	4.2	228.9	4.2	4.1	4.0	4.1
23	4.3	4.2	4.3	4.2	4.2	4.2	4.2	103.6	4.2	4.1	4.0	4.1
24	4.2	4.2	4.3	4.2	4.1	4.2	4.2	594.7	4.2	4.1	4.0	4.1
25	4.2	4.2	4.3	4.3	4.1	4.2	1,569.8	299.1	4.2	4.1	4.0	4.1
26	4.2	4.2	4.3	9.4	4.1	4.2	529.6	126.7	4.2	4.1	4.0	4.1
27	4.2	4.2	4.2	4.4	4.1	4.2	297.1	61.6	4.2	4.1	4.0	4.1
28	4.2	4.2	4.2	4.3	4.1	4.2	202.9	21.5	4.2	4.1	4.0	4.1
29	4.2	4.2	4.3	4.3	4.1	4.2	314.1	4.4	4.1	4.1	4.0	4.0
30	4.2		4.2	4.2	4.1	4.2	129.7	4.4	4.1	4.1	4.0	4.0
31	4.2		4.2		4.1		4.4	10.4		4.1		4.0
Average	66.9	4.3	6.0	11.7	4.2	4.2	177.8	182.4	12.2	4.1	4.0	4.1
Maximum	1,320.3	6.4	59.5	148.7	4.3	4.3	1,569.8	1,115.8	151.7	4.1	4.1	4.3
Minimum	4.0	4.1	4.2	4.2	4.1	4.1	4.2	4.3	4.1	4.1	4.0	4.0

Average annual discharge = 41 (m^3/sec)

Annual inflow volume = 1,287 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1965

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.3	123.7	33.5	4.3	4.2	6.4	4.2	4.1	4.0	4.0
2	4.0	4.1	4.2	4.4	11.4	4.4	4.4	4.3	4.2	4.1	4.0	4.0
3	4.0	4.3	4.3	4.3	4.4	4.4	4.3	4.3	4.2	4.1	4.0	4.0
4	4.1	123.7	4.2	50.5	4.4	4.4	4.4	4.3	4.2	4.1	4.0	4.0
5	4.1	4.3	4.2	7.4	4.4	4.4	4.3	4.3	4.1	4.1	4.1	4.0
6	4.1	4.1	4.3	109.7	4.4	4.4	4.3	4.4	4.1	4.1	4.1	4.0
7	4.1	4.2	4.3	236.9	4.4	4.4	4.2	4.3	4.1	4.1	4.1	4.0
8	4.1	4.2	4.3	146.7	11.4	4.3	4.3	4.3	4.1	4.1	4.0	4.0
9	4.1	4.2	9.4	103.6	6.4	4.3	4.4	4.4	4.1	4.1	4.0	4.0
10	4.0	4.1	4.3	56.5	4.4	4.3	4.3	4.3	4.1	4.1	4.0	4.0
11	4.0	4.1	4.2	40.5	4.4	4.3	4.3	4.3	4.1	4.1	4.0	4.0
12	4.0	4.2	4.2	22.5	4.3	4.3	4.3	4.2	4.1	4.1	4.0	4.0
13	4.0	4.2	4.2	40.5	4.3	4.3	4.2	4.2	4.1	4.1	4.0	4.0
14	4.0	4.2	4.3	15.5	4.3	4.3	4.2	4.2	4.1	4.1	4.1	4.0
15	4.0	4.2	4.3	4.4	4.4	4.3	9.4	4.2	4.1	4.1	4.1	4.0
16	4.0	4.3	4.3	4.4	4.4	4.3	211.9	4.2	4.1	4.0	4.1	4.0
17	4.0	636.8	4.3	4.4	4.4	4.3	24.5	4.3	4.1	4.0	4.0	4.0
18	4.0	208.9	4.3	137.7	4.4	4.2	168.8	4.2	4.1	4.0	4.0	4.0
19	328.1	52.5	57.5	308.1	4.4	4.2	32.5	4.2	4.1	4.0	4.0	4.0
20	4.3	4.4	7.4	109.7	9.4	4.3	129.7	4.3	4.1	4.0	4.0	4.0
21	4.2	4.4	4.3	23.5	59.5	4.3	4.3	4.2	4.1	4.0	4.0	4.0
22	4.1	4.3	4.2	10.4	208.9	4.3	4.3	211.9	4.2	4.0	4.0	4.0
23	4.1	4.3	4.2	57.5	160.8	4.3	126.7	4.3	4.1	4.0	4.0	4.0
24	4.1	4.3	4.2	750.0	56.5	4.3	236.9	171.8	4.1	4.0	4.0	4.0
25	4.1	4.3	4.2	274.0	4.4	4.3	384.3	4.4	4.1	4.0	4.0	4.0
26	4.1	4.3	4.3	143.7	4.3	4.3	571.7	4.3	4.1	4.0	4.0	4.0
27	4.1	4.3	4.3	103.6	4.4	4.3	103.6	4.2	4.1	4.0	4.0	4.0
28	4.1	4.3	4.2	89.6	4.4	4.3	4.4	4.4	4.1	4.0	4.0	4.0
29	4.1		4.2	51.5	4.4	4.3	4.3	4.3	4.1	4.0	4.0	4.0
30	4.2		4.2	35.5	4.4	4.3	4.3	4.3	4.1	4.0	4.0	4.0
31	4.1		5.4		4.3		4.4	4.2		4.0		4.0
Average	14.5	40.1	6.3	102.4	21.1	4.3	67.3	16.4	4.1	4.1	4.0	4.0
Maximum	328.1	636.8	57.5	750.0	208.9	4.4	571.7	211.9	4.2	4.1	4.1	4.0
Minimum	4.0	4.1	4.2	4.3	4.3	4.2	4.2	4.2	4.1	4.0	4.0	4.0

Average annual discharge = 24 (m^3/sec)

Annual inflow volume = 753 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1966

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.0	4.2	4.3	4.3	4.2	4.3	824.2	4.3	4.3	4.1	4.1
2	4.0	4.0	4.2	4.3	4.3	4.2	4.2	322.1	4.2	4.3	4.1	4.1
3	4.0	4.0	4.2	4.3	4.3	4.2	4.2	214.9	299.1	4.3	4.1	4.1
4	4.0	4.0	4.3	4.3	4.3	4.2	53.5	168.8	4.4	13.4	4.1	4.1
5	4.0	4.0	4.4	4.3	4.3	4.2	4.3	180.8	4.3	4.3	4.1	4.1
6	4.0	4.0	4.2	4.3	4.3	4.2	4.2	314.1	4.3	4.4	4.1	4.1
7	4.0	4.0	4.2	16.5	4.3	4.2	4.2	782.1	4.4	4.3	4.1	4.1
8	4.0	4.1	4.2	4.3	4.3	4.2	4.2	257.0	1,966.7	4.3	4.1	4.1
9	4.0	4.2	4.2	4.3	4.3	4.2	4.2	131.7	2,608.1	4.2	4.1	4.1
10	4.0	4.1	4.2	4.2	4.3	4.2	4.1	117.7	236.9	97.6	4.1	4.1
11	4.0	4.1	4.2	4.2	117.7	4.2	4.1	109.7	131.7	9.4	4.1	4.1
12	4.0	126.7	4.3	4.2	21.5	4.1	4.4	21.5	62.6	4.3	4.1	4.1
13	4.0	182.8	4.3	4.3	4.4	4.2	38.5	35.5	52.5	4.3	4.1	4.1
14	4.0	4.4	4.3	18.5	4.3	4.2	4.4	9.4	33.5	4.3	4.1	4.1
15	4.0	4.2	4.3	4.4	4.3	4.2	4.2	97.6	22.5	4.3	4.1	4.1
16	4.0	4.1	4.3	4.3	4.2	4.2	4.3	4.4	10.4	4.2	4.1	4.1
17	4.0	4.1	4.3	4.4	4.2	4.2	4.2	4.4	29.5	4.2	4.1	4.1
18	4.0	4.1	70.6	4.3	4.2	4.3	4.2	4.4	12.4	4.2	4.1	4.1
19	4.0	4.1	4.3	4.3	4.2	45.5	4.2	89.6	43.5	4.2	4.1	4.1
20	4.0	4.1	4.3	4.2	4.2	4.4	4.4	171.8	4.4	61.6	4.1	4.1
21	4.0	13.4	4.2	4.3	4.2	4.3	4.2	4.4	4.4	4.2	4.1	4.1
22	4.0	4.3	4.3	4.3	4.2	4.4	68.6	4.3	4.4	4.2	4.1	4.1
23	4.0	4.1	97.6	4.3	4.2	82.6	205.9	4.2	4.4	4.2	4.1	4.1
24	4.0	4.1	35.5	4.3	4.2	208.9	47.5	4.2	4.3	4.2	4.1	4.1
25	4.0	4.1	4.4	4.2	4.2	89.6	664.9	4.2	4.3	4.2	4.1	4.1
26	4.0	77.6	4.4	4.2	4.3	4.3	787.1	4.2	4.3	4.2	4.1	4.1
27	4.0	4.4	236.9	4.3	4.3	4.2	51.5	4.2	4.3	4.2	4.1	4.1
28	4.0	4.3	23.5	4.4	4.3	4.3	100.6	4.2	4.3	4.1	4.1	4.1
29	4.0		4.4	4.4	4.3	4.4	19.5	4.2	4.3	4.1	4.1	4.1
30	4.0		4.4	4.4	8.4	68.6	185.8	4.2	4.3	4.1	4.1	4.1
31	4.0		4.3		4.3		784.1	4.2		4.1		4.1
Average	4.0	17.8	18.6	5.2	8.6	20.0	99.6	126.1	186.1	9.6	4.1	4.1
Maximum	4.0	182.8	236.9	18.5	117.7	208.9	787.1	824.2	2,608.1	97.6	4.1	4.1
Minimum	4.0	4.0	4.2	4.2	4.2	4.1	4.1	4.2	4.2	4.1	4.1	4.1

Average annual discharge = 42 (m^3/sec)

Annual inflow volume = 1,326 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1967

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.0	4.2	112.7	95.6	4.2	4.3	4.4	4.2	4.1	4.1	4.0
2	4.1	4.0	4.2	563.6	67.6	4.3	4.3	4.4	4.3	4.1	4.1	4.0
3	4.1	4.0	4.2	95.6	4.3	4.3	4.2	631.8	4.3	4.1	4.1	373.2
4	4.1	4.0	4.2	4.4	4.3	4.3	4.3	117.7	4.3	4.2	4.1	4.2
5	4.1	4.0	4.2	4.3	4.3	4.2	4.2	291.1	4.2	4.1	4.1	4.1
6	4.1	4.0	4.2	4.3	4.3	4.2	4.2	396.3	4.2	4.1	4.1	4.1
7	4.1	4.0	4.2	4.3	4.2	4.3	4.2	47.5	77.6	4.1	4.1	4.1
8	4.1	4.0	4.1	4.3	4.2	4.3	4.3	140.7	4.2	4.1	4.1	4.1
9	4.1	4.0	4.1	4.2	4.3	4.2	4.3	28.5	4.2	4.1	4.1	4.1
10	4.1	4.0	4.1	4.2	4.3	4.2	4.3	4.4	4.2	4.1	4.1	4.1
11	4.1	4.0	4.1	4.2	4.3	4.2	4.3	4.4	7.4	4.1	4.1	4.1
12	4.1	4.0	4.3	4.2	4.2	4.2	4.2	109.7	4.4	4.1	4.1	4.1
13	4.0	4.0	251.0	4.2	4.2	4.2	36.5	4.3	168.8	4.1	4.1	4.1
14	4.0	4.0	13.4	4.2	4.2	4.2	4.2	770.1	137.7	4.1	4.1	4.1
15	4.0	4.0	4.3	4.3	4.2	4.2	4.2	4.4	4.3	4.1	4.1	4.1
16	4.0	4.0	342.2	4.3	4.2	4.4	4.2	4.4	4.3	4.1	4.1	4.1
17	4.0	4.1	97.6	4.3	4.2	4.3	4.2	4.3	4.3	4.1	4.1	4.1
18	4.0	4.1	37.5	4.3	4.2	4.2	4.2	4.4	4.2	4.1	4.1	4.1
19	4.0	4.4	11.4	4.3	4.2	4.2	4.2	4.4	4.3	4.1	4.1	4.1
20	4.0	407.3	4.4	4.3	4.3	4.1	832.2	103.6	4.2	4.1	4.1	4.1
21	4.0	30.5	4.4	4.3	4.3	4.1	25.5	4.3	4.2	4.1	4.1	4.1
22	4.0	4.3	4.4	4.3	4.3	4.1	4.4	4.3	4.2	4.1	4.1	4.1
23	4.0	4.2	4.4	4.3	4.3	4.1	770.1	4.3	4.1	4.1	4.1	4.1
24	4.0	4.2	4.4	4.3	4.3	4.1	134.7	4.4	4.1	4.1	4.1	4.2
25	4.0	4.2	926.4	4.3	4.3	4.2	97.6	4.3	4.2	4.2	4.1	4.2
26	4.0	4.2	551.6	4.3	4.3	4.2	39.5	4.3	4.2	4.2	4.1	478.5
27	4.0	4.1	35.5	4.4	4.2	4.2	345.2	4.3	4.2	4.1	4.1	333.1
28	4.0	4.2	4.4	376.2	4.2	4.2	13.4	4.3	4.1	4.1	4.1	4.3
29	4.0		4.4	157.8	4.2	4.2	4.4	4.3	4.1	4.1	4.1	4.2
30	4.0		4.3	4.4	4.2	46.5	319.1	4.3	4.1	4.1	4.1	4.2
31	4.0		4.3		4.2		4.4	4.3		4.1		4.2
Average	4.0	19.4	76.1	47.1	9.2	5.6	87.2	88.0	16.7	4.1	4.1	41.9
Maximum	4.1	407.3	926.4	563.6	95.6	46.5	832.2	770.1	168.8	4.2	4.1	478.5
Minimum	4.0	4.0	4.1	4.2	4.2	4.1	4.2	4.3	4.1	4.1	4.1	4.0

Average annual discharge = 34 (m^3/sec)

Annual inflow volume = 1,070 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1968

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.2	4.3	4.3	4.2	4.3	4.2	4.2	4.4	4.2	4.1	4.2	4.1
2	4.2	4.2	4.3	4.2	4.3	4.2	4.2	4.4	4.2	4.1	4.3	4.1
3	4.2	4.2	4.3	4.2	4.2	4.2	4.2	4.3	4.2	4.1	4.1	4.0
4	4.1	4.2	4.3	4.2	4.2	4.2	4.2	126.7	4.2	4.2	4.1	4.0
5	4.1	4.2	4.3	4.2	4.2	4.2	4.2	72.6	4.2	4.2	4.1	4.0
6	4.1	4.3	4.3	4.3	4.2	4.2	4.2	469.4	4.2	4.1	4.1	4.0
7	4.1	4.3	4.3	4.3	4.2	4.2	4.2	4.4	4.2	24.5	4.1	4.0
8	4.1	4.2	4.3	4.3	4.2	4.2	4.2	6.4	4.2	4.2	4.1	4.0
9	4.1	4.2	4.3	4.3	4.1	4.2	19.5	79.6	4.2	4.1	4.1	4.0
10	4.1	4.2	4.3	4.3	4.1	4.2	4.4	61.6	4.2	4.1	4.1	4.0
11	4.1	4.2	4.3	4.2	4.1	4.2	4.3	664.9	4.1	4.1	4.1	4.1
12	4.1	4.2	4.3	4.2	4.1	4.4	29.5	157.8	4.2	4.1	4.1	4.2
13	4.1	4.2	4.3	4.2	4.2	4.2	4.3	84.6	4.2	4.1	4.1	4.1
14	4.1	4.2	4.3	24.5	4.2	4.2	48.5	216.9	4.1	4.2	4.1	4.1
15	4.1	4.2	4.3	182.8	4.2	4.2	4.3	120.7	4.1	4.2	4.1	4.1
16	4.1	4.2	4.3	4.4	4.2	4.2	4.3	39.5	4.1	4.1	4.1	4.1
17	4.1	4.2	4.3	4.3	4.1	4.2	4.2	41.5	4.1	4.1	4.1	4.1
18	4.1	4.2	85.6	4.3	4.2	4.2	4.2	199.9	4.1	4.1	4.1	4.1
19	4.1	4.2	225.9	4.3	4.2	4.2	4.3	331.1	4.1	4.1	4.1	4.0
20	171.8	367.2	86.6	4.3	4.2	4.2	4.3	100.6	4.1	4.1	4.1	4.0
21	117.7	4.4	31.5	4.3	4.3	4.2	10.4	10.4	4.1	4.1	4.1	4.0
22	4.4	4.4	4.4	4.3	4.4	4.2	4.3	148.7	4.1	4.1	4.1	4.0
23	4.3	4.3	4.3	4.4	4.4	4.2	4.4	28.5	4.1	4.1	4.1	4.0
24	4.3	4.3	4.3	4.3	4.2	4.2	4.3	4.4	4.1	4.1	4.1	4.0
25	4.3	4.3	4.3	4.3	4.2	4.3	4.2	4.4	4.1	4.1	4.1	4.1
26	4.3	4.3	36.5	4.3	4.2	4.4	4.2	4.3	4.1	4.1	4.1	4.1
27	7.4	109.7	4.3	4.3	4.2	4.2	4.2	4.3	4.1	4.1	4.1	4.1
28	148.7	30.5	4.3	4.3	4.2	4.3	4.4	4.3	4.1	4.1	4.1	4.0
29	25.5	4.4	4.2	4.3	4.2	4.2	997.6	4.2	4.1	4.1	4.1	4.0
30	4.3		4.2	4.3	4.2	4.2	27.5	4.2	4.1	4.1	4.1	4.0
31	4.3		4.2		4.2		4.4	4.2		4.1		4.0
Average	18.7	21.3	18.6	10.9	4.2	4.2	40.0	97.2	4.1	4.8	4.1	4.1
Maximum	171.8	367.2	225.9	182.8	4.4	4.4	997.6	664.9	4.2	24.5	4.3	4.2
Minimum	4.1	4.2	4.2	4.2	4.1	4.2	4.2	4.2	4.1	4.1	4.1	4.0

Average annual discharge = 19 (m^3/sec)

Annual inflow volume = 616 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1969

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	61.6	4.2	4.3	4.3	4.4	4.2	4.2	4.1	4.2	4.1	4.0
2	4.0	4.2	4.2	4.3	4.3	4.3	4.2	4.2	4.1	4.3	4.1	4.0
3	4.0	4.1	4.2	4.3	4.3	4.3	4.2	4.3	4.1	4.1	4.1	4.0
4	4.0	4.1	4.2	4.2	4.3	4.3	4.2	49.5	4.1	4.1	4.1	4.0
5	4.0	4.1	4.2	4.2	4.3	4.3	4.2	381.2	4.1	4.1	4.1	4.0
6	4.0	4.1	4.2	4.2	4.3	4.2	4.2	1,385.4	4.3	4.1	4.1	4.0
7	4.0	4.1	4.2	4.2	4.3	4.2	4.2	163.8	4.2	4.1	4.1	4.0
8	4.0	4.1	4.2	4.2	4.3	4.2	4.3	38.5	4.1	4.1	4.1	4.0
9	4.0	4.1	4.2	4.3	4.3	4.2	4.4	120.7	4.2	4.1	4.1	4.0
10	4.0	4.1	4.2	4.3	4.4	4.2	4.3	225.9	4.1	4.1	4.1	4.0
11	4.0	4.1	4.2	4.3	4.4	4.2	4.2	54.5	4.1	4.3	4.1	4.0
12	4.0	4.1	4.2	4.2	106.7	4.2	4.2	45.5	4.1	4.2	4.1	4.0
13	4.1	4.1	4.3	4.2	381.2	4.2	4.2	4.4	4.1	4.1	4.1	4.0
14	4.1	4.1	4.3	4.2	231.9	4.2	70.6	4.4	4.2	4.1	4.1	4.0
15	4.1	4.1	4.3	4.2	34.5	4.2	4.4	37.5	4.2	4.2	4.1	4.0
16	4.0	4.1	4.3	4.3	4.4	4.2	4.3	50.5	4.2	4.2	4.1	4.0
17	4.0	4.2	4.2	4.2	4.3	4.2	4.2	180.8	4.1	4.1	4.1	4.0
18	4.0	4.2	4.3	4.2	4.3	4.2	4.2	126.7	4.1	4.1	4.1	4.0
19	4.0	4.1	254.0	4.2	4.3	4.2	4.2	42.5	4.1	4.1	4.0	4.0
20	4.0	4.1	112.7	148.7	4.3	4.3	4.4	18.5	4.1	4.1	4.0	4.0
21	4.0	4.1	4.3	22.5	4.2	4.2	89.6	4.4	4.1	4.1	4.0	4.0
22	4.0	4.1	4.3	4.3	4.3	4.2	4.4	11.4	4.1	4.1	4.0	4.0
23	4.0	4.1	100.6	4.2	4.3	4.3	4.3	4.3	4.1	4.1	4.0	4.0
24	4.0	4.1	4.4	4.2	4.3	4.2	929.4	4.3	4.1	4.1	4.0	4.0
25	4.0	4.1	88.6	4.2	4.2	4.2	89.6	4.3	4.1	4.1	4.0	4.0
26	4.1	4.1	348.2	4.2	4.2	4.2	68.6	4.3	4.1	4.1	4.0	4.0
27	4.2	58.5	36.5	4.2	4.2	4.2	50.5	4.2	4.1	4.1	4.0	4.0
28	4.1	4.2	4.4	4.2	4.2	4.3	202.9	4.2	4.1	4.1	4.0	4.0
29	4.1		4.3	328.1	4.2	4.2	19.5	4.2	4.1	4.1	4.0	4.0
30	4.1		4.3	24.5	4.2	4.3	4.3	4.2	4.1	4.1	4.0	4.0
31	4.1		4.3		4.2		4.2	4.2		4.1		4.0
Average	4.1	8.1	33.8	21.1	28.1	4.2	52.2	96.7	4.1	4.1	4.1	4.0
Maximum	4.2	61.6	348.2	328.1	381.2	4.4	929.4	1,385.4	4.3	4.3	4.1	4.0
Minimum	4.0	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.0	4.0

Average annual discharge = 22 (m^3/sec)

Annual inflow volume = 704 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1970

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.0	4.2	4.1	4.1	4.1	4.3	4.1	1,147.9	4.1	4.1	4.0
2	4.0	4.0	4.1	4.1	4.1	4.1	174.8	4.2	74.6	4.1	4.1	4.0
3	4.0	4.0	4.1	4.1	4.1	4.1	14.5	4.1	4.4	4.1	4.1	4.0
4	4.0	4.0	4.1	4.1	4.1	4.4	32.5	4.2	565.6	4.1	4.1	4.0
5	4.0	4.0	4.1	4.1	4.1	4.2	4.3	4.4	60.6	4.1	4.1	4.0
6	4.0	4.0	4.1	4.2	4.1	4.1	4.3	4.2	21.5	4.2	4.1	4.0
7	4.0	4.0	4.1	4.2	4.2	4.1	4.2	4.1	131.7	4.1	4.1	4.0
8	4.0	4.0	4.1	4.2	4.1	4.1	4.2	4.1	353.2	4.1	4.1	4.0
9	4.0	4.0	4.1	4.2	4.1	4.1	4.2	4.3	72.6	4.1	4.1	4.0
10	4.0	4.0	4.1	4.2	4.1	4.1	76.6	248.0	32.5	4.1	4.1	4.0
11	4.0	4.0	4.1	4.2	4.1	4.1	4.2	4.3	216.9	4.1	4.1	4.0
12	4.0	4.0	4.1	4.2	4.1	4.1	4.2	4.3	120.7	4.1	4.1	4.0
13	4.0	4.0	4.2	4.2	4.1	97.6	4.2	418.3	64.6	4.1	4.1	4.0
14	4.0	4.0	4.3	4.2	4.1	4.2	4.2	63.6	63.6	4.1	4.1	4.0
15	4.0	4.0	4.4	4.2	4.1	4.4	4.1	62.6	4.4	4.1	4.0	4.0
16	4.0	4.0	4.4	4.2	4.1	4.2	4.2	8.4	4.4	4.1	4.0	4.0
17	4.0	4.0	4.2	4.2	4.1	4.1	4.2	39.5	4.4	4.1	4.0	4.0
18	4.0	4.0	4.2	4.1	4.1	4.1	4.3	333.1	4.4	4.1	4.0	4.0
19	4.0	4.0	4.2	4.1	4.1	4.1	4.1	41.5	55.5	4.1	4.0	4.0
20	4.0	4.0	4.1	4.1	4.1	4.1	4.2	4.4	66.6	4.1	4.0	4.0
21	4.0	4.0	4.2	4.1	4.1	4.1	4.2	725.0	4.4	4.1	4.0	4.0
22	4.0	4.0	4.2	4.2	4.1	4.1	4.2	64.6	4.3	4.3	4.0	4.0
23	4.0	4.1	4.2	4.2	4.2	4.1	4.1	126.7	4.3	4.2	4.0	4.0
24	4.0	4.1	4.2	4.2	4.1	4.1	4.1	117.7	4.2	4.2	4.0	4.0
25	4.4	4.1	4.2	4.2	4.1	4.1	4.1	219.9	4.1	4.1	4.0	4.0
26	4.2	4.1	4.2	4.2	4.1	4.1	4.1	515.5	4.1	4.1	4.0	4.0
27	4.1	4.1	4.3	4.2	4.1	4.1	4.3	131.7	4.1	4.1	4.0	4.0
28	4.1	148.7	4.3	4.2	4.1	4.4	4.2	46.5	4.1	4.1	4.0	4.0
29	4.1		4.2	4.1	4.1	4.3	4.2	219.9	4.1	4.1	4.0	4.0
30	4.1		4.1	4.1	4.1	4.2	4.2	58.5	4.1	4.1	4.0	4.0
31	4.1		4.1		4.1		4.2	852.3		4.1		4.0
Average	4.1	9.2	4.2	4.2	4.1	7.3	13.3	140.1	103.7	4.1	4.1	4.0
Maximum	4.4	148.7	4.4	4.2	4.2	97.6	174.8	852.3	1,147.9	4.3	4.1	4.0
Minimum	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.0	4.0

Average annual discharge = 25 (m^3/sec)

Annual inflow volume = 797 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1971

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.0	4.1	4.1	4.1	16.5	4.2	597.7	69.6	4.1	4.1	4.0
2	4.0	4.0	4.1	4.1	4.1	4.3	407.3	982.5	8.4	4.1	4.1	4.0
3	4.0	4.0	4.1	4.1	4.1	4.3	62.6	97.6	29.5	4.1	4.1	4.0
4	4.0	4.0	4.1	4.1	4.1	4.2	11.4	14.5	4.4	4.1	4.1	4.0
5	4.0	4.0	4.1	4.2	4.1	4.2	55.5	12.4	4.3	4.1	4.1	4.0
6	4.0	4.0	4.1	4.1	4.1	4.2	4.3	4.4	4.2	4.1	4.1	4.0
7	4.0	4.0	4.1	4.1	4.1	4.2	4.3	571.7	4.2	4.1	4.1	4.0
8	4.0	4.0	4.1	4.1	4.1	4.2	4.3	251.0	4.2	4.1	4.1	4.0
9	4.0	4.0	4.1	4.1	4.1	4.3	4.2	268.0	4.2	4.1	4.1	4.0
10	4.0	4.0	4.1	4.1	4.1	379.2	4.2	78.6	4.2	4.1	4.1	4.0
11	4.0	4.0	4.1	4.1	4.1	39.5	4.2	19.5	4.2	4.1	4.1	4.0
12	4.0	4.0	4.1	4.1	4.1	4.3	4.2	4.4	4.2	4.1	4.1	4.0
13	4.0	4.0	4.1	4.1	4.1	4.2	438.4	4.3	4.2	4.1	4.1	4.0
14	4.0	4.0	4.1	4.1	4.1	129.7	22.5	4.3	4.1	4.1	4.1	4.0
15	4.0	4.0	4.1	4.1	4.1	4.4	4.3	4.3	4.1	4.1	4.0	4.0
16	4.0	4.0	4.1	4.1	4.1	4.3	4.4	4.2	4.1	4.1	4.0	4.0
17	4.0	4.0	4.1	4.1	4.1	4.2	92.6	4.3	4.1	4.1	4.0	4.0
18	4.0	4.0	4.1	4.1	4.1	4.2	4.3	4.2	4.1	4.1	4.0	4.0
19	4.0	4.0	4.1	4.1	4.1	4.2	4.3	4.2	4.1	4.1	4.0	4.0
20	4.0	4.0	4.1	4.1	4.1	4.2	4.3	4.3	4.1	4.1	4.0	4.0
21	4.0	4.0	4.1	62.6	4.3	4.3	4.2	4.3	4.1	4.1	4.0	4.0
22	4.0	4.0	4.1	4.2	4.3	297.1	4.2	4.2	4.1	4.1	4.0	4.0
23	4.0	4.0	4.1	4.2	4.2	285.0	4.2	4.2	4.1	4.1	4.0	4.0
24	4.0	4.0	4.1	4.2	4.2	62.6	4.1	4.2	4.1	4.1	4.0	4.0
25	4.0	4.0	4.1	4.1	4.2	57.5	4.2	4.4	4.1	4.1	4.0	4.0
26	4.0	4.0	4.1	4.1	4.2	27.5	86.6	767.1	4.1	4.1	4.0	4.0
27	4.0	225.9	4.1	4.2	4.2	4.4	4.3	80.6	4.1	4.1	4.0	4.0
28	4.0	4.1	4.1	4.2	4.3	45.5	4.2	4.4	4.1	4.1	4.0	4.0
29	4.0		4.1	4.2	4.2	4.3	698.9	4.3	4.1	4.1	4.0	4.0
30	4.0		4.1	4.2	4.2	4.2	103.6	236.9	4.1	4.1	4.0	4.0
31	4.0		4.1		4.3		4.4	29.5		4.1		4.0
Average	4.0	12.0	4.1	6.1	4.2	47.5	66.7	131.6	7.3	4.1	4.1	4.0
Maximum	4.0	225.9	4.1	62.6	4.3	379.2	698.9	982.5	69.6	4.1	4.1	4.0
Minimum	4.0	4.0	4.1	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.0	4.0

Average annual discharge = 25 (m^3/sec)

Annual inflow volume = 783 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1972

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	280.0	4.1	4.2	4.2	4.2	4.2	4.2	4.3	4.1	4.1	4.1
2	4.0	8.4	4.1	4.2	4.1	4.2	4.1	4.1	4.2	4.1	4.1	4.1
3	4.0	4.2	4.1	4.2	4.1	4.2	46.5	4.1	4.2	4.1	4.1	4.1
4	4.0	4.1	4.2	4.2	4.1	4.2	4.3	4.1	4.2	4.1	4.1	4.1
5	4.0	4.1	4.2	4.4	4.1	4.1	4.4	67.6	4.2	4.1	4.1	4.0
6	4.0	4.1	4.1	4.2	4.1	4.1	4.3	1,717.1	4.2	4.1	4.1	4.0
7	4.0	4.1	4.1	4.2	4.2	4.1	4.3	4.1	4.3	4.1	4.1	4.0
8	4.0	4.1	117.7	4.2	4.2	4.1	4.2	4.4	4.3	4.1	4.1	4.0
9	4.0	4.1	29.5	4.2	4.2	4.1	1,204.0	76.6	106.7	4.1	4.1	4.0
10	4.0	4.1	4.3	4.2	4.2	4.1	219.9	4.3	294.1	4.1	4.1	4.3
11	4.0	4.1	4.2	4.1	4.2	4.1	365.2	4.2	4.3	4.1	4.1	4.2
12	4.0	129.7	4.2	4.2	4.2	4.1	157.8	4.2	4.2	4.1	4.1	4.1
13	4.0	4.4	85.6	4.2	4.2	4.1	4.4	4.2	4.2	4.1	4.1	4.1
14	4.0	4.2	4.3	4.2	4.2	4.1	4.3	4.4	4.2	4.1	4.1	4.1
15	4.0	4.1	4.2	4.2	4.2	4.1	4.2	4.2	4.1	4.1	4.1	4.1
16	4.0	4.1	4.2	4.3	4.2	4.1	4.2	4.2	4.3	4.1	4.1	4.1
17	4.0	4.1	4.2	46.5	4.2	4.2	4.3	13.4	4.4	4.1	4.1	4.1
18	4.0	4.1	4.2	4.4	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1
19	4.0	4.1	4.2	4.3	4.2	4.1	4.2	89.6	53.5	4.3	4.1	4.1
20	4.0	4.1	28.5	4.3	4.2	4.1	4.2	74.6	4.4	4.2	4.1	4.1
21	4.0	4.1	4.4	4.2	4.2	4.1	4.2	4.3	4.2	4.1	4.1	4.1
22	4.3	4.1	4.3	4.2	4.2	4.1	4.1	4.2	4.2	34.5	4.1	4.1
23	4.1	4.1	4.3	4.2	19.5	4.1	4.1	4.2	4.2	4.2	4.1	4.1
24	4.1	4.1	4.3	4.2	89.6	4.1	4.2	4.2	4.1	4.2	4.1	4.1
25	4.0	4.1	4.3	4.2	4.2	4.2	4.2	4.3	4.1	4.1	4.1	4.1
26	4.0	4.1	4.4	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1
27	4.0	4.1	71.6	4.2	4.2	4.2	4.1	4.2	4.1	4.1	4.1	4.2
28	4.0	4.1	4.4	4.3	4.2	24.5	4.1	4.2	4.1	4.1	4.1	4.2
29	4.0	4.1	4.4	4.3	4.2	4.2	4.1	71.6	4.1	4.1	4.1	4.2
30	4.0		4.4	4.2	4.2	4.2	4.3	7.4	4.1	4.1	4.1	4.1
31	4.2		4.3		4.2		4.2	4.4		4.1		4.1
Average	4.1	18.1	14.3	5.6	7.4	4.8	67.8	71.5	18.9	5.1	4.1	4.1
Maximum	4.3	280.0	117.7	46.5	89.6	24.5	1,204.0	1,717.1	294.1	34.5	4.1	4.3
Minimum	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.0

Average annual discharge = 19 (m^3/sec)

Annual inflow volume = 599 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1973

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.3	53.5	4.3	4.2	4.2	4.2	271.0	4.3	4.1	4.0
2	4.1	4.1	6.4	4.4	4.3	4.1	4.3	4.2	75.6	4.2	4.1	4.0
3	4.1	4.1	4.3	11.4	4.3	4.1	4.3	182.8	32.5	4.1	4.1	4.0
4	4.1	4.1	4.3	9.4	4.3	4.2	4.2	51.5	4.4	4.1	4.1	4.0
5	4.1	4.1	4.3	4.4	4.3	4.2	177.8	4.4	4.3	4.1	4.1	4.0
6	4.1	4.1	4.2	4.4	4.3	4.2	4.3	268.0	4.3	4.1	4.1	4.0
7	4.1	4.1	4.2	4.3	4.2	4.2	4.2	87.6	4.3	4.1	4.1	4.0
8	4.1	4.1	48.5	4.3	4.3	4.2	4.3	588.7	4.2	4.1	4.1	4.0
9	4.1	4.1	265.0	4.3	4.3	4.2	4.2	3,294.6	4.2	4.1	4.1	4.0
10	4.1	4.1	1,462.6	4.3	4.2	4.2	4.1	659.8	4.2	4.1	4.1	4.0
11	4.1	4.2	435.4	4.4	4.2	4.2	4.1	263.0	4.2	4.1	4.1	4.0
12	4.1	4.2	180.8	9.4	4.1	4.3	131.7	231.9	4.3	4.1	4.1	4.0
13	4.3	4.2	81.6	4.3	4.1	4.3	733.0	424.3	4.2	4.1	4.1	4.0
14	4.1	4.2	61.6	4.3	4.1	4.3	4.2	381.2	4.3	4.1	4.1	4.0
15	4.1	4.2	35.5	4.3	4.1	4.2	160.8	265.0	4.3	4.1	4.1	4.0
16	4.1	4.2	34.5	4.2	4.2	4.2	4.4	177.8	4.2	4.1	4.1	4.1
17	4.1	4.2	26.5	4.2	4.4	4.2	4.1	112.7	4.2	4.1	4.1	4.2
18	4.1	4.2	4.4	4.2	4.2	4.3	4.2	92.6	6.4	4.1	4.1	4.1
19	194.8	4.1	4.3	4.3	4.2	4.2	41.5	185.8	4.3	4.1	4.1	4.1
20	750.0	4.1	4.4	4.3	4.1	4.3	40.5	95.6	185.8	4.1	4.1	4.1
21	55.5	4.1	4.4	4.4	4.1	4.4	52.5	339.2	4.3	4.1	4.1	4.0
22	4.3	4.1	4.3	4.3	4.1	4.3	4.2	197.8	4.2	4.1	4.1	4.0
23	5.4	4.1	4.3	4.3	4.2	4.2	4.1	82.6	4.2	4.1	4.0	4.0
24	4.2	81.6	4.4	4.4	4.2	4.3	29.5	41.5	4.2	4.1	4.0	4.0
25	4.2	739.0	38.5	4.3	4.2	4.4	4.4	4.3	77.6	4.1	4.0	4.0
26	4.2	560.6	37.5	4.4	4.2	95.6	126.7	4.4	4.2	4.1	4.0	4.0
27	4.2	88.6	41.5	4.4	4.2	4.3	257.0	311.1	4.2	4.1	4.0	4.0
28	4.2	5.4	29.5	4.3	4.2	4.2	4.4	4.2	4.2	4.1	4.0	4.0
29	4.1		7.4	4.3	4.2	4.2	4.3	4.2	4.1	4.1	4.0	4.0
30	4.1		10.4	4.3	4.2	4.2	4.3	4.2	4.2	4.1	4.0	4.0
31	4.1		38.5		4.2		4.3	421.3		4.1		4.0
Average	36.0	56.1	93.5	6.5	4.2	7.3	59.4	283.6	25.0	4.1	4.1	4.1
Maximum	750.0	739.0	1,462.6	53.5	4.4	95.6	733.0	3,294.6	271.0	4.3	4.1	4.2
Minimum	4.1	4.1	4.2	4.2	4.1	4.1	4.1	4.2	4.1	4.1	4.0	4.0

Average annual discharge = 49 (m^3/sec)

Annual inflow volume = 1,546 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1974

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.2	4.1	4.0	4.0
2	4.0	4.1	4.2	4.2	4.1	4.1	4.2	4.3	4.2	4.1	4.0	4.0
3	4.0	151.7	4.2	4.2	4.1	4.1	4.3	228.9	4.1	4.1	4.0	4.0
4	4.0	4.2	4.2	4.2	4.1	4.1	4.3	109.7	4.1	4.1	4.0	4.0
5	4.0	4.2	4.2	4.2	4.1	4.1	4.2	22.5	4.1	4.1	4.0	4.0
6	4.0	4.1	4.2	4.2	4.1	4.3	4.2	4.4	4.1	4.1	4.0	4.0
7	4.0	4.1	4.2	4.2	4.1	4.1	4.2	4.3	4.1	4.1	4.0	4.0
8	4.0	4.1	4.2	4.1	4.1	4.1	4.2	4.2	4.2	4.1	4.0	4.0
9	4.0	4.1	4.2	4.3	4.1	4.1	4.2	4.2	4.1	4.1	4.0	4.0
10	4.0	4.1	4.2	4.2	4.1	4.1	103.6	4.1	4.1	4.1	4.0	4.0
11	4.0	4.1	4.2	4.2	4.1	4.1	4.4	4.2	4.1	4.1	4.0	4.0
12	4.0	4.1	4.2	4.2	4.1	4.1	4.3	4.3	4.1	4.1	4.0	4.0
13	4.0	4.1	4.1	4.2	4.1	4.1	4.3	4.3	4.1	4.1	4.0	4.0
14	4.1	4.1	4.1	4.2	4.1	4.1	4.2	8.4	4.1	4.1	4.0	4.0
15	4.1	4.1	4.1	4.2	4.1	4.1	51.5	4.4	4.1	4.1	4.0	4.0
16	4.1	4.1	4.1	4.2	4.1	4.1	4.4	4.2	4.1	4.0	4.0	4.1
17	4.0	4.1	4.1	4.2	4.1	4.1	6.4	4.2	4.1	4.0	4.0	4.1
18	4.0	4.1	4.1	4.2	4.1	4.1	4.3	4.1	4.1	4.0	4.0	4.0
19	4.0	4.1	4.1	4.2	4.1	4.1	4.3	4.1	4.1	4.0	4.0	4.0
20	44.5	4.1	4.2	4.2	4.1	4.3	157.8	4.2	4.1	4.0	4.0	4.0
21	4.3	4.1	4.2	4.2	4.1	4.3	4.3	4.1	4.1	4.0	4.0	4.0
22	4.1	4.3	4.3	4.2	4.1	4.1	54.5	4.1	4.1	4.0	4.0	4.0
23	4.1	4.4	4.3	4.1	4.1	103.6	4.3	4.1	4.1	4.0	4.0	4.0
24	4.1	4.2	117.7	4.1	4.1	782.1	134.7	4.1	4.1	4.0	4.0	4.0
25	4.1	4.1	61.6	4.2	4.1	168.8	49.5	4.2	4.1	4.0	4.0	4.0
26	4.1	4.1	4.3	4.2	4.1	4.4	114.7	4.1	4.1	4.0	4.0	4.0
27	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.1	4.1	4.0	4.0	4.0
28	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.1	4.1	4.0	4.0	4.0
29	4.1		4.2	4.1	4.1	4.2	4.2	4.1	4.1	4.0	4.0	4.0
30	4.1		4.2	4.1	4.1	4.2	4.2	4.1	4.1	4.0	4.0	4.0
31	4.1		4.2		4.1		4.4	4.1		4.0		4.0
Average	5.4	9.4	9.7	4.2	4.1	38.9	24.9	15.6	4.1	4.1	4.0	4.0
Maximum	44.5	151.7	117.7	4.3	4.2	782.1	157.8	228.9	4.2	4.1	4.0	4.1
Minimum	4.0	4.1	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.0	4.0	4.0

Average annual discharge = 11 (m^3/sec)

Annual inflow volume = 337 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1975

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.2	4.3	4.2	4.2	4.2	4.2	143.7	4.2	4.1	4.1
2	4.0	4.1	4.2	4.3	4.2	4.2	4.2	177.8	280.0	4.2	4.1	4.0
3	4.0	4.1	4.2	4.4	4.2	4.2	4.2	73.6	126.7	4.2	4.1	4.0
4	4.0	4.1	4.4	4.4	4.3	4.2	4.2	83.6	43.5	4.2	4.1	4.0
5	4.0	4.0	4.3	4.3	4.3	4.2	4.2	393.3	109.7	4.2	4.1	4.0
6	4.0	4.1	4.2	4.3	4.2	4.2	4.2	106.7	4.4	4.2	4.1	4.0
7	4.0	4.1	4.2	4.3	4.2	4.2	4.2	73.6	163.8	4.1	4.1	4.0
8	4.0	4.1	4.2	4.3	4.2	4.2	4.2	14.5	4.4	4.1	4.1	4.0
9	4.0	4.2	4.2	4.2	4.1	4.2	4.2	4.4	12.4	4.1	4.1	4.0
10	4.0	4.1	4.3	4.2	4.2	4.2	4.2	4.3	19.5	4.1	4.1	4.0
11	4.0	4.1	100.6	4.2	4.2	4.2	4.2	4.4	605.7	4.1	4.1	4.0
12	4.0	4.1	4.3	4.2	4.2	4.2	4.3	704.9	148.7	4.1	4.1	4.0
13	4.0	171.8	4.2	4.2	4.2	4.2	4.2	106.7	79.6	4.1	4.1	4.0
14	4.0	4.3	4.2	4.2	4.2	4.2	4.4	4.4	52.5	4.1	4.1	4.0
15	4.0	4.2	4.2	4.2	4.2	4.2	503.5	4.4	103.6	4.1	4.1	4.0
16	4.0	4.1	4.2	4.2	4.3	4.2	1,216.1	27.5	4.3	4.1	4.1	4.0
17	4.0	4.1	4.2	4.2	106.7	4.2	177.8	40.5	117.7	4.1	4.1	4.0
18	4.0	4.1	4.2	4.2	4.3	4.2	4.4	543.6	32.5	4.1	4.1	4.0
19	4.0	4.1	4.2	4.2	4.2	4.2	58.5	687.9	58.5	4.1	4.1	4.0
20	4.0	4.1	4.2	4.2	4.2	4.3	4.4	1,819.4	47.5	4.1	4.1	4.0
21	4.0	4.1	4.2	4.2	4.2	4.2	202.9	342.2	48.5	4.1	4.1	4.0
22	4.0	4.1	4.3	4.2	4.2	4.2	4.4	594.7	53.5	4.1	4.1	4.0
23	4.0	4.1	299.1	17.5	4.2	4.2	4.3	659.8	4.3	4.1	4.1	4.0
24	4.0	4.1	40.5	4.3	4.2	4.2	7.4	194.8	4.2	4.1	4.1	4.0
25	4.0	4.1	4.4	4.3	4.2	4.2	4.4	89.6	4.2	4.1	4.1	4.0
26	4.0	4.2	4.3	100.6	4.2	4.2	4.3	4.4	4.2	4.1	4.1	4.0
27	4.0	4.2	4.3	114.7	4.2	4.2	4.3	4.4	4.2	4.1	4.1	4.0
28	4.0	4.3	4.3	4.3	4.2	4.4	4.4	1,833.4	4.2	4.1	4.1	4.0
29	4.0		4.3	4.2	4.3	4.4	64.6	427.3	4.2	4.1	4.1	4.0
30	4.1		4.3	4.2	4.2	4.2	4.3	248.0	4.2	4.1	4.1	4.0
31	4.2		4.3		4.2		4.2	180.8		4.1		4.0
Average	4.0	10.1	18.0	11.6	7.5	4.2	75.3	305.1	76.5	4.1	4.1	4.0
Maximum	4.2	171.8	299.1	114.7	106.7	4.4	1,216.1	1,833.4	605.7	4.2	4.1	4.1
Minimum	4.0	4.0	4.2	4.2	4.1	4.2	4.2	4.2	4.2	4.1	4.1	4.0

Average annual discharge = 44 (m^3/sec)

Annual inflow volume = 1,394 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1976

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.2	4.4	4.3	4.3	4.3	4.2	3,521.0	62.6	4.4	4.1	4.1
2	4.0	4.2	4.4	4.3	4.3	4.3	4.3	3,691.4	225.9	4.2	4.1	4.1
3	4.0	4.1	4.4	4.3	4.3	4.3	4.3	679.9	404.3	4.2	4.1	4.1
4	4.0	4.1	4.4	4.2	4.3	4.3	4.3	546.6	285.0	4.2	4.1	4.1
5	4.0	4.1	4.4	60.6	4.3	4.3	4.2	799.2	129.7	4.2	4.1	4.1
6	4.0	4.1	4.4	17.5	4.3	4.3	4.2	799.2	41.5	4.1	4.1	4.1
7	4.0	4.1	4.3	4.3	4.3	4.3	4.2	2,015.8	15.5	4.2	4.1	4.1
8	4.0	4.1	4.3	4.3	4.3	4.3	4.3	611.7	62.6	4.2	4.1	4.1
9	4.0	4.1	51.5	4.4	4.3	4.3	4.4	356.2	4.4	4.1	4.1	4.1
10	4.0	4.1	4.4	62.6	4.3	4.3	362.2	228.9	4.3	4.1	4.1	4.1
11	4.0	4.1	4.3	37.5	4.4	4.3	69.6	134.7	4.3	4.1	4.1	4.1
12	4.0	4.1	4.2	4.4	4.3	4.4	58.5	185.8	4.3	4.1	4.1	4.1
13	4.1	4.2	4.3	4.4	4.4	49.5	106.7	58.5	4.4	4.1	4.1	4.1
14	4.4	4.3	4.3	4.4	4.3	4.4	171.8	299.1	4.3	4.1	4.1	4.1
15	4.1	849.3	4.3	4.4	4.3	74.6	219.9	100.6	4.3	4.1	4.1	4.1
16	4.1	140.7	328.1	4.4	4.3	13.4	759.1	165.8	4.3	4.1	4.1	4.1
17	4.1	38.5	333.1	5.4	41.5	62.6	123.7	69.6	4.3	4.1	4.1	4.0
18	4.1	242.9	148.7	4.4	4.4	14.5	1,255.1	95.6	4.3	4.1	4.1	4.0
19	4.0	199.9	87.6	4.4	4.4	4.4	299.1	140.7	4.2	4.1	4.1	4.0
20	4.0	69.6	168.8	28.5	4.3	4.2	328.1	151.7	4.2	4.1	4.1	4.0
21	4.0	12.4	100.6	45.5	4.3	4.3	285.0	49.5	4.2	4.1	4.1	4.0
22	4.0	4.4	47.5	43.5	4.3	4.3	143.7	4.4	4.2	4.1	4.1	4.0
23	4.0	4.3	13.4	29.5	4.3	4.3	180.8	4.4	4.2	4.1	4.1	4.0
24	4.0	4.3	4.4	79.6	4.4	4.2	297.1	4.4	4.2	4.1	4.1	4.0
25	4.0	148.7	4.4	65.6	4.4	4.2	117.7	18.5	4.2	4.2	4.1	4.0
26	4.1	137.7	4.4	27.5	4.3	4.2	546.6	4.4	4.2	4.1	4.1	4.0
27	342.2	27.5	31.5	18.5	4.3	4.2	231.9	100.6	4.2	4.1	4.1	4.1
28	4.4	4.4	45.5	32.5	4.3	4.2	41.5	4.4	4.2	4.1	4.1	4.0
29	4.2	4.4	4.4	9.4	4.3	4.2	27.5	4.4	4.2	4.1	4.1	4.0
30	4.1		4.3	4.4	4.3	4.2	21.5	4.4	4.4	4.1	4.1	4.0
31	4.1		4.3		4.3		4.4	4.2		4.1		4.0
Average	15.0	67.1	46.6	21.0	5.5	10.7	183.5	479.2	44.0	4.1	4.1	4.1
Maximum	342.2	849.3	333.1	79.6	41.5	74.6	1,255.1	3,691.4	404.3	4.4	4.1	4.1
Minimum	4.0	4.1	4.2	4.2	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.0

Average annual discharge = 74 (m^3/sec)

Annual inflow volume = 2,352 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1977

Synthetic Mean Daily Discharges (with Project) (m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.2	4.1	4.1	4.2	4.2	4.3	4.2	4.3	4.2	4.1	4.1
2	4.1	4.2	4.1	4.1	4.2	4.2	89.6	137.7	4.3	4.2	4.1	4.1
3	4.0	4.2	4.1	4.1	168.8	4.2	180.8	69.6	35.5	4.2	72.6	4.1
4	4.0	4.1	4.1	4.1	20.5	4.2	9.4	1,329.3	4.2	4.1	4.2	4.1
5	4.0	4.1	4.1	4.2	4.3	4.2	5.4	444.4	8.4	4.1	4.1	4.1
6	4.0	4.1	4.1	4.4	4.2	4.2	1,155.9	180.8	109.7	4.2	4.1	4.1
7	4.0	4.1	4.1	4.2	4.2	4.1	15.5	88.6	4.2	4.1	4.1	4.1
8	4.0	4.1	4.2	4.2	4.2	4.1	39.5	100.6	97.6	4.1	4.1	4.1
9	4.0	4.1	4.2	4.2	4.3	4.1	4.4	23.5	4.2	4.1	4.1	4.1
10	4.1	4.1	4.2	4.2	4.4	4.1	4.3	11.4	4.3	4.2	4.1	4.1
11	4.3	4.1	4.1	4.2	4.3	4.1	401.3	23.5	4.3	4.1	4.1	4.1
12	4.1	4.1	4.1	4.2	4.2	4.2	60.6	86.6	4.2	4.1	4.1	4.1
13	4.0	4.1	4.1	4.2	4.2	4.2	163.8	5.4	4.3	4.1	4.1	4.1
14	4.0	4.1	4.2	4.2	4.3	4.3	529.6	15.5	4.2	4.1	4.1	4.1
15	4.0	4.1	4.1	4.2	4.2	4.2	1,144.9	4.3	4.2	4.1	4.1	4.1
16	4.0	4.1	4.2	4.2	4.2	4.1	926.4	202.9	4.2	4.3	4.1	4.1
17	4.0	4.1	4.1	4.2	4.2	4.2	407.3	4.4	4.2	4.2	4.1	4.1
18	4.0	4.1	4.1	4.2	4.2	4.2	106.7	30.5	131.7	4.1	4.1	4.1
19	4.1	4.1	4.1	89.6	4.2	4.1	92.6	117.7	4.4	4.1	4.1	4.1
20	4.1	4.1	4.1	17.5	4.2	4.2	100.6	61.6	4.2	4.1	4.1	4.1
21	4.1	4.1	4.1	4.3	4.2	4.2	157.8	6.4	4.2	4.1	4.1	4.1
22	4.1	4.1	4.1	4.2	4.2	4.2	291.1	20.5	4.2	4.1	4.1	4.1
23	4.1	4.1	4.1	4.2	4.2	4.2	174.8	29.5	4.2	4.1	4.1	4.1
24	62.6	4.1	4.1	4.2	4.2	69.6	348.2	30.5	4.2	4.1	4.1	4.1
25	299.1	4.1	4.2	4.2	4.3	4.3	311.1	4.4	4.2	387.3	4.1	126.7
26	45.5	4.1	4.1	4.2	4.2	257.0	174.8	4.3	4.2	4.4	4.1	239.9
27	4.4	4.1	4.2	4.2	4.2	4.4	97.6	4.2	4.2	4.2	4.1	4.4
28	4.2	4.1	4.1	4.2	4.2	4.3	10.4	4.3	4.2	4.1	4.1	4.2
29	4.2		4.1	4.2	4.2	185.8	4.3	4.3	4.2	4.1	4.1	4.1
30	4.2		4.1	4.2	4.3	4.3	4.4	97.6	4.3	4.1	4.2	4.1
31	4.2		4.1		4.2		4.2	4.4		4.1		4.1
Average	16.8	4.1	4.1	7.5	10.1	20.9	226.5	101.7	16.3	16.5	6.4	15.7
Maximum	299.1	4.2	4.2	89.6	168.8	257.0	1,155.9	1,329.3	131.7	387.3	72.6	239.9
Minimum	4.0	4.1	4.1	4.1	4.2	4.1	4.2	4.2	4.2	4.1	4.1	4.1

Average annual discharge = 38 (m³/sec)

Annual inflow volume = 1,191 (Mm³)

River: Poonch **Station:** EFlow Site 2 **Year:** 1978

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.2	26.5	4.4	4.4	4.2	4.4	222.9	4.4	4.3	4.1	4.1
2	4.1	4.2	4.4	4.4	4.4	4.3	4.4	208.9	4.3	4.2	4.1	4.1
3	4.1	4.2	4.3	4.4	4.4	4.3	216.9	1,048.7	4.4	4.2	4.1	4.1
4	4.1	4.2	4.4	4.4	4.4	4.3	30.5	95.6	4.3	4.2	4.2	4.1
5	4.1	4.2	112.7	4.4	4.4	4.3	188.8	57.5	4.3	4.2	4.1	4.1
6	4.1	4.2	41.5	4.4	4.4	4.3	1,366.4	33.5	4.3	4.2	5.4	4.1
7	4.1	4.2	4.4	4.4	4.4	4.3	656.8	4.4	4.3	4.2	4.4	4.1
8	4.1	4.2	4.3	4.4	4.3	4.3	177.8	18.5	4.3	4.2	4.3	4.1
9	4.1	4.1	4.3	4.4	4.4	4.3	57.5	1,453.6	4.3	4.2	4.3	4.1
10	4.1	4.2	33.5	14.5	4.4	4.3	97.6	756.1	4.3	4.2	4.2	4.1
11	4.1	4.2	100.6	13.4	4.4	4.2	4.4	622.8	4.3	4.2	4.2	4.1
12	4.1	4.2	31.5	32.5	4.3	4.2	4.4	441.4	4.3	4.2	4.2	4.1
13	4.1	4.2	4.4	34.5	4.3	4.3	151.7	585.7	4.3	4.2	4.3	4.1
14	4.2	4.2	4.4	51.5	4.3	4.3	131.7	260.0	39.5	4.1	4.3	4.1
15	4.1	4.2	4.4	53.5	4.3	4.2	41.5	157.8	4.4	4.1	4.2	4.1
16	4.1	4.2	619.8	44.5	4.3	4.2	53.5	381.2	4.3	4.1	4.1	4.1
17	4.1	4.2	3,096.1	85.6	4.3	4.2	120.7	188.8	4.3	4.1	4.1	4.1
18	4.1	4.2	512.5	265.0	4.4	4.2	88.6	177.8	4.3	4.1	4.1	4.1
19	4.1	4.2	271.0	35.5	4.3	4.2	205.9	529.6	4.3	4.1	4.1	4.1
20	4.1	4.2	171.8	4.4	4.3	4.2	112.7	242.9	4.3	4.1	4.1	4.1
21	4.1	4.2	123.7	4.4	4.3	4.3	628.8	191.8	4.3	4.1	4.1	4.1
22	4.1	4.2	85.6	4.3	4.3	4.3	342.2	322.1	4.3	4.1	4.1	4.1
23	4.1	4.2	61.6	4.4	4.3	4.3	407.3	65.6	33.5	4.1	4.1	4.0
24	4.1	4.2	51.5	4.4	4.4	4.3	367.2	47.5	4.4	4.1	4.1	4.0
25	4.1	4.2	36.5	4.4	76.6	4.3	359.2	20.5	4.3	4.1	4.1	4.0
26	4.1	4.3	20.5	4.4	6.4	4.3	325.1	6.4	4.2	4.1	4.1	4.0
27	4.1	4.2	15.5	4.4	4.4	4.4	356.2	4.4	53.5	4.1	4.1	4.0
28	56.5	4.2	35.5	4.4	4.3	4.3	236.9	50.5	8.4	4.1	4.1	4.0
29	69.6		16.5	4.4	4.3	55.5	174.8	4.4	4.3	4.1	4.1	4.0
30	4.3		4.4	4.4	4.3	926.4	875.3	4.4	4.3	4.1	4.1	4.0
31	4.2		4.4		4.3		316.1	4.4		4.1		4.0
Average	7.9	4.2	177.8	23.9	6.7	36.7	261.5	264.8	8.2	4.1	4.2	4.1
Maximum	69.6	4.3	3,096.1	265.0	76.6	926.4	1,366.4	1,453.6	53.5	4.3	5.4	4.1
Minimum	4.1	4.1	4.3	4.3	4.3	4.2	4.4	4.4	4.2	4.1	4.1	4.0

Average annual discharge = 68 (m^3/sec)

Annual inflow volume = 2,147 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1979

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.1	4.4	4.2	4.1	4.2	4.1	4.2	4.2	4.1	4.1
2	4.0	4.1	4.2	4.3	4.2	4.4	4.2	458.4	4.2	4.2	4.1	4.1
3	4.0	4.1	36.5	4.4	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1
4	4.0	4.1	248.0	92.6	4.2	4.1	4.2	599.7	4.3	4.2	4.1	4.1
5	4.0	4.1	602.7	19.5	4.2	4.1	4.3	11.4	4.3	4.1	4.1	4.1
6	4.0	4.1	515.5	4.4	4.2	4.2	4.2	4.3	4.3	4.2	4.1	4.1
7	4.0	4.1	260.0	4.4	4.2	4.2	4.2	4.3	4.3	4.1	4.1	4.1
8	4.0	4.1	219.9	5.4	4.2	4.2	4.1	151.7	4.4	4.1	4.1	4.1
9	4.0	4.1	120.7	4.4	4.2	4.3	4.2	117.7	4.2	4.1	4.2	4.1
10	4.0	4.1	89.6	4.4	4.3	4.2	4.2	129.7	4.2	4.1	4.1	4.1
11	4.0	4.1	20.5	4.4	4.2	4.2	4.2	120.7	18.5	4.1	4.1	4.1
12	4.0	4.1	4.4	4.4	4.1	4.2	4.3	100.6	4.4	4.1	4.1	4.1
13	4.0	4.1	4.4	4.4	4.2	171.8	468.4	78.6	4.2	4.2	4.1	4.1
14	4.1	4.1	4.4	4.3	4.2	4.3	32.5	38.5	4.3	4.2	4.1	4.1
15	4.1	4.1	4.4	4.3	4.2	4.2	4.2	89.6	4.3	4.2	4.1	4.1
16	4.1	4.1	4.3	4.3	4.2	4.1	4.2	56.5	4.3	4.1	4.1	4.1
17	4.1	4.1	684.9	4.3	4.2	4.1	4.2	4.3	4.2	4.1	4.1	4.1
18	4.0	4.0	46.5	4.3	4.1	4.1	4.1	4.3	4.4	4.1	4.1	4.1
19	4.0	75.6	4.4	4.2	4.1	4.2	4.1	4.4	44.5	4.1	4.1	4.1
20	4.1	271.0	4.4	4.3	4.1	4.2	4.4	4.3	4.4	4.1	4.1	4.1
21	4.1	4.2	11.4	4.2	4.2	4.2	4.2	4.2	10.4	4.1	4.1	4.1
22	4.1	4.1	15.5	4.2	4.2	4.3	95.6	4.2	4.3	4.1	4.1	4.1
23	4.1	4.1	13.4	4.2	4.2	4.3	4.2	4.4	4.3	4.1	4.1	4.1
24	4.1	4.1	9.4	4.2	4.2	4.3	4.4	70.6	4.3	4.1	4.1	4.1
25	4.1	4.2	11.4	4.2	4.2	4.3	4.2	4.4	28.5	4.1	4.3	4.1
26	4.1	4.2	4.4	4.2	4.4	4.2	4.1	4.3	4.3	4.1	4.2	4.1
27	4.1	4.2	4.4	4.2	4.3	4.2	4.1	4.2	4.3	4.1	4.1	4.1
28	4.1	4.2	17.5	4.2	4.2	4.2	4.2	4.2	4.3	4.1	4.1	4.1
29	4.1		4.4	4.2	4.2	4.2	4.1	4.3	4.2	4.1	4.1	4.1
30	4.2		32.5	4.2	4.1	4.2	4.1	4.2	4.2	4.1	4.1	4.1
31	4.1		47.5		4.1		4.2	4.2		4.1		4.1
Average	4.1	16.2	98.6	7.8	4.2	9.8	23.0	67.8	7.1	4.1	4.1	4.1
Maximum	4.2	271.0	684.9	92.6	4.4	171.8	468.4	599.7	44.5	4.2	4.3	4.1
Minimum	4.0	4.0	4.1	4.2	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.1

Average annual discharge = 21 (m^3/sec)

Annual inflow volume = 665 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1980

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.2	4.1	4.2	4.3	4.2	4.3	4.1	4.3	27.5	4.1	4.1	4.1
2	4.2	4.1	4.2	4.3	4.2	4.3	4.2	4.4	4.1	4.1	4.1	4.1
3	4.1	4.3	4.2	4.3	4.2	4.2	4.2	776.1	4.1	4.1	4.1	4.1
4	4.1	4.2	4.1	4.2	4.2	4.2	4.4	171.8	4.1	4.1	4.1	4.1
5	4.1	4.2	367.2	4.2	4.2	4.2	4.4	88.6	4.1	4.1	4.1	4.1
6	4.1	4.2	444.4	4.3	4.2	4.2	4.3	4.4	4.2	4.1	4.1	4.1
7	4.1	4.2	17.5	4.3	4.2	4.2	4.2	4.4	4.2	4.1	4.1	4.1
8	4.1	4.1	9.4	4.2	4.2	4.2	4.1	4.3	4.2	4.3	4.1	4.1
9	4.1	4.1	4.3	4.2	4.2	4.2	4.2	336.1	4.2	4.2	4.1	4.1
10	4.1	4.1	4.2	4.3	4.2	4.2	4.1	4.1	65.6	4.1	4.1	4.1
11	4.1	4.1	4.2	4.3	4.2	4.2	165.8	4.1	4.2	4.1	4.1	4.1
12	4.1	4.1	4.3	4.2	4.2	4.2	4.3	4.1	4.2	4.1	4.1	4.1
13	4.1	4.1	4.2	4.2	4.2	28.5	4.2	4.1	4.4	4.1	4.1	4.1
14	4.1	4.1	4.2	4.2	4.2	15.5	4.4	4.2	4.3	4.1	4.1	4.1
15	4.1	5.4	4.4	4.2	4.2	4.3	4.4	4.2	4.2	4.1	4.1	4.1
16	4.1	4.3	4.3	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1
17	4.1	4.2	4.3	4.2	4.2	4.2	4.2	4.3	4.1	4.1	4.1	4.1
18	4.1	4.2	39.5	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1
19	4.1	4.2	4.3	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1
20	4.1	4.2	4.3	4.3	4.2	4.2	4.3	4.1	4.1	4.1	4.1	4.1
21	4.1	4.2	4.2	4.3	4.2	4.4	4.2	4.1	4.1	4.1	4.1	4.1
22	4.1	4.2	86.6	4.2	4.2	4.3	4.2	4.1	4.1	4.1	4.1	4.1
23	4.1	4.3	4.4	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.1
24	4.1	4.2	4.4	4.2	4.2	762.1	4.2	4.2	4.1	4.1	4.1	4.1
25	4.1	4.2	4.3	4.2	4.2	44.5	4.2	4.2	4.1	4.1	4.1	4.1
26	4.1	4.2	4.4	4.2	4.2	53.5	4.4	4.2	4.1	4.1	4.1	4.1
27	4.2	4.3	4.3	4.2	4.2	4.3	76.6	4.2	4.1	4.1	100.6	4.1
28	4.2	37.5	4.3	4.2	4.2	4.2	30.5	4.1	4.1	4.1	4.2	4.1
29	4.2	4.3	4.3	4.2	4.2	4.2	24.5	4.1	4.1	4.1	4.1	4.1
30	4.1		4.3	4.2	4.2	4.2	4.4	4.2	4.1	4.1	4.1	4.1
31	4.1		4.3		4.2		4.3	4.3		4.1		4.1
Average	4.1	5.4	34.6	4.2	4.2	33.7	13.3	47.9	7.0	4.1	7.3	4.1
Maximum	4.2	37.5	444.4	4.3	4.2	762.1	165.8	776.1	65.6	4.3	100.6	4.1
Minimum	4.1	4.1	4.1	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1

Average annual discharge = 14 (m^3/sec)

Annual inflow volume = 449 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1981

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.2	56.5	112.7	4.3	4.4	4.3	81.6	4.1	4.1	4.1	4.0
2	4.1	4.2	4.4	75.6	4.3	4.3	4.4	44.5	4.1	4.2	4.1	4.0
3	4.1	4.2	4.3	160.8	4.4	4.2	4.2	24.5	4.1	4.1	4.1	4.0
4	4.1	4.3	4.3	123.7	4.3	4.2	4.2	34.5	4.1	4.1	4.1	4.0
5	4.3	216.9	4.3	40.5	44.5	4.2	19.5	277.0	4.1	4.1	4.1	4.0
6	4.2	21.5	379.2	4.4	4.4	4.2	4.4	214.9	4.1	4.1	4.1	4.0
7	4.1	4.3	311.1	4.4	4.3	4.2	4.2	271.0	4.1	4.1	4.1	4.0
8	4.1	4.3	97.6	4.4	4.3	4.2	4.3	168.8	4.1	4.1	4.1	4.0
9	4.1	4.3	36.5	4.4	4.3	4.3	194.8	325.1	4.1	4.1	4.1	4.0
10	4.1	4.3	131.7	4.4	4.2	4.2	15.5	109.7	4.1	4.1	4.1	4.0
11	4.1	4.3	55.5	4.4	4.2	4.2	4.3	71.6	4.1	4.1	4.1	4.0
12	4.1	4.3	4.4	10.4	4.2	4.1	4.3	10.4	4.1	4.1	4.1	4.0
13	4.1	4.4	4.4	20.5	4.2	4.1	168.8	29.5	4.1	4.1	4.1	4.0
14	4.1	486.5	73.6	11.4	4.3	4.1	708.0	4.4	4.1	4.1	4.1	4.0
15	4.1	123.7	60.6	34.5	4.3	4.1	4.3	69.6	4.1	4.1	4.1	4.0
16	4.1	29.5	19.5	242.9	4.2	4.1	41.5	4.4	4.1	4.1	4.1	4.0
17	4.1	4.4	4.4	67.6	4.2	4.1	4.2	4.3	4.1	4.1	4.1	4.0
18	4.1	4.4	10.4	4.4	4.3	4.1	197.8	4.3	4.1	4.1	4.1	4.0
19	4.1	4.4	14.5	4.4	4.3	4.1	24.5	4.2	4.1	4.1	4.1	4.0
20	4.1	4.3	285.0	4.4	4.3	4.1	4.2	4.2	4.1	4.1	4.1	4.0
21	4.1	4.3	529.6	168.8	4.3	4.1	4.2	4.2	4.1	4.1	4.1	4.0
22	4.1	4.3	211.9	45.5	4.2	4.1	4.4	4.2	4.1	4.1	4.1	4.0
23	4.1	4.3	106.7	4.3	4.2	4.1	11.4	4.2	4.1	4.1	4.1	4.0
24	71.6	4.3	70.6	4.3	4.3	4.1	739.0	4.2	4.1	4.1	4.0	4.0
25	74.6	28.5	63.6	4.4	4.3	4.2	594.7	4.1	4.1	4.1	4.0	4.0
26	4.3	4.3	29.5	4.4	4.3	4.1	140.7	4.1	4.1	4.1	4.0	4.0
27	4.2	4.2	14.5	4.3	4.2	4.2	51.5	4.3	4.1	4.1	4.0	4.0
28	4.3	4.4	22.5	4.3	4.2	4.2	413.3	4.2	4.1	4.1	4.0	4.0
29	4.3		86.6	4.3	4.2	4.2	260.0	4.3	4.1	4.1	4.0	4.0
30	4.4		1,050.7	4.3	4.2	4.3	331.1	4.2	4.2	4.1	4.0	4.0
31	4.3		288.0		112.7		188.8	4.1		4.1		4.0
Average	8.6	35.7	130.2	39.6	9.1	4.2	134.2	58.2	4.1	4.1	4.1	4.0
Maximum	74.6	486.5	1,050.7	242.9	112.7	4.4	739.0	325.1	4.2	4.2	4.1	4.0
Minimum	4.1	4.2	4.3	4.3	4.2	4.1	4.2	4.1	4.1	4.1	4.0	4.0

Average annual discharge = 37 (m^3/sec)

Annual inflow volume = 1,154 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1982

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	41.5	89.6	77.6	4.3	171.8	776.1	4.1	4.1	4.1	4.1
2	4.0	4.1	21.5	72.6	129.7	4.2	4.3	246.0	4.1	4.1	4.1	4.1
3	4.0	4.1	4.3	60.6	62.6	4.2	4.3	49.5	4.1	4.1	4.1	4.1
4	4.0	4.1	4.2	57.5	26.5	4.2	4.2	4.4	4.1	4.1	4.1	4.1
5	4.1	4.1	55.5	40.5	31.5	4.2	4.2	664.9	4.1	4.1	4.1	4.1
6	4.0	4.1	17.5	21.5	24.5	4.3	4.2	100.6	4.1	4.0	4.1	4.1
7	4.0	4.1	4.3	6.4	92.6	4.3	4.2	1,141.9	4.1	4.0	4.1	4.1
8	4.0	4.1	4.3	4.3	34.5	4.3	4.3	194.8	4.1	4.0	4.1	4.1
9	4.0	4.1	4.2	4.3	4.4	4.3	4.2	379.2	4.1	4.0	4.1	4.2
10	4.0	4.1	182.8	4.3	4.4	4.3	4.2	594.7	4.1	4.0	4.1	4.2
11	4.0	4.2	4.4	4.3	160.8	4.3	4.1	277.0	4.1	4.0	4.1	4.1
12	4.0	4.1	4.3	4.3	58.5	4.3	4.2	165.8	4.1	4.3	4.1	4.1
13	4.0	4.1	4.3	4.3	4.4	4.3	4.3	225.9	4.1	4.1	4.1	4.1
14	4.0	4.1	4.3	4.3	4.3	4.3	4.2	95.6	4.1	4.1	4.1	4.1
15	4.0	4.1	4.3	4.3	4.3	17.5	4.2	103.6	4.1	4.1	4.2	4.1
16	4.0	4.1	28.5	216.9	4.3	4.4	4.2	106.7	4.1	4.1	160.8	4.1
17	4.0	4.1	36.5	602.7	4.3	4.3	4.2	4.4	4.1	4.1	4.2	4.1
18	4.0	4.1	4.4	280.0	4.2	4.3	4.2	4.3	4.1	4.1	4.2	4.1
19	4.0	4.1	4.3	114.7	4.3	4.2	38.5	4.4	4.1	4.1	4.2	4.1
20	4.0	25.5	4.3	51.5	4.2	4.2	146.7	4.3	4.1	4.1	4.1	4.1
21	4.0	4.3	4.3	10.4	4.2	4.3	64.6	4.2	4.1	4.1	4.1	4.1
22	4.1	4.2	233.9	4.4	4.2	4.2	4.3	4.2	39.5	4.1	4.1	4.1
23	4.1	4.1	325.1	4.4	84.6	4.2	251.0	4.2	4.2	4.1	4.1	4.1
24	4.1	4.1	708.0	26.5	18.5	4.2	711.0	24.5	4.2	4.1	4.1	4.1
25	4.0	4.1	662.9	7.4	4.3	4.1	4.4	4.3	4.1	4.1	4.1	4.1
26	4.1	4.1	233.9	19.5	4.3	4.1	45.5	4.2	4.1	4.1	4.1	4.1
27	4.1	4.1	137.7	146.7	4.4	4.3	4.2	4.2	4.1	4.1	4.1	4.1
28	4.1	4.3	114.7	398.3	4.4	4.3	4.4	4.2	4.1	4.4	4.1	4.1
29	4.1		89.6	291.1	4.3	4.2	4.4	4.2	4.1	4.1	4.1	4.1
30	4.1		106.7	112.7	4.4	4.4	87.6	4.2	4.1	4.1	4.1	4.1
31	4.1		109.7		4.4		345.2	4.2		4.1		4.1
Average	4.0	4.9	102.1	89.0	28.5	4.7	63.1	168.1	5.3	4.1	9.3	4.1
Maximum	4.1	25.5	708.0	602.7	160.8	17.5	711.0	1,141.9	39.5	4.4	160.8	4.2
Minimum	4.0	4.1	4.2	4.3	4.2	4.1	4.1	4.2	4.1	4.0	4.1	4.1

Average annual discharge = 41 (m^3/sec)

Annual inflow volume = 1,294 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1983

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.2	97.6	29.5	87.6	4.4	222.9	95.6	28.5	4.1	4.1	4.1
2	4.1	4.2	565.6	41.5	23.5	4.4	85.6	120.7	980.5	4.1	4.1	4.1
3	4.1	4.2	171.8	13.4	18.5	4.4	151.7	19.5	246.0	4.1	4.1	4.1
4	4.1	4.1	60.6	134.7	32.5	4.3	265.0	222.9	214.9	4.1	4.1	4.1
5	4.1	4.1	12.4	83.6	32.5	4.3	92.6	57.5	95.6	4.1	4.1	4.1
6	4.1	4.1	4.3	17.5	29.5	4.3	77.6	129.7	71.6	4.1	4.1	4.1
7	4.1	4.1	4.3	89.6	43.5	4.2	4.3	288.0	45.5	4.1	4.1	4.1
8	4.1	4.1	4.3	248.0	48.5	4.3	4.3	112.7	23.5	4.1	4.1	4.1
9	4.1	4.1	4.3	97.6	46.5	4.4	4.2	143.7	4.4	4.1	4.1	4.1
10	4.1	4.1	4.4	71.6	70.6	4.3	4.3	65.6	48.5	4.1	4.1	4.1
11	4.1	4.1	117.7	71.6	97.6	10.4	4.3	9.4	4.3	4.1	4.1	4.1
12	4.1	4.1	22.5	231.9	49.5	4.3	4.2	80.6	4.3	4.1	4.1	4.1
13	4.1	4.1	4.4	957.5	14.5	4.3	4.2	15.5	4.3	4.2	4.1	4.1
14	4.1	4.1	4.3	396.3	47.5	4.3	4.3	4.4	4.2	4.3	4.1	4.1
15	4.1	37.5	4.3	767.1	31.5	4.4	4.2	4.4	33.5	4.2	4.1	4.1
16	4.1	4.2	4.3	782.1	4.4	14.5	4.3	4.3	35.5	4.1	4.1	4.1
17	4.1	4.2	4.3	381.2	4.3	4.4	4.3	4.4	4.3	4.1	4.1	4.1
18	4.1	4.1	4.2	297.1	54.5	4.3	4.3	478.5	4.2	4.1	4.1	4.1
19	4.1	4.1	725.0	188.8	66.6	4.3	4.3	151.7	4.2	4.1	4.1	4.1
20	4.1	4.1	418.3	146.7	82.6	4.2	4.2	81.6	4.2	4.1	4.1	4.1
21	4.1	4.1	92.6	117.7	87.6	4.2	4.2	81.6	4.2	4.1	4.1	4.1
22	4.1	4.1	30.5	97.6	54.5	4.2	4.3	46.5	4.2	4.1	4.1	4.1
23	4.1	4.1	4.4	109.7	67.6	4.3	362.2	75.6	4.2	4.1	4.1	4.1
24	4.1	88.6	4.3	87.6	4.3	4.2	53.5	151.7	4.2	4.1	4.1	4.1
25	4.1	4.3	265.0	65.6	4.3	4.2	88.6	483.5	4.2	4.1	4.1	4.1
26	4.1	4.2	427.3	95.6	4.4	4.2	251.0	430.4	4.1	4.1	4.1	4.1
27	4.4	4.2	208.9	157.8	4.4	4.3	435.4	157.8	4.1	4.1	4.1	4.1
28	246.0	4.2	65.6	117.7	4.4	4.3	81.6	66.6	4.1	4.1	4.1	4.1
29	106.7		36.5	86.6	4.4	4.3	4.4	4.4	4.1	4.1	4.1	4.1
30	4.4		18.5	103.6	4.4	4.4	4.4	4.3	4.1	4.1	4.1	4.1
31	4.2		12.4		4.3		4.4	12.4		4.1		4.1
Average	15.2	8.4	109.8	202.9	36.5	4.8	72.6	116.3	63.5	4.1	4.1	4.1
Maximum	246.0	88.6	725.0	957.5	97.6	14.5	435.4	483.5	980.5	4.3	4.1	4.1
Minimum	4.1	4.1	4.2	13.4	4.3	4.2	4.2	4.3	4.1	4.1	4.1	4.1

Average annual discharge = 54 (m^3/sec)

Annual inflow volume = 1,694 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1984

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.0	4.1	106.7	4.1	4.1	4.2	4.4	370.4	4.2	4.1	4.1
2	4.1	4.0	4.1	131.7	4.1	4.1	4.2	4.3	339.2	4.2	4.1	4.1
3	4.0	4.0	4.1	75.6	4.1	4.1	4.2	4.2	415.8	4.2	4.1	4.1
4	4.0	4.0	4.1	4.3	4.2	4.2	4.2	4.2	248.4	4.2	4.1	4.1
5	4.0	4.0	4.1	4.3	4.1	4.1	4.2	333.5	140.7	4.2	4.1	4.1
6	4.0	4.0	4.1	4.2	4.2	4.2	4.2	4.4	140.7	4.2	4.1	4.1
7	4.0	4.0	4.1	4.2	4.2	4.1	4.2	4.3	203.1	4.2	4.1	4.1
8	4.0	4.0	4.1	4.2	4.2	4.1	4.4	503.7	123.7	4.2	4.1	4.1
9	4.0	4.0	4.1	4.2	4.2	4.1	4.3	233.9	71.6	4.1	4.1	4.1
10	4.0	4.0	4.1	4.2	4.2	4.1	4.2	51.5	45.5	4.1	4.1	4.1
11	4.0	4.0	4.1	4.1	4.2	4.2	4.2	325.1	22.5	4.1	4.1	4.1
12	4.0	4.0	4.1	4.2	4.2	4.2	4.2	154.8	7.4	4.1	4.1	4.1
13	4.0	4.0	4.1	4.2	4.2	4.1	4.2	268.3	4.4	4.1	4.1	4.1
14	4.0	4.0	4.1	4.2	4.2	4.1	4.1	424.3	40.5	4.1	4.1	4.1
15	4.0	4.0	4.1	4.2	4.2	4.1	4.3	154.8	4.4	4.1	4.1	4.1
16	4.0	4.0	4.1	4.2	4.1	4.1	4.2	537.7	4.3	4.1	4.1	4.1
17	4.0	4.0	4.1	4.2	4.1	4.1	4.3	134.7	4.3	4.1	4.1	4.1
18	4.0	4.1	4.3	4.2	4.1	188.9	4.3	60.6	4.3	4.1	4.1	4.1
19	4.0	4.1	4.2	4.2	4.1	25.5	4.4	464.4	4.3	4.1	4.1	4.1
20	4.0	4.2	4.1	4.2	4.1	4.3	4.4	191.8	4.3	4.1	4.1	4.1
21	4.0	4.1	4.1	4.2	4.1	4.2	4.3	154.8	4.3	4.1	4.1	4.1
22	4.0	4.1	4.1	4.1	4.1	4.2	4.4	435.4	4.3	4.1	4.1	4.1
23	4.0	4.1	4.1	4.1	4.1	4.2	4.3	148.7	4.2	4.1	4.2	4.1
24	4.0	4.1	4.1	4.1	4.1	4.2	4.2	331.1	4.4	4.1	4.1	4.1
25	4.0	4.1	4.3	4.1	4.1	4.3	4.2	268.0	4.3	4.1	4.1	4.1
26	4.0	4.1	4.2	4.2	4.2	4.3	4.2	123.7	4.2	4.1	4.1	4.1
27	4.0	4.1	4.2	4.2	4.1	4.3	4.2	228.9	4.2	4.1	4.1	4.1
28	4.0	4.1	4.2	4.2	4.2	4.3	126.5	134.7	4.2	4.1	4.1	4.1
29	4.0	4.1	4.2	4.2	4.2	4.2	5.4	106.7	4.2	4.1	4.1	4.1
30	4.0		4.2	4.1	4.1	4.2	22.5	60.6	4.2	4.1	4.1	4.1
31	4.0		4.2		4.1		4.3	152.0		4.1		4.1
Average	4.0	4.1	4.1	14.2	4.1	11.1	8.8	193.9	74.7	4.1	4.1	4.1
Maximum	4.1	4.2	4.3	131.7	4.2	188.9	126.5	537.7	415.8	4.2	4.2	4.1
Minimum	4.0	4.0	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.1	4.1	4.1

Average annual discharge = 28 (m^3/sec)

Annual inflow volume = 878 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1985

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.1	4.1	4.2	4.1	4.1	9.4	4.1	4.1	4.1	4.1
2	4.1	4.1	4.1	4.1	4.4	4.1	4.1	9.4	4.1	4.1	4.1	4.1
3	4.1	4.1	4.1	4.1	4.2	4.1	4.1	83.7	4.1	4.1	4.1	4.1
4	4.1	4.1	4.1	4.2	4.1	4.1	4.1	259.8	4.1	4.1	4.1	4.1
5	4.1	4.2	4.1	4.1	4.1	4.1	4.1	219.9	4.2	4.2	4.1	4.1
6	4.1	4.1	4.1	4.1	4.1	4.1	4.1	129.7	4.1	4.2	4.1	4.1
7	4.1	4.1	4.1	4.2	4.1	4.1	4.4	1,312.3	4.1	4.2	4.1	4.1
8	4.1	4.1	4.1	4.4	4.2	4.2	34.5	214.9	4.1	4.1	4.1	4.2
9	4.1	4.1	4.1	4.4	4.2	4.1	4.2	78.6	4.1	4.3	4.1	4.1
10	4.1	4.1	4.1	4.3	4.3	4.2	4.2	51.5	4.1	4.3	4.1	4.1
11	4.1	4.1	4.1	4.2	4.2	4.3	4.2	25.5	4.1	4.2	4.1	4.1
12	4.1	4.1	4.1	4.2	4.2	4.1	4.3	24.5	4.1	4.2	4.1	4.1
13	4.1	4.1	4.1	4.2	4.2	4.1	47.5	4.4	4.1	4.1	4.1	4.1
14	4.1	4.1	4.1	4.2	4.2	4.1	4.4	4.3	4.1	4.1	4.1	4.1
15	4.1	4.1	4.1	4.2	4.1	4.1	4.4	4.3	4.1	4.1	4.1	4.1
16	4.1	4.1	4.1	4.1	4.1	4.1	205.9	4.3	4.1	4.1	4.1	4.2
17	4.1	4.1	4.1	4.1	4.1	4.1	129.7	4.2	4.1	4.1	4.1	4.2
18	4.1	4.1	4.1	4.2	4.1	4.1	4.4	4.2	4.2	4.1	4.1	4.1
19	4.1	4.1	4.1	4.2	4.1	4.1	4.4	4.2	4.1	4.1	4.1	4.1
20	4.1	4.1	4.1	4.2	4.1	4.1	61.6	4.2	4.1	4.1	4.1	4.1
21	4.1	4.1	4.1	4.2	4.2	4.1	4.3	4.2	4.1	4.1	4.1	4.1
22	4.1	4.1	4.1	4.2	4.2	4.1	97.6	4.2	4.2	4.1	4.1	4.1
23	4.1	4.1	4.1	4.1	4.2	4.1	4.3	79.6	4.2	4.1	4.1	4.1
24	4.1	4.1	4.1	4.1	4.2	4.1	4.4	4.2	4.2	4.1	4.1	4.1
25	4.1	4.1	4.1	4.1	4.3	4.1	886.3	4.2	4.1	4.1	4.1	126.7
26	4.2	4.1	4.1	4.1	4.2	4.1	365.2	4.2	4.1	4.1	4.1	693.9
27	4.2	4.1	4.2	4.1	4.1	4.2	143.7	4.2	4.1	4.1	4.1	24.5
28	4.1	4.1	4.2	4.1	4.1	4.2	70.6	4.1	4.1	4.1	4.1	4.2
29	4.1		4.2	4.1	4.1	4.2	87.6	4.1	4.1	4.1	4.1	4.2
30	4.1		4.1	4.1	4.1	4.2	268.0	4.2	4.1	4.1	4.1	4.2
31	4.1		4.1		4.1		214.9	4.1		4.1		4.2
Average	4.1	4.1	4.1	4.2	4.2	4.1	86.8	83.1	4.1	4.1	4.1	31.0
Maximum	4.2	4.2	4.2	4.4	4.4	4.3	886.3	1,312.3	4.2	4.3	4.1	693.9
Minimum	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Average annual discharge = 20 (m^3/sec)

Annual inflow volume = 635 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1986

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.2	32.5	4.4	4.3	4.4	631.8	4.2	4.1	4.1	4.2
2	4.1	4.1	4.2	4.4	4.4	4.3	4.2	194.8	4.2	4.1	4.1	4.2
3	4.1	4.1	4.2	4.4	4.4	4.3	4.2	183.2	4.2	4.1	4.1	4.2
4	4.1	4.1	4.2	4.4	4.3	4.3	4.2	1,541.8	4.2	4.1	4.1	4.2
5	4.1	4.1	4.2	4.4	4.3	4.3	4.3	608.7	4.2	4.1	4.1	4.2
6	4.1	4.1	4.2	16.5	4.3	4.3	4.2	282.5	4.2	4.1	4.1	4.2
7	4.1	4.1	4.2	31.5	4.4	4.2	177.8	296.7	4.2	4.1	4.1	4.2
8	4.1	4.1	4.2	37.5	4.4	4.3	4.3	160.8	4.2	4.1	4.1	4.2
9	4.1	4.1	4.2	32.5	112.7	4.3	4.3	160.8	4.2	4.2	4.1	4.2
10	4.1	4.1	4.2	40.5	69.5	4.3	4.3	112.7	4.2	4.1	4.1	4.2
11	4.1	4.1	4.4	54.5	4.4	4.3	4.3	64.6	4.2	4.2	4.1	45.5
12	4.1	4.1	381.2	62.6	4.4	4.3	4.3	32.5	4.2	4.2	4.1	920.4
13	4.1	92.5	565.6	41.5	4.4	4.3	4.2	41.5	4.2	4.1	4.1	336.1
14	4.1	4.3	1,312.3	56.5	4.4	4.3	4.2	4.4	4.2	4.1	4.1	58.5
15	4.1	4.3	415.3	28.5	4.4	4.3	4.2	123.7	4.2	4.2	421.3	4.4
16	4.1	4.2	242.9	4.4	4.4	4.3	34.5	15.5	4.2	4.2	117.7	4.4
17	4.1	4.2	202.9	4.4	4.3	4.3	19.5	4.4	4.2	25.5	4.3	4.3
18	4.1	32.5	362.2	4.4	4.3	4.3	299.1	82.6	4.1	4.2	4.2	4.3
19	4.1	4.3	219.9	4.4	4.4	4.3	137.7	5.4	4.1	4.2	4.2	4.3
20	4.1	4.2	134.7	4.4	4.4	4.3	4.4	4.3	4.1	4.2	4.2	4.3
21	4.1	4.4	120.7	4.4	4.4	4.3	4.3	4.3	4.1	4.2	4.2	4.3
22	4.1	4.4	134.7	4.4	4.4	4.3	35.5	4.3	4.1	4.1	4.2	4.3
23	4.1	4.3	66.6	4.4	4.3	4.4	5.4	4.3	4.1	4.1	4.2	4.3
24	4.1	4.3	28.5	26.9	4.3	4.4	4.4	4.3	4.2	4.1	4.2	4.3
25	4.1	4.3	4.4	279.6	4.3	89.6	4.4	4.4	4.1	4.1	4.2	4.2
26	4.1	4.2	4.4	551.9	4.3	12.5	4.4	4.4	4.2	4.1	4.4	4.2
27	4.1	4.2	30.5	546.6	4.3	4.8	520.5	34.5	4.2	4.1	129.7	4.2
28	4.1	4.2	100.6	146.7	4.3	4.3	260.0	4.3	4.3	4.1	4.3	4.2
29	4.1		50.5	50.5	4.4	4.3	26.5	4.2	4.3	4.1	4.3	4.2
30	4.1		21.5	21.5	4.3	18.5	197.8	4.2	4.2	4.1	4.2	4.2
31	4.1		8.4		4.4		296.7	4.2		4.1		4.2
Average	4.1	8.4	143.7	70.4	9.9	7.9	67.5	149.4	4.2	4.8	26.0	47.6
Maximum	4.1	92.5	1,312.3	551.9	112.7	89.6	520.5	1,541.8	4.3	25.5	421.3	920.4
Minimum	4.1	4.1	4.2	4.4	4.3	4.2	4.2	4.2	4.1	4.1	4.1	4.2

Average annual discharge = 46 (m^3/sec)

Annual inflow volume = 1,445 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1987

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.2	4.1	4.2	4.4	4.3	4.4	4.2	4.2	4.3	4.1	4.1	4.1
2	4.2	4.1	4.2	24.5	4.3	4.4	4.2	4.2	4.1	4.1	4.1	4.1
3	4.2	4.1	4.2	62.6	4.2	69.6	4.2	4.2	4.1	4.1	4.1	4.1
4	4.2	4.1	4.2	35.5	4.2	78.6	4.2	10.4	4.1	4.1	4.1	4.1
5	4.2	4.1	4.2	4.4	4.2	10.4	4.2	4.4	4.2	4.1	4.1	4.1
6	4.2	4.1	4.2	4.4	4.3	8.4	4.3	4.2	4.1	4.1	4.1	4.1
7	4.2	4.1	4.3	4.3	4.2	4.4	4.3	4.2	4.1	4.1	4.1	4.1
8	4.2	4.1	4.4	4.3	100.6	8.4	4.2	4.2	4.1	4.1	4.1	4.1
9	4.2	4.1	4.3	143.7	64.6	211.9	4.2	4.2	4.3	4.1	4.1	4.1
10	4.2	4.1	4.2	13.4	194.8	137.7	4.2	4.2	4.2	45.9	4.1	4.1
11	4.2	4.1	4.2	4.4	48.5	9.4	4.2	4.2	4.2	4.4	4.1	4.1
12	4.2	4.1	4.2	4.3	4.4	4.4	4.2	4.3	4.1	15.9	4.1	4.1
13	4.2	4.1	4.2	4.3	4.4	4.3	4.2	4.3	4.1	4.3	4.1	4.1
14	4.2	4.1	4.2	4.3	4.4	4.3	4.2	4.2	4.1	4.3	4.1	4.1
15	4.2	4.1	4.2	4.3	4.3	4.3	4.2	4.2	4.1	4.2	4.1	4.1
16	4.2	4.1	4.4	4.3	4.3	4.3	4.3	4.2	4.1	4.2	4.1	4.1
17	4.2	4.3	4.3	4.3	4.3	4.3	4.2	4.2	4.1	4.1	4.1	4.1
18	4.2	4.3	4.3	4.3	4.3	4.2	4.2	4.4	4.1	4.3	4.1	4.1
19	4.1	4.3	4.3	4.3	4.3	4.2	4.2	4.2	4.1	4.3	4.1	4.1
20	4.1	4.1	4.3	4.3	4.4	4.3	4.2	4.3	4.1	4.2	4.1	4.1
21	4.1	4.1	4.4	4.3	15.0	4.3	4.2	39.5	4.1	4.2	4.1	4.1
22	4.1	4.1	171.8	4.3	83.9	4.2	4.2	4.4	4.1	4.2	4.1	4.1
23	4.1	4.2	211.9	4.3	611.5	4.2	4.2	4.3	4.1	4.1	4.1	4.1
24	4.1	177.8	75.6	4.3	200.2	4.2	4.3	17.5	4.1	4.1	4.1	4.1
25	4.1	114.7	31.5	4.3	57.0	4.2	4.3	4.3	4.1	4.1	4.1	4.1
26	4.1	4.3	242.9	4.3	41.1	4.2	45.5	4.2	4.1	4.1	4.1	4.1
27	4.1	4.3	88.6	4.3	20.5	4.2	4.3	4.2	4.1	4.1	4.1	4.1
28	4.1	4.2	4.3	4.3	17.5	4.2	4.2	4.2	4.1	4.1	4.1	4.1
29	4.1		9.4	4.3	4.4	4.2	4.2	4.2	4.1	4.1	4.1	4.1
30	4.1		4.4	4.3	4.4	4.2	4.2	4.2	4.1	4.1	4.1	4.1
31	4.1		4.4		4.4		4.2	4.2		4.1		4.1
Average	4.2	14.3	30.1	12.9	49.6	21.0	5.6	6.0	4.1	5.9	4.1	4.1
Maximum	4.2	177.8	242.9	143.7	611.5	211.9	45.5	39.5	4.3	45.9	4.1	4.1
Minimum	4.1	4.1	4.2	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1	4.1

Average annual discharge = 14 (m^3/sec)

Annual inflow volume = 426 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1988

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.2	4.4	4.3	4.2	4.2	1,136.2	4.2	4.2	4.1	4.1
2	4.1	4.1	4.2	4.4	4.2	4.2	4.2	512.2	4.2	4.2	4.2	4.1
3	4.1	4.1	4.2	4.3	4.2	4.1	4.4	393.1	4.2	4.2	4.1	4.1
4	4.1	4.1	4.2	4.3	4.2	4.1	68.4	293.9	4.2	4.2	4.1	4.1
5	4.1	4.1	4.2	4.2	4.2	4.1	4.4	217.3	4.2	4.2	4.1	4.1
6	4.1	4.1	4.2	4.2	4.2	4.1	4.3	171.9	4.2	4.2	4.1	4.1
7	4.1	4.1	5.6	4.2	4.2	4.1	4.2	135.0	4.2	4.2	4.1	4.1
8	4.1	4.1	4.3	4.3	4.1	4.1	4.1	325.0	4.2	4.2	4.1	4.1
9	4.1	4.1	4.2	4.3	4.1	4.1	4.1	390.3	4.3	4.1	4.1	4.1
10	4.1	4.1	4.2	4.3	4.1	4.1	4.1	135.0	4.2	4.2	4.1	4.1
11	4.1	4.1	903.6	4.2	4.2	4.1	4.2	160.6	4.2	4.1	4.1	4.1
12	4.1	4.1	852.5	4.3	4.2	4.1	4.2	74.9	4.2	4.1	4.1	4.1
13	4.1	4.1	118.0	4.3	4.2	4.1	532.1	220.1	4.2	4.1	4.1	4.1
14	4.1	4.1	7.3	4.3	4.2	4.1	506.5	80.8	4.2	4.1	4.1	4.1
15	4.1	4.1	4.4	4.3	4.1	4.1	1,422.6	322.2	4.3	4.1	4.1	4.1
16	4.1	4.1	34.6	4.3	4.1	4.1	3,237.7	89.6	4.3	4.1	4.1	4.1
17	4.1	4.1	21.9	4.3	4.1	4.1	730.6	103.8	4.2	4.1	4.1	4.1
18	4.1	4.1	22.7	4.3	4.1	4.1	364.7	106.6	4.2	4.1	4.1	4.1
19	4.1	4.1	4.4	4.4	4.1	4.1	359.1	84.2	4.2	4.1	4.1	4.1
20	4.1	4.1	4.4	4.4	4.1	4.1	1,031.3	45.7	4.2	4.1	4.1	4.1
21	4.1	4.1	4.3	4.3	4.1	4.1	478.2	57.5	4.2	4.2	4.1	4.1
22	4.1	4.1	4.4	4.2	4.1	4.2	829.8	31.2	4.2	4.1	4.1	4.2
23	4.1	4.1	4.4	4.2	4.1	4.2	583.1	17.1	4.1	4.1	4.1	17.0
24	4.1	4.1	4.4	4.2	4.1	4.2	520.7	4.4	36.9	4.1	4.1	4.2
25	4.1	4.1	4.4	4.2	4.1	4.1	276.8	109.5	276.8	4.1	4.1	4.1
26	4.1	4.1	217.3	4.2	4.1	4.2	180.4	4.4	4.4	4.1	4.1	4.1
27	4.1	4.1	50.2	4.2	4.1	4.3	248.5	4.4	4.3	4.1	4.1	4.1
28	4.1	109.5	9.9	4.2	4.1	4.2	305.2	4.3	4.2	4.1	4.1	4.1
29	4.1	4.3	18.5	4.3	4.1	296.7	1,442.5	4.3	4.2	4.1	4.1	4.1
30	4.1		33.7	4.2	4.1	4.3	359.0	4.3	4.2	4.1	4.1	4.1
31	4.1		31.2		4.1		1,122.0	4.3		4.1		4.1
Average	4.1	7.7	77.4	4.3	4.2	13.9	472.4	169.2	14.4	4.1	4.1	4.5
Maximum	4.1	109.5	903.6	4.4	4.3	296.7	3,237.7	1,136.2	276.8	4.2	4.2	17.0
Minimum	4.1	4.1	4.2	4.2	4.1	4.1	4.1	4.3	4.1	4.1	4.1	4.1

Average annual discharge = 66 (m^3/sec)

Annual inflow volume = 2,085 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1989

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.1	399.1	4.2	4.2	4.2	455.8	4.2	4.1	4.1	4.1
2	4.1	4.1	4.1	106.7	4.3	4.2	4.3	284.0	4.2	4.1	4.1	4.1
3	4.1	4.1	4.1	36.7	4.4	4.2	4.2	111.5	4.2	4.1	4.1	4.1
4	4.1	4.1	4.1	4.4	4.4	4.2	4.2	19.7	4.2	4.1	4.1	4.1
5	4.1	4.1	4.1	4.4	4.3	4.3	4.2	55.9	4.2	4.1	4.2	4.1
6	205.8	4.1	4.1	4.3	4.2	4.2	4.3	4.4	4.2	4.1	4.1	4.1
7	4.3	4.1	4.1	4.3	4.2	4.2	4.2	4.3	4.2	4.1	4.1	4.1
8	4.2	4.1	4.1	4.3	4.2	4.2	4.2	4.3	4.2	4.1	4.1	4.1
9	4.2	4.1	4.2	75.5	4.2	4.2	4.2	27.6	4.2	4.1	4.1	4.1
10	4.2	4.1	4.2	85.8	4.2	4.2	4.1	4.3	4.2	4.1	4.1	4.1
11	4.2	4.1	4.2	4.4	4.2	4.2	4.2	4.3	4.2	4.1	4.1	4.1
12	4.2	4.1	4.2	4.3	4.2	4.2	4.1	4.4	4.2	4.2	4.1	4.1
13	4.2	4.1	4.2	4.3	4.2	4.2	4.3	4.4	4.2	4.4	4.1	4.1
14	4.1	4.1	4.2	4.3	4.3	4.2	4.3	4.3	4.2	4.2	4.1	4.1
15	4.1	4.1	4.2	4.3	4.3	4.2	147.0	4.3	4.2	4.1	4.1	4.1
16	4.1	4.1	4.2	4.3	4.3	4.2	4.4	4.3	4.2	4.1	4.1	4.1
17	4.1	4.1	4.2	4.3	4.3	4.2	4.2	4.3	4.2	4.1	4.1	4.1
18	4.1	4.1	4.3	4.3	4.3	4.2	4.2	4.3	4.2	4.1	4.1	4.1
19	4.1	4.1	4.3	4.3	4.3	4.2	4.2	4.3	4.2	4.1	4.1	4.1
20	4.1	4.1	4.3	4.3	4.3	4.2	4.2	159.9	4.2	4.1	4.1	4.1
21	4.1	4.1	4.3	4.3	4.3	4.2	4.1	4.4	4.2	4.1	4.1	4.1
22	4.1	4.1	278.7	4.2	4.3	4.1	4.1	4.3	4.2	4.1	4.1	4.1
23	4.1	4.1	268.0	4.2	4.2	4.1	4.2	4.4	4.3	4.1	4.1	4.2
24	4.1	4.1	50.1	4.3	4.2	4.1	4.4	4.3	4.2	4.1	4.1	4.2
25	4.1	4.1	14.7	4.4	4.2	4.1	4.3	4.3	4.2	4.1	4.1	4.1
26	4.1	4.1	4.4	4.3	4.2	4.2	4.3	4.3	4.1	4.1	4.1	4.1
27	4.1	4.1	31.9	4.3	4.2	4.2	4.2	52.5	4.1	4.1	4.1	4.1
28	4.1	4.1	31.3	4.2	4.2	4.2	4.2	31.3	4.1	4.1	4.1	4.1
29	4.1		13.4	4.2	4.2	4.2	1,270.1	4.3	4.1	4.1	4.1	4.1
30	4.1		4.4	4.2	4.2	4.2	1,553.1	4.3	4.1	4.1	4.1	4.1
31	4.1		60.3		4.2		1,884.9	4.2		4.1		4.1
Average	10.6	4.1	27.3	27.0	4.2	4.2	160.3	41.7	4.2	4.1	4.1	4.1
Maximum	205.8	4.1	278.7	399.1	4.4	4.3	1,884.9	455.8	4.3	4.4	4.2	4.2
Minimum	4.1	4.1	4.1	4.2	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.1

Average annual discharge = 25 (m^3/sec)

Annual inflow volume = 788 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1990

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.3	16.9	4.3	4.2	4.4	4.2	4.4	4.2	4.1	4.1
2	4.1	4.1	4.3	4.9	4.3	4.2	4.2	573.5	4.3	4.1	4.1	4.1
3	4.1	4.1	4.2	4.4	4.3	4.2	4.3	4.3	4.3	4.1	4.1	4.1
4	4.1	4.1	4.2	4.4	4.3	4.2	278.3	83.3	4.4	4.1	4.1	4.1
5	4.1	4.1	4.2	4.4	4.3	4.2	4.3	115.0	57.0	4.1	4.1	4.1
6	4.1	4.1	4.2	63.2	4.3	4.2	4.4	81.5	4.4	4.1	4.1	4.1
7	4.1	4.2	4.2	250.3	4.3	4.2	148.3	50.7	4.3	4.1	4.1	4.1
8	4.1	105.9	4.2	120.0	4.3	4.2	4.3	241.9	4.3	4.1	4.1	4.1
9	4.1	28.8	4.2	19.8	4.3	4.2	157.5	917.4	4.2	4.1	4.1	4.1
10	4.1	4.3	4.2	4.4	4.3	4.2	4.4	337.3	4.2	4.1	4.1	4.1
11	4.1	4.2	117.2	4.3	4.3	4.2	4.3	158.1	4.2	4.1	4.1	4.1
12	4.1	4.2	4.3	4.3	4.3	4.2	4.2	71.9	4.2	4.1	4.1	4.1
13	4.1	4.4	4.2	4.3	4.3	4.3	4.2	118.0	4.3	4.1	4.1	4.1
14	4.1	14.4	4.3	4.4	4.3	4.2	4.2	176.5	4.3	4.1	4.1	4.1
15	4.1	4.2	4.3	4.3	4.4	4.2	4.2	40.7	4.2	4.1	4.1	4.1
16	4.1	4.2	4.3	4.3	4.4	4.2	4.3	8.5	4.2	4.1	4.1	4.3
17	4.1	4.2	260.0	4.4	4.3	4.2	4.3	4.4	4.2	4.1	4.1	4.3
18	4.1	4.2	225.0	4.4	4.4	4.2	4.2	4.4	4.2	4.3	4.1	4.1
19	4.1	4.1	231.8	4.4	4.4	4.2	4.3	4.3	4.4	4.1	4.1	4.1
20	4.1	4.1	578.5	4.3	4.3	4.2	25.2	4.3	4.2	4.1	4.1	4.1
21	4.1	4.1	1,081.8	4.3	4.3	4.2	4.3	4.2	4.2	4.1	4.1	4.1
22	4.1	4.1	1,771.3	4.3	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1
23	4.1	4.1	559.6	4.3	4.3	4.2	4.2	4.3	4.2	4.1	4.1	4.1
24	4.1	4.2	268.2	4.3	4.3	4.3	4.2	4.2	4.2	4.1	4.1	4.1
25	4.1	4.3	191.2	4.3	4.3	169.5	4.2	4.2	4.2	4.1	4.1	4.1
26	4.1	35.4	129.5	4.4	4.3	4.3	85.1	4.2	4.2	4.1	4.1	4.1
27	4.3	19.0	94.2	4.3	4.3	4.2	71.9	4.2	4.1	4.1	4.1	4.1
28	4.3	4.4	71.0	4.3	4.3	4.3	4.3	4.4	4.1	4.1	4.1	734.1
29	4.1		72.7	4.3	4.3	4.2	4.2	177.9	4.2	4.1	4.1	2,090.9
30	4.1		109.7	4.3	4.3	4.3	4.2	113.6	4.2	4.1	4.0	336.3
31	4.1		40.2		4.3		4.3	44.0		4.1		66.4
Average	4.1	10.7	189.2	19.3	4.3	9.7	28.2	108.7	6.0	4.1	4.1	107.7
Maximum	4.3	105.9	1,771.3	250.3	4.4	169.5	278.3	917.4	57.0	4.3	4.1	2,090.9
Minimum	4.1	4.1	4.2	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.0	4.1

Average annual discharge = 42 (m^3/sec)

Annual inflow volume = 1,322 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1991

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.4	4.2	4.3	92.6	4.4	4.2	4.2	4.2	36.7	4.1	4.1	4.1
2	4.4	4.2	4.3	214.8	4.4	4.2	4.2	4.2	4.4	4.1	4.1	4.1
3	4.3	4.2	4.3	249.7	4.4	4.2	4.2	4.2	4.3	4.1	4.1	4.1
4	4.3	4.2	545.6	109.0	4.3	4.2	4.2	4.2	4.3	4.1	4.1	4.1
5	4.3	4.2	210.1	88.1	4.3	4.2	4.2	4.3	15.3	4.1	4.1	4.1
6	4.3	4.3	78.2	94.5	4.3	4.2	4.3	4.2	4.4	4.1	4.1	4.1
7	4.3	4.3	43.2	75.3	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1
8	4.2	4.3	123.9	285.9	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1
9	4.2	4.3	94.4	672.3	4.3	4.2	4.2	4.2	4.2	4.1	4.1	4.1
10	4.2	196.9	17.4	344.8	4.3	4.3	4.3	4.2	4.2	4.1	4.1	4.1
11	4.2	464.5	4.4	142.6	4.2	4.3	4.4	4.2	4.3	4.1	4.1	4.1
12	4.2	498.4	15.3	105.5	4.2	4.2	23.8	4.2	4.2	4.1	4.1	4.1
13	4.2	72.7	24.7	204.7	4.2	4.2	54.1	4.2	4.2	4.1	4.1	4.1
14	4.2	19.4	12.2	999.5	4.2	4.2	260.2	4.1	136.0	4.1	4.1	4.1
15	4.1	50.7	4.9	467.3	4.2	4.3	72.4	4.1	243.0	4.1	4.1	4.1
16	4.1	4.4	4.4	166.9	4.2	4.3	4.4	4.1	266.4	4.1	4.1	4.1
17	4.1	4.3	4.4	100.4	4.2	4.3	4.3	4.2	202.7	4.1	4.1	4.1
18	4.1	4.3	68.1	58.8	4.2	4.4	4.3	4.2	4.4	4.1	4.1	4.1
19	4.1	4.3	183.8	37.4	4.3	17.5	4.3	4.2	4.3	4.1	4.1	4.1
20	4.1	4.3	36.6	19.2	4.3	4.3	67.2	4.2	4.3	4.1	4.1	4.1
21	4.1	4.2	34.0	8.6	4.4	4.3	223.1	4.2	4.2	4.1	4.1	4.1
22	4.1	4.2	62.0	4.4	4.4	4.2	85.2	4.2	4.3	4.1	4.1	4.2
23	4.1	4.2	144.8	14.2	4.3	4.3	4.4	4.4	4.2	4.1	4.1	4.1
24	4.1	4.3	51.8	4.4	4.3	4.2	4.3	4.2	4.2	4.1	4.1	4.1
25	4.1	51.3	12.7	4.4	4.3	4.2	26.6	4.2	4.2	4.1	4.1	4.1
26	4.1	5.3	12.2	4.4	4.2	4.2	4.2	4.2	4.3	4.1	4.1	4.1
27	4.3	4.4	24.2	4.4	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1
28	4.3	4.4	39.1	4.3	4.2	4.2	4.2	82.8	4.2	4.1	4.1	4.1
29	4.3		57.3	4.4	4.2	4.2	4.2	206.5	4.2	4.1	4.1	4.1
30	4.2		75.2	4.4	4.2	4.2	4.3	108.6	4.1	4.1	4.1	4.1
31	4.2		85.2		4.1		4.3	73.2		4.1		4.1
Average	4.2	51.6	67.2	152.9	4.3	4.7	29.4	18.9	33.4	4.1	4.1	4.1
Maximum	4.4	498.4	545.6	999.5	4.4	17.5	260.2	206.5	266.4	4.1	4.1	4.2
Minimum	4.1	4.2	4.3	4.3	4.1	4.2	4.2	4.1	4.1	4.1	4.1	4.1

Average annual discharge = 31 (m^3/sec)

Annual inflow volume = 984 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1992

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	26.6	4.2	84.5	60.3	4.3	4.3	4.3	164.5	61.3	4.4	4.3
2	4.1	4.3	4.2	73.9	48.4	4.3	4.3	4.4	313.0	57.1	4.4	4.3
3	4.1	4.3	4.2	68.7	162.2	4.4	4.3	732.0	258.3	51.3	4.4	4.3
4	4.1	4.2	4.2	64.4	97.2	4.3	4.3	120.7	125.4	42.1	4.4	4.3
5	4.1	4.2	4.1	78.2	50.3	4.3	4.3	135.7	112.6	33.3	4.4	4.3
6	4.1	4.3	4.1	229.4	21.6	4.3	4.3	206.1	163.9	34.5	4.4	4.3
7	4.1	41.2	4.1	641.7	21.7	4.3	4.3	24.8	155.3	36.0	4.4	4.3
8	4.1	4.3	4.1	101.0	30.5	4.3	4.3	38.7	110.5	27.2	4.4	4.3
9	4.1	4.3	4.1	88.4	28.8	4.3	4.3	343.2	5,168.1	22.6	4.4	4.3
10	4.1	4.2	4.1	542.8	16.9	4.3	4.3	123.8	6,371.2	18.4	4.3	4.3
11	4.1	4.2	4.1	75.4	16.7	4.4	8.3	54.1	1,169.6	18.3	4.3	4.3
12	4.1	4.2	4.1	59.9	26.3	4.4	4.3	34.1	676.0	14.2	4.3	4.3
13	4.1	305.1	4.3	59.6	45.7	4.4	4.3	14.6	561.3	12.5	4.3	4.3
14	4.1	46.4	4.3	51.6	48.8	4.3	4.4	68.0	510.3	12.1	4.3	4.3
15	4.1	4.4	4.2	49.7	48.1	4.3	4.4	78.2	467.0	11.7	4.3	4.3
16	4.1	4.3	4.2	49.4	43.6	4.3	4.3	650.4	360.8	11.1	4.3	4.3
17	4.1	4.3	4.2	47.7	40.2	4.3	4.4	619.9	376.4	9.0	4.3	4.3
18	4.1	4.3	4.2	112.2	10.1	4.3	32.2	275.0	288.6	7.8	4.3	4.3
19	4.1	4.3	4.2	37.7	4.4	4.3	4.4	221.4	254.9	205.4	4.4	4.3
20	4.1	4.3	4.2	56.6	4.4	4.3	21.5	176.3	226.1	51.8	104.6	4.3
21	4.1	4.2	4.3	481.3	4.4	4.4	16.0	183.2	205.7	21.1	4.4	4.3
22	4.1	4.2	4.4	206.8	4.3	4.3	19.6	198.4	184.2	13.6	4.3	4.3
23	4.1	4.2	973.2	66.4	4.4	4.3	4.3	86.1	165.9	9.5	4.3	4.3
24	4.1	4.2	447.7	67.3	4.4	4.3	80.1	81.0	148.2	6.1	4.3	4.3
25	4.1	4.2	720.3	75.3	4.4	4.3	159.0	135.2	129.1	4.4	4.3	4.3
26	4.1	4.2	1,312.9	75.1	47.0	4.3	72.2	132.7	114.4	4.4	4.3	4.3
27	4.3	4.2	780.8	74.1	67.0	4.3	4.3	71.0	102.3	4.4	4.3	4.3
28	62.8	4.2	248.9	78.2	12.4	4.3	4.3	60.5	90.2	4.4	4.3	4.3
29	381.2	4.3	313.4	153.6	4.4	4.4	47.4	49.7	77.0	4.4	4.3	4.3
30	1,129.7		128.2	106.5	4.4	4.3	6.9	161.9	67.0	4.4	4.3	4.3
31	156.4		91.9		4.3		4.4	275.9		4.4		4.4
Average	59.4	18.1	164.8	131.9	31.8	4.3	17.9	173.0	637.3	26.4	7.7	4.3
Maximum	1,129.7	305.1	1,312.9	641.7	162.2	4.4	159.0	732.0	6,371.2	205.4	104.6	4.4
Minimum	4.1	4.2	4.1	37.7	4.3	4.3	4.3	4.3	67.0	4.4	4.3	4.3

Average annual discharge = 106 (m^3/sec)

Annual inflow volume = 3,349 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1993

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	50.9	4.2	4.2	4.3	7.0	7.1	4.4	4.4	47.6	4.1	4.1	4.1
2	4.4	4.2	4.2	4.3	22.3	4.3	4.4	4.3	4.4	4.1	4.1	4.1
3	4.4	4.2	4.2	4.3	4.4	4.4	4.3	43.9	16.5	4.1	4.1	4.1
4	4.4	4.2	4.2	4.3	4.4	4.3	4.3	4.4	4.3	4.1	4.1	4.1
5	4.3	4.2	4.2	4.3	4.4	4.3	28.1	4.3	4.2	4.1	4.1	4.1
6	4.4	4.2	4.2	4.4	4.4	4.3	4.4	4.3	4.3	4.1	12.9	4.1
7	4.4	4.2	4.2	4.4	4.4	4.3	4.4	11.2	4.3	4.1	4.3	4.1
8	4.4	4.2	4.2	4.4	4.4	4.3	166.8	4.3	4.4	4.1	4.1	4.1
9	4.4	4.2	4.2	4.4	4.4	4.3	231.9	4.2	4.4	4.1	4.2	4.1
10	4.3	4.2	4.2	4.4	35.6	4.3	616.4	4.3	4.3	4.1	4.1	4.1
11	4.3	4.2	102.4	13.0	4.4	4.3	386.8	4.3	4.4	4.1	4.1	4.1
12	4.3	4.2	394.3	28.4	4.3	4.3	224.7	4.3	4.3	4.1	4.1	4.1
13	4.3	4.2	171.4	21.3	4.3	4.3	44.0	4.3	4.3	4.1	4.1	4.1
14	4.3	4.1	55.4	28.5	4.3	4.4	4.4	4.2	4.2	4.1	4.1	4.1
15	4.3	4.1	19.7	39.5	4.3	4.4	64.7	4.4	4.1	4.1	4.1	4.1
16	4.3	4.2	4.4	4.4	4.4	4.4	122.2	4.3	4.1	4.1	4.1	4.1
17	72.9	4.3	4.3	4.4	4.3	4.6	4.3	4.3	4.1	4.1	4.1	4.1
18	4.4	4.2	4.3	4.4	4.3	4.4	100.7	4.2	4.1	4.1	4.1	4.1
19	4.3	4.2	4.3	4.4	4.3	4.4	4.4	4.2	4.1	4.1	4.1	4.1
20	4.3	4.2	4.3	4.4	4.2	4.3	4.3	4.4	4.1	4.1	4.1	4.1
21	4.3	4.2	4.3	4.4	4.2	4.3	4.3	4.2	4.1	4.1	4.1	4.1
22	4.2	4.2	4.3	4.4	4.3	4.3	116.8	4.2	4.1	4.1	4.1	4.1
23	4.2	4.1	277.4	4.4	4.3	4.4	439.1	4.1	4.2	4.1	4.1	4.1
24	4.2	4.1	1,540.8	4.4	4.3	287.7	426.8	4.2	4.2	4.1	4.1	4.1
25	4.2	4.3	299.1	6.1	4.3	157.3	910.4	4.2	4.1	4.1	4.1	4.1
26	4.2	60.7	47.4	17.2	4.3	35.4	244.9	4.2	4.1	4.1	4.1	4.1
27	4.2	4.3	4.4	5.2	4.3	4.4	114.9	4.2	4.1	4.1	4.1	4.1
28	4.2	4.3	9.3	19.6	4.3	4.3	66.8	4.2	4.1	4.1	4.1	4.1
29	4.2		4.4	12.8	4.4	4.3	27.4	4.1	4.1	4.1	4.1	4.1
30	4.2		4.4	18.2	4.4	4.2	48.5	4.1	4.1	4.1	4.1	4.1
31	4.2		4.4		4.3		21.6	4.4		4.1		4.1
Average	8.0	6.2	97.0	9.8	6.0	20.0	143.6	5.8	6.1	4.1	4.4	4.1
Maximum	72.9	60.7	1,540.8	39.5	35.6	287.7	910.4	43.9	47.6	4.1	12.9	4.1
Minimum	4.2	4.1	4.2	4.3	4.2	4.2	4.3	4.1	4.1	4.1	4.1	4.1

Average annual discharge = 27 (m^3/sec)

Annual inflow volume = 838 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1994

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.1	4.3	4.3	4.2	328.9	127.0	262.3	4.2	4.1	4.1
2	4.1	4.1	4.1	4.2	4.4	4.2	4.4	82.6	242.8	4.1	4.1	4.1
3	4.1	4.1	4.1	4.2	4.3	4.2	624.0	44.4	16.9	4.1	4.1	4.1
4	4.1	4.1	4.2	65.4	4.3	4.2	137.0	186.8	90.9	4.2	4.1	4.1
5	4.1	4.1	4.2	752.2	4.3	4.2	4.4	125.1	172.5	4.2	4.1	4.1
6	4.1	4.1	4.2	796.9	4.3	4.2	4.3	138.4	136.3	4.2	4.1	4.3
7	4.1	4.1	4.2	147.4	4.3	4.2	682.3	995.6	62.4	4.2	4.1	4.3
8	4.1	4.1	4.2	4.4	9.7	4.2	86.8	202.1	11.0	4.2	4.1	372.2
9	4.1	4.1	4.2	4.4	83.9	4.2	46.1	79.7	8.1	4.2	4.1	7.4
10	4.1	4.1	4.2	4.3	4.3	4.4	467.3	418.6	11.6	4.2	4.1	4.3
11	4.1	4.1	4.2	4.3	5.9	4.3	152.7	98.9	41.9	4.1	4.1	4.2
12	4.1	4.1	4.2	4.3	4.3	4.4	43.2	60.3	17.4	4.1	4.1	4.2
13	4.1	4.1	4.1	4.3	4.3	4.4	14.5	24.8	20.7	4.1	4.1	4.2
14	4.1	4.1	4.2	4.2	4.3	4.2	186.1	446.4	12.0	4.1	4.1	4.1
15	4.1	4.1	4.2	4.3	4.4	4.2	48.5	113.0	6.8	4.1	4.1	4.2
16	4.1	4.1	4.2	4.2	4.3	4.2	4.4	123.2	4.4	4.1	4.1	4.1
17	4.1	4.1	4.1	4.2	4.3	4.2	13.7	1,012.6	4.4	4.1	4.1	4.1
18	4.1	4.1	4.1	4.2	4.3	4.2	489.4	312.3	4.4	4.1	4.1	4.1
19	4.1	4.1	4.1	4.2	4.3	4.2	4.4	164.5	4.3	4.1	4.1	4.1
20	4.1	4.1	4.4	4.2	4.3	4.3	1,100.4	148.1	4.3	4.1	4.1	4.1
21	4.1	337.8	4.2	4.2	4.3	4.3	160.4	272.0	4.3	4.1	4.1	4.1
22	4.1	4.4	4.2	4.2	4.3	4.2	966.6	396.8	4.2	4.1	4.1	4.1
23	4.1	4.2	4.2	4.2	4.3	4.3	490.5	376.9	4.2	4.1	4.1	4.2
24	4.1	4.2	4.1	4.2	4.3	4.3	1,026.6	158.7	4.2	4.1	4.1	4.2
25	4.1	4.2	4.2	4.1	4.3	36.2	52.1	128.2	4.2	4.1	4.1	4.2
26	4.1	4.2	4.2	4.2	4.3	216.3	18.6	445.7	4.2	4.3	4.1	4.2
27	4.2	4.2	4.2	4.2	4.3	4.4	28.1	169.9	4.2	4.3	4.1	4.3
28	4.2	4.1	4.2	4.2	4.3	4.3	657.3	127.2	4.2	4.2	4.1	129.2
29	4.1		4.2	4.3	4.3	4.3	186.5	101.2	4.2	4.2	4.1	4.4
30	4.1		4.2	4.3	4.3	83.2	899.1	94.0	4.2	4.2	4.1	4.2
31	4.1		4.3		4.2		268.2	87.5		4.1		4.2
Average	4.1	16.0	4.2	62.4	7.1	15.0	296.7	234.3	39.2	4.1	4.1	20.2
Maximum	4.2	337.8	4.4	796.9	83.9	216.3	1,100.4	1,012.6	262.3	4.3	4.1	372.2
Minimum	4.1	4.1	4.1	4.1	4.2	4.2	4.3	24.8	4.2	4.1	4.1	4.1

Average annual discharge = 60 (m^3/sec)

Annual inflow volume = 1,880 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1995

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.2	4.1	4.3	26.3	4.4	4.2	4.3	513.0	48.1	4.1	4.1	4.1
2	4.2	4.1	4.3	4.4	4.3	4.2	4.2	526.8	4.4	4.1	4.1	4.1
3	4.2	4.1	4.3	4.4	4.3	4.2	4.2	380.7	4.4	4.1	4.1	4.1
4	4.2	4.1	4.3	4.3	4.3	4.2	4.2	493.3	4.3	4.1	4.1	4.1
5	4.2	4.1	4.3	4.3	4.3	4.2	4.3	367.4	4.3	4.1	4.1	4.1
6	4.2	4.1	4.3	4.3	4.3	4.3	4.3	282.9	4.3	4.1	4.1	4.1
7	4.2	4.1	4.3	4.3	4.3	4.3	4.3	218.7	4.3	4.1	4.1	4.1
8	4.2	4.1	4.3	4.3	4.3	4.3	4.4	139.1	4.3	4.1	4.1	4.1
9	4.2	4.1	4.3	4.4	4.3	4.3	8.0	88.7	4.3	4.1	4.1	4.1
10	4.2	4.1	4.3	62.3	4.3	4.3	4.3	134.1	4.3	4.1	4.1	4.1
11	4.2	72.3	4.3	4.4	4.4	4.3	4.4	44.3	4.3	4.1	4.1	4.1
12	4.2	232.8	4.2	52.0	4.4	4.3	4.3	24.6	4.3	4.1	4.1	4.1
13	4.1	4.3	4.2	12.5	4.4	4.3	4.3	53.4	4.2	4.1	4.1	4.1
14	4.1	4.4	4.2	9.4	4.4	4.3	4.3	105.4	4.2	4.1	4.1	4.1
15	4.2	52.4	4.2	43.5	4.3	4.3	4.3	78.8	4.2	4.1	4.1	4.1
16	4.2	4.4	4.2	100.0	4.3	4.3	4.4	42.7	4.2	4.1	4.1	4.1
17	4.1	4.3	4.2	49.9	4.3	4.3	16.8	53.8	4.2	4.1	4.1	4.1
18	4.1	4.4	4.2	32.7	4.3	4.3	5.7	29.1	4.2	4.1	4.1	4.1
19	4.1	4.3	4.3	32.8	4.3	7.1	256.3	23.8	4.1	4.1	4.1	4.1
20	4.2	4.3	4.3	19.7	4.3	12.5	247.8	372.9	4.1	4.1	4.1	4.1
21	4.2	4.3	4.3	22.3	4.3	81.5	138.0	227.7	4.1	4.1	4.1	4.1
22	4.1	4.2	4.3	26.7	4.3	12.1	276.2	165.9	4.1	4.1	4.1	4.1
23	4.1	4.2	24.7	34.9	4.3	4.3	454.7	51.8	4.1	4.1	4.1	4.1
24	4.1	4.2	44.3	53.8	4.3	4.3	392.3	105.6	4.2	4.1	4.1	4.1
25	4.1	4.2	7.3	42.3	4.2	4.2	879.3	4.8	4.2	4.1	4.1	4.1
26	4.1	4.2	209.8	44.2	4.2	4.2	1,350.3	4.4	4.1	4.1	4.1	4.1
27	4.1	18.4	50.6	45.1	4.2	4.2	1,560.8	49.6	4.1	4.1	4.1	4.1
28	4.1	4.4	242.2	18.9	4.2	4.2	2,226.2	29.6	4.1	4.1	4.1	4.1
29	4.1		260.6	4.4	4.2	4.2	1,017.6	54.5	4.1	4.1	4.2	4.1
30	4.1		113.2	4.4	4.2	4.2	594.6	72.1	4.1	4.1	4.1	4.1
31	4.1		61.2		4.2		493.5	191.6		4.1		4.1
Average	4.2	17.1	35.7	25.9	4.3	7.5	322.0	159.1	5.7	4.1	4.1	4.1
Maximum	4.2	232.8	260.6	100.0	4.4	81.5	2,226.2	526.8	48.1	4.1	4.2	4.1
Minimum	4.1	4.1	4.2	4.3	4.2	4.2	4.2	4.4	4.1	4.1	4.1	4.1

Average annual discharge = 50 (m^3/sec)

Annual inflow volume = 1,582 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1996

Synthetic Mean Daily Discharges (with Project) (m³/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.4	128.5	19.3	4.3	168.6	34.6	4.3	4.2	4.1	4.1
2	4.1	4.1	4.3	77.1	4.4	4.3	44.0	4.4	4.4	4.2	4.1	4.1
3	4.1	4.1	4.3	37.7	4.3	4.3	4.4	94.1	4.4	81.9	4.1	4.1
4	4.1	4.2	4.2	4.4	4.3	4.3	146.2	66.6	4.3	110.7	4.1	4.1
5	4.1	4.1	4.2	9.5	4.3	4.3	89.0	85.2	4.3	4.3	4.1	4.1
6	4.1	4.1	4.3	25.2	4.3	4.3	46.8	200.0	4.4	4.1	4.1	4.1
7	4.1	4.1	4.4	62.2	4.3	4.3	4.4	68.8	4.4	4.1	4.1	4.1
8	4.1	4.1	4.4	154.2	4.3	4.3	4.3	59.6	4.3	4.1	4.1	4.1
9	4.1	4.3	4.3	9.2	4.3	4.3	4.3	48.0	4.3	4.2	4.1	4.1
10	4.1	4.3	4.3	4.4	4.3	4.3	4.3	53.8	4.3	4.2	4.1	4.1
11	4.1	4.2	4.3	4.4	4.3	4.3	4.4	65.1	4.2	4.2	4.1	4.1
12	4.1	4.2	107.5	4.4	4.3	4.3	4.4	253.9	4.2	4.1	4.1	4.1
13	4.1	4.2	88.3	4.4	4.3	34.1	4.4	728.9	4.2	4.1	4.1	4.1
14	4.2	4.3	86.3	4.4	4.2	4.4	43.7	763.6	4.3	4.1	4.1	4.1
15	391.7	372.4	233.1	4.4	4.3	33.5	4.4	445.2	4.2	4.1	4.1	4.1
16	128.2	39.7	410.1	4.4	4.3	122.9	4.3	333.4	4.2	4.1	4.1	4.1
17	4.3	4.4	722.3	17.9	4.3	52.2	4.3	258.1	4.2	4.1	4.1	4.1
18	4.2	4.3	1,008.2	15.7	4.2	4.4	4.3	175.8	4.2	4.0	4.1	4.1
19	4.2	4.3	588.6	15.6	4.2	115.0	4.3	127.7	4.2	4.0	4.1	4.1
20	4.1	4.4	331.0	4.4	4.2	428.5	44.2	38.4	4.1	4.1	4.1	4.1
21	4.1	4.4	258.8	4.4	4.4	893.0	51.1	4.4	4.1	4.1	4.1	4.1
22	4.1	24.8	174.0	4.4	65.8	266.6	4.3	28.5	4.3	4.1	4.1	4.1
23	4.1	53.5	108.8	4.4	78.3	152.8	4.4	793.4	4.2	4.1	4.1	4.0
24	4.1	485.5	71.8	4.3	31.3	137.7	4.4	463.8	4.2	4.1	4.1	4.0
25	4.1	248.5	24.2	4.4	227.5	67.4	4.3	301.2	4.2	4.1	4.1	4.0
26	4.1	130.8	52.8	4.4	118.4	37.2	4.3	147.6	4.2	4.1	4.1	4.0
27	4.1	116.8	106.7	4.4	53.5	54.0	4.2	78.6	4.2	4.1	4.1	4.0
28	4.1	60.1	202.6	4.4	33.2	36.9	4.4	32.2	4.2	4.1	4.1	4.0
29	4.1	24.3	575.9	4.4	14.0	100.9	68.9	4.4	4.2	4.1	4.1	4.0
30	4.1		300.8	7.4	4.4	231.2	4.4	21.9	4.2	4.1	4.1	4.0
31	4.1		174.5		4.3		63.7	4.4		4.1		4.0
Average	20.6	56.4	183.0	21.3	23.7	94.1	27.7	186.6	4.2	10.1	4.1	4.1
Maximum	391.7	485.5	1,008.2	154.2	227.5	893.0	168.6	793.4	4.4	110.7	4.1	4.1
Minimum	4.1	4.1	4.2	4.3	4.2	4.3	4.2	4.4	4.1	4.0	4.1	4.0

Average annual discharge = 53 (m³/sec)

Annual inflow volume = 1,683 (Mm³)

River: Poonch **Station:** EFlow Site 2 **Year:** 1997

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.1	146.7	4.2	4.2	4.3	4.4	155.4	4.2	4.2	4.2
2	4.0	4.0	4.2	263.7	4.2	4.2	4.2	37.5	148.6	4.3	4.2	4.2
3	4.0	4.1	4.2	195.9	4.2	4.2	4.2	4.4	113.1	4.3	4.2	4.2
4	4.0	4.1	4.2	361.1	4.2	4.2	4.3	4.3	19.6	4.3	4.2	4.2
5	4.0	4.1	4.1	103.2	4.2	4.2	4.3	4.2	29.1	4.3	4.2	4.2
6	4.0	4.1	4.1	14.1	4.2	4.2	4.3	4.3	89.9	4.3	4.2	4.2
7	4.0	4.1	4.1	4.3	4.4	4.3	4.3	4.3	138.8	4.2	4.1	4.2
8	4.0	4.1	4.1	4.3	4.4	4.3	4.4	4.3	372.5	4.3	4.1	4.2
9	4.0	4.1	4.1	4.3	4.4	4.4	133.5	4.3	137.9	4.2	4.2	48.1
10	4.0	4.1	4.1	4.3	4.3	4.3	14.8	4.4	67.3	4.2	4.3	4.3
11	4.0	4.1	4.1	4.3	4.2	4.2	4.4	32.2	11.9	4.3	4.2	4.3
12	4.0	4.1	4.1	4.3	4.2	4.2	4.3	416.8	4.4	4.2	4.2	4.2
13	4.0	4.1	4.1	4.3	4.2	4.2	4.3	155.7	15.8	4.2	4.2	4.2
14	4.0	4.0	4.1	4.3	4.2	4.2	4.3	108.8	4.4	4.2	4.2	4.2
15	4.0	4.0	4.1	40.6	4.2	4.2	4.3	43.6	4.4	4.2	4.2	4.2
16	4.0	4.0	4.2	4.3	4.2	4.2	4.4	27.8	4.3	4.2	4.2	4.2
17	4.0	4.0	4.2	4.3	4.2	4.2	4.3	4.4	4.3	4.2	4.2	4.2
18	4.0	4.0	4.2	4.3	4.2	4.3	4.4	4.4	4.3	4.2	4.2	4.2
19	4.0	4.0	104.3	4.2	4.2	4.2	245.5	4.3	4.3	4.2	4.1	4.2
20	4.1	4.0	4.3	4.2	4.2	4.2	4.4	32.1	4.3	4.3	4.1	4.2
21	4.1	4.0	4.2	4.2	4.2	4.3	4.4	4.4	4.3	4.4	4.1	4.2
22	4.1	4.0	4.2	4.2	4.2	4.2	43.7	187.7	4.3	4.3	4.1	4.1
23	4.1	4.0	4.2	4.2	4.2	4.3	4.4	74.0	4.3	4.2	4.1	4.1
24	4.0	4.0	4.1	4.2	4.2	4.3	4.4	28.1	4.2	4.2	4.1	4.1
25	4.0	4.1	4.1	4.2	4.2	4.3	4.4	50.7	4.2	4.2	4.2	4.1
26	4.0	4.1	4.1	4.2	4.2	4.2	160.6	238.3	4.2	4.2	4.3	4.1
27	4.0	4.1	4.1	4.2	4.2	4.4	543.9	5,508.3	4.2	4.3	4.4	4.1
28	4.1	4.1	4.3	4.2	4.2	4.4	69.6	1,362.4	4.2	4.2	4.3	4.1
29	4.1		327.9	4.2	4.2	41.8	141.9	565.8	4.3	4.2	4.2	4.1
30	4.1		102.4	4.2	4.2	4.4	92.2	330.8	4.2	4.2	4.2	4.1
31	4.1		80.9		4.2		52.6	245.6		4.2		4.1
Average	4.1	4.1	23.5	40.8	4.2	5.5	51.3	306.5	45.9	4.2	4.2	5.6
Maximum	4.1	4.1	327.9	361.1	4.4	41.8	543.9	5,508.3	372.5	4.4	4.4	48.1
Minimum	4.0	4.0	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.1

Average annual discharge = 42 (m^3/sec)

Annual inflow volume = 1,329 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1998

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	170.9	14.9	97.8	4.3	65.7	4.2	4.2	4.1	4.1	4.0
2	4.1	4.1	210.9	42.6	94.0	4.2	4.4	4.2	4.2	4.1	4.1	4.0
3	4.1	4.1	277.8	88.6	86.5	4.2	4.3	4.2	4.2	4.1	4.1	4.0
4	4.1	4.1	2,070.9	93.4	73.9	4.2	7.2	4.2	4.2	4.1	4.1	4.0
5	4.1	4.1	870.3	90.1	63.1	4.2	4.3	4.2	4.2	4.1	4.1	4.0
6	4.1	4.1	415.6	90.4	31.1	4.2	20.1	4.3	4.2	4.1	4.1	4.1
7	4.1	4.1	281.3	76.8	4.3	4.2	4.3	4.2	4.2	4.1	4.1	4.1
8	4.1	4.1	255.1	980.5	29.1	4.2	4.2	4.2	4.1	4.1	4.1	4.1
9	4.1	4.2	201.2	470.9	4.4	4.2	4.2	4.1	4.2	4.1	4.1	4.1
10	4.1	4.2	145.9	185.8	4.3	4.2	24.5	4.2	4.2	4.1	4.1	4.1
11	4.1	4.2	109.9	157.7	4.3	4.2	4.6	4.2	4.2	4.1	4.1	4.1
12	4.1	4.2	129.6	104.4	4.2	55.6	187.9	4.2	4.2	4.1	4.1	4.1
13	4.2	4.2	123.1	64.1	4.2	4.3	175.3	4.3	4.2	4.1	4.1	4.1
14	4.2	4.3	67.1	49.4	4.3	4.2	191.6	4.4	4.2	4.1	4.1	4.0
15	20.5	571.8	33.4	46.7	4.3	4.2	239.9	11.1	4.2	4.1	4.1	4.0
16	4.3	170.5	33.8	44.4	4.3	4.1	342.4	4.2	4.1	4.1	4.1	4.1
17	4.2	341.7	37.9	37.9	4.3	4.1	136.6	4.2	4.1	4.1	4.1	4.1
18	4.2	720.7	29.6	31.3	4.3	4.2	12.0	4.2	4.1	4.1	4.1	4.0
19	4.2	227.1	44.9	45.2	4.3	4.2	4.3	4.2	4.1	4.1	4.0	4.0
20	4.2	144.8	51.5	56.7	4.3	4.1	4.2	4.2	4.1	4.1	4.0	4.0
21	4.1	96.7	28.5	77.3	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
22	4.1	125.0	80.9	90.7	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
23	4.1	136.1	60.1	104.8	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
24	4.1	500.9	26.5	120.2	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
25	4.1	437.9	22.1	144.3	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
26	4.1	259.0	4.4	528.9	4.2	4.2	4.3	4.2	4.1	4.1	4.0	4.0
27	4.1	204.0	4.4	204.3	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
28	4.1	181.3	4.4	132.3	4.3	4.2	4.2	4.2	4.1	4.1	4.0	4.0
29	4.1		20.6	122.0	4.4	4.3	4.2	4.2	4.1	4.1	4.0	4.0
30	4.1		6.3	110.7	4.3	4.3	4.2	4.2	4.1	4.1	4.0	4.0
31	4.1		4.4		4.3		4.3	4.3		4.1		4.0
Average	4.7	149.1	187.8	146.9	18.7	5.9	48.0	4.4	4.2	4.1	4.1	4.0
Maximum	20.5	720.7	2,070.9	980.5	97.8	55.6	342.4	11.1	4.2	4.1	4.1	4.1
Minimum	4.1	4.1	4.4	14.9	4.2	4.1	4.2	4.1	4.1	4.1	4.0	4.0

Average annual discharge = 48 (m^3/sec)

Annual inflow volume = 1,506 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 1999

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.1	4.2	4.2	4.1	4.3	104.2	4.3	4.3	4.1	4.1
2	4.0	4.1	4.1	4.2	4.2	4.1	4.2	15.3	4.4	4.2	4.1	4.1
3	4.0	4.1	4.1	4.2	4.2	4.1	4.2	4.4	4.2	4.2	4.1	4.1
4	4.0	4.1	4.2	4.2	4.1	4.1	4.1	4.4	4.2	4.2	4.1	4.1
5	4.0	4.1	4.2	4.2	4.1	4.1	4.1	4.4	4.2	4.2	4.1	4.1
6	4.0	4.1	4.2	4.2	4.1	4.1	4.1	60.3	4.4	4.1	4.1	4.1
7	4.1	4.1	39.9	4.2	4.1	4.1	4.1	388.3	4.2	4.1	4.1	4.1
8	4.1	4.1	106.5	4.2	4.1	4.1	4.1	80.6	4.2	4.1	4.1	4.1
9	4.1	4.1	82.8	4.2	4.1	4.1	4.1	15.7	4.3	4.1	4.1	4.1
10	4.1	4.1	4.4	4.2	4.1	4.1	4.1	87.3	4.2	4.1	4.1	4.1
11	4.1	4.1	4.3	4.2	4.1	4.1	4.2	12.6	4.2	4.1	4.1	4.1
12	4.1	4.1	4.2	4.2	4.1	4.1	4.2	19.6	4.2	4.1	4.1	4.1
13	4.1	4.1	4.2	4.3	4.1	4.1	4.2	66.8	4.2	4.1	4.1	4.1
14	4.0	4.1	4.2	4.2	4.1	4.1	4.2	4.4	4.2	4.1	4.1	4.1
15	4.0	4.1	4.2	4.2	4.1	4.1	4.1	4.3	4.4	4.1	4.1	4.1
16	4.0	4.1	4.1	4.2	4.1	4.1	4.1	4.2	4.3	4.1	4.1	4.1
17	4.0	4.1	4.1	4.2	4.1	4.1	6.1	4.2	4.3	4.1	4.1	4.1
18	4.0	4.2	4.1	4.2	4.1	4.1	165.0	4.2	4.2	4.1	4.1	4.1
19	4.0	4.3	4.1	4.2	4.1	4.2	105.1	4.2	46.6	4.1	4.1	4.1
20	4.1	4.2	4.1	4.2	4.1	4.3	23.0	4.2	4.4	4.1	4.1	4.1
21	4.3	4.1	4.1	4.2	4.2	4.2	4.3	4.2	4.2	4.1	4.1	4.1
22	4.3	4.1	4.1	4.1	4.2	4.1	4.3	4.2	4.2	4.1	4.1	4.1
23	4.2	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.2	4.1	4.1	4.1
24	63.3	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.3	4.1	4.1	4.1
25	4.4	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.3	4.1	4.1	4.1
26	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.3	4.2	4.1	4.1	4.1
27	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.3	4.2	4.1	4.1	4.1
28	4.1	4.1	4.1	4.2	4.1	4.1	4.1	4.2	4.2	4.1	4.1	4.1
29	4.1		4.1	4.2	4.1	4.1	4.3	4.2	4.3	4.1	4.1	4.1
30	4.1		4.2	4.2	4.1	4.1	4.3	4.2	40.3	4.1	4.1	4.1
31	4.1		4.2		4.1		4.4	4.2		4.1		4.1
Average	6.0	4.1	11.1	4.2	4.1	4.1	13.3	30.3	6.9	4.1	4.1	4.1
Maximum	63.3	4.3	106.5	4.3	4.2	4.3	165.0	388.3	46.6	4.3	4.1	4.1
Minimum	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.2	4.1	4.1	4.1

Average annual discharge = 8 (m^3/sec)

Annual inflow volume = 256 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2000

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	18.1	4.1	4.2	4.1	4.1	4.3	1,531.7	4.3	4.1	4.1	4.1
2	4.0	4.3	4.1	4.2	4.2	4.1	4.4	673.1	4.3	4.1	4.1	4.1
3	4.0	4.2	4.1	4.2	4.2	4.1	4.4	255.8	4.2	4.1	4.1	4.1
4	4.0	4.2	4.1	4.2	4.2	4.1	4.3	146.6	4.3	4.1	4.1	4.1
5	4.0	4.2	4.2	4.2	4.1	4.1	4.1	85.6	4.2	4.1	4.1	4.1
6	4.0	4.2	4.1	4.2	4.1	4.1	4.1	68.8	4.2	4.1	4.1	4.1
7	4.0	4.1	4.1	4.2	4.1	4.1	4.1	66.0	4.3	4.1	4.1	4.1
8	4.0	4.1	4.1	4.1	4.1	4.1	4.3	40.6	4.2	4.1	4.1	4.1
9	4.0	4.1	4.1	4.1	4.2	4.2	4.4	170.8	4.3	4.1	4.1	4.1
10	4.0	4.3	4.2	4.2	4.2	4.1	4.2	125.7	4.2	4.1	4.1	4.1
11	4.0	4.3	4.1	4.2	4.2	4.2	4.2	83.4	4.2	4.1	4.1	4.1
12	4.4	4.2	4.1	4.2	4.2	4.1	4.2	51.7	4.2	4.1	4.1	4.1
13	45.0	4.2	4.1	4.2	4.3	4.1	4.2	13.0	4.1	4.1	4.1	4.1
14	4.4	4.1	4.1	4.2	4.2	4.1	4.3	24.9	4.1	4.1	4.1	4.1
15	4.2	4.1	4.1	4.2	4.2	4.2	4.3	35.1	4.1	4.1	4.1	4.1
16	4.1	4.1	4.1	4.2	4.2	4.1	4.2	43.9	4.1	4.1	4.1	4.1
17	4.1	4.1	4.1	4.2	4.2	4.1	4.3	4.4	4.1	4.1	4.1	4.1
18	4.1	4.1	4.1	4.2	4.2	4.2	4.2	4.4	4.1	4.1	4.1	4.1
19	4.1	4.1	4.1	4.2	4.2	4.2	4.1	4.3	4.1	4.1	4.1	4.1
20	4.1	4.1	4.1	4.2	4.2	4.3	4.3	4.3	11.2	4.1	4.1	4.1
21	4.1	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.3	4.1	4.1	4.1
22	4.1	4.1	4.1	4.2	4.2	4.1	423.9	4.3	4.3	4.1	4.1	4.1
23	4.1	4.1	4.1	4.1	4.2	4.2	536.0	4.3	4.2	4.1	4.1	4.1
24	4.1	4.1	4.1	4.1	4.1	4.1	169.1	4.3	4.2	4.1	4.1	4.1
25	4.1	4.1	4.1	4.2	4.1	4.1	69.7	4.2	4.2	4.1	4.1	4.1
26	4.1	4.1	4.2	4.2	4.1	4.2	68.0	4.2	4.4	4.1	4.1	4.0
27	4.1	4.1	4.2	4.2	4.1	4.3	4.4	4.2	4.2	4.1	4.1	4.1
28	4.1	4.1	4.2	4.1	4.1	15.2	4.4	4.2	4.2	4.1	4.1	4.1
29	4.1	4.1	4.3	4.1	4.1	4.2	4.4	4.4	4.2	4.1	4.1	4.0
30	4.1		4.2	4.1	4.1	122.8	4.3	4.4	4.1	4.1	4.1	4.0
31	4.1		4.2		4.1		446.5	4.3		4.1		4.0
Average	5.4	4.6	4.1	4.2	4.2	8.5	58.7	112.3	4.4	4.1	4.1	4.1
Maximum	45.0	18.1	4.3	4.2	4.3	122.8	536.0	1,531.7	11.2	4.1	4.1	4.1
Minimum	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.1	4.0

Average annual discharge = 18 (m^3/sec)

Annual inflow volume = 583 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2001

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.0	4.1	4.1	4.1	4.1	4.2	96.9	4.3	4.1	4.1	4.0
2	4.1	4.0	4.1	4.1	4.1	4.3	4.2	63.7	4.3	4.1	4.1	4.0
3	4.1	4.0	4.0	4.1	4.1	4.4	4.2	72.2	4.3	4.1	4.1	4.0
4	4.1	4.0	4.0	4.1	4.1	4.2	4.2	260.2	4.3	4.1	4.1	4.0
5	4.1	4.0	4.0	4.1	4.1	4.3	4.2	123.1	4.2	4.1	4.1	4.0
6	4.1	4.0	4.0	4.1	4.1	4.3	4.1	135.1	4.2	4.1	4.1	4.0
7	4.1	4.0	4.0	4.1	4.1	4.3	4.1	196.5	4.2	4.1	4.1	4.0
8	4.0	4.0	4.0	4.1	4.2	4.3	4.2	58.0	4.2	4.1	4.1	4.0
9	4.0	4.0	4.0	4.1	4.1	4.3	4.2	30.3	4.2	4.1	4.1	4.0
10	4.0	4.0	4.0	4.1	4.1	4.3	4.2	39.5	4.2	4.1	4.1	4.0
11	4.0	4.0	4.0	4.1	4.2	4.2	435.2	4.4	4.2	4.1	4.1	4.0
12	4.0	4.0	4.0	4.1	4.2	4.2	4.3	4.3	4.3	4.1	4.1	4.0
13	4.0	4.0	4.0	4.1	4.2	4.1	18.0	4.3	4.2	4.1	4.1	4.0
14	4.0	4.0	4.0	4.1	4.1	4.3	4.3	173.1	9.8	4.1	4.1	4.0
15	4.0	4.0	4.0	4.1	4.2	4.3	4.3	144.9	4.4	4.1	4.1	4.0
16	4.0	4.0	4.1	4.1	4.1	4.4	185.3	88.3	4.2	4.1	4.1	4.0
17	4.0	4.0	4.1	4.2	4.2	250.3	72.7	4.4	4.2	4.1	4.1	4.0
18	4.0	4.0	4.0	4.3	4.1	4.4	4.4	4.4	4.2	4.1	4.1	4.0
19	4.0	4.0	4.0	4.2	4.1	4.2	4.3	4.3	4.2	4.1	4.1	4.1
20	4.0	4.0	4.1	4.2	4.3	4.2	4.3	4.4	4.2	4.1	4.1	4.1
21	4.0	4.0	4.1	4.1	4.2	4.3	4.3	4.4	4.2	4.1	4.1	4.0
22	4.0	4.0	4.1	4.1	4.2	4.4	213.0	4.4	4.1	4.1	4.1	4.0
23	4.0	4.0	4.1	4.1	4.2	4.3	442.7	20.8	4.1	4.1	4.0	4.0
24	4.0	4.1	4.1	4.1	4.1	4.3	328.0	4.3	4.1	4.1	4.0	4.0
25	4.0	4.1	4.1	4.1	4.1	4.2	106.7	4.3	4.1	4.1	4.0	4.0
26	4.0	4.1	4.1	4.1	4.1	4.3	4.4	4.3	4.1	4.1	4.0	4.0
27	4.0	4.1	4.1	4.1	4.1	4.2	4.4	4.3	4.1	4.1	4.0	4.0
28	4.0	4.1	4.1	4.1	4.1	4.1	4.3	4.3	4.1	4.1	4.0	4.0
29	4.0		4.1	4.1	4.1	4.1	411.4	4.3	4.1	4.1	4.0	4.0
30	4.0		4.1	4.1	4.1	39.5	334.7	4.2	4.1	4.1	4.0	4.0
31	4.0		4.1		4.1		165.4	4.3		4.1		4.0
Average	4.0	4.0	4.1	4.1	4.1	13.6	90.3	50.8	4.4	4.1	4.1	4.0
Maximum	4.1	4.1	4.1	4.3	4.3	250.3	442.7	260.2	9.8	4.1	4.1	4.1
Minimum	4.0	4.0	4.0	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.0	4.0

Average annual discharge = 16 (m^3/sec)

Annual inflow volume = 510 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2002

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.4	4.1	4.1	4.0
2	4.0	4.1	4.1	4.2	4.1	4.1	4.1	4.2	48.8	4.1	4.1	4.0
3	4.0	4.1	4.1	4.2	4.1	4.2	4.1	4.2	4.4	4.1	4.1	4.0
4	4.0	4.1	4.1	4.2	4.1	4.1	4.1	4.2	119.6	4.1	4.1	4.0
5	4.0	4.1	4.1	4.2	4.2	4.1	4.1	4.3	24.4	4.1	4.1	4.0
6	4.0	4.1	4.1	4.2	4.2	4.1	4.1	39.5	4.3	4.1	4.1	4.0
7	4.0	4.1	4.1	4.3	4.2	4.1	4.1	4.4	4.3	4.1	4.1	4.0
8	4.0	4.1	4.1	4.2	4.2	4.1	4.1	4.3	4.3	4.1	4.1	4.0
9	4.0	4.1	4.1	4.2	4.2	4.1	4.1	4.2	4.3	4.1	4.1	4.0
10	4.0	4.1	20.6	4.2	4.2	4.2	4.1	4.2	4.2	4.1	4.1	4.0
11	4.0	4.1	4.3	4.2	4.2	4.2	4.1	4.2	4.2	4.1	4.1	4.0
12	4.0	4.1	4.2	4.2	4.2	4.2	4.1	381.1	4.2	4.1	4.1	4.0
13	4.0	4.1	4.2	4.2	4.2	4.2	4.1	675.3	4.2	4.1	4.1	4.0
14	4.0	4.1	4.2	4.2	4.2	4.4	4.1	325.9	4.3	4.1	4.1	4.0
15	4.1	4.1	4.2	4.2	4.2	4.3	4.1	211.6	4.3	4.1	4.1	4.0
16	4.3	4.1	4.2	4.2	4.2	4.3	4.1	41.7	4.3	4.1	4.1	4.0
17	4.2	4.1	4.2	4.2	4.2	4.4	4.1	4.4	4.4	4.1	4.1	4.0
18	4.1	4.1	4.2	4.2	4.2	4.3	4.2	4.3	4.3	4.1	4.1	4.0
19	4.1	4.1	4.2	4.2	4.2	4.3	4.2	4.3	4.3	4.1	4.1	4.0
20	4.1	4.1	4.2	4.2	4.2	4.2	4.3	4.3	4.2	4.1	4.0	4.0
21	4.1	4.1	4.2	4.2	4.2	4.2	75.2	4.2	4.2	4.1	4.0	4.1
22	4.1	4.2	4.2	4.2	4.2	4.2	4.3	4.3	4.2	4.1	4.0	4.1
23	4.1	343.5	4.2	4.2	4.2	4.2	4.4	4.3	4.1	4.1	4.0	4.0
24	4.1	6.0	4.2	4.2	4.1	47.1	4.2	4.4	4.2	4.1	4.1	4.0
25	4.1	4.3	25.0	4.2	4.1	4.4	4.2	41.3	4.1	4.1	4.0	4.0
26	4.1	4.2	4.3	4.2	4.1	4.2	4.2	22.0	4.1	4.1	4.0	4.0
27	4.1	4.1	4.3	4.1	4.1	4.2	4.2	16.1	4.1	4.1	4.0	4.0
28	4.1	4.1	4.2	4.1	4.1	4.2	4.2	4.3	4.1	4.1	4.0	4.0
29	4.1		4.2	4.1	4.2	4.3	4.2	4.3	4.1	4.1	4.0	4.0
30	4.1		4.2	4.1	4.2	4.2	4.2	90.1	4.1	4.1	4.0	4.0
31	4.1		4.2		4.1		4.2	4.4		4.1		4.0
Average	4.1	16.3	5.4	4.2	4.2	5.6	6.5	62.4	10.2	4.1	4.1	4.0
Maximum	4.3	343.5	25.0	4.3	4.2	47.1	75.2	675.3	119.6	4.1	4.1	4.1
Minimum	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.0	4.0

Average annual discharge = 11 (m^3/sec)

Annual inflow volume = 345 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2003

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	257.9	4.4	102.0	4.1	4.2	4.4	4.2	4.2	4.1	4.0
2	4.0	4.1	965.5	4.4	4.3	4.1	4.1	90.8	4.2	4.1	4.1	4.0
3	4.0	4.1	393.7	4.3	4.2	4.1	4.1	13.3	4.2	4.1	4.1	4.0
4	4.0	4.0	225.7	4.4	4.2	4.1	4.2	4.3	4.4	4.1	4.1	4.0
5	4.0	4.0	140.5	4.3	4.2	4.1	4.3	4.2	4.3	4.1	4.1	4.1
6	4.0	4.0	109.6	4.3	4.1	4.1	4.3	4.2	4.2	4.1	4.1	4.0
7	4.0	4.0	89.3	4.3	4.1	4.2	4.4	4.1	4.2	4.1	4.1	4.1
8	4.0	4.0	53.7	4.3	4.1	4.2	4.2	4.2	4.2	4.1	4.1	4.0
9	4.0	4.0	29.4	4.4	4.1	4.2	4.4	4.1	4.3	4.1	4.1	4.0
10	4.0	4.0	8.2	4.4	4.1	4.2	4.2	4.1	4.2	4.1	4.0	4.1
11	4.0	4.0	4.4	4.4	4.1	4.2	4.3	4.1	4.2	4.1	4.1	4.1
12	4.0	4.0	4.4	4.4	4.1	4.2	4.2	4.1	4.2	4.1	4.0	4.1
13	4.0	4.0	4.4	4.4	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.1
14	4.0	4.0	4.4	4.4	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.1
15	4.0	4.0	4.4	4.4	4.1	4.2	4.2	4.1	4.2	4.1	4.1	4.2
16	4.0	4.1	7.6	84.0	4.1	4.2	4.4	4.1	4.2	4.1	4.1	4.1
17	4.0	154.6	4.4	30.9	4.1	4.2	4.2	4.1	4.1	4.1	4.1	4.1
18	4.0	3,304.6	4.4	6.4	4.1	4.1	4.2	4.3	4.1	4.1	4.1	4.1
19	4.0	1,431.5	4.4	11.1	4.1	4.2	4.2	10.6	4.1	4.1	4.1	4.1
20	4.0	220.7	4.4	33.3	4.1	4.2	4.2	39.4	4.1	4.1	4.1	4.1
21	4.0	86.7	4.5	4.4	4.1	4.3	4.3	4.4	4.1	4.1	4.1	4.1
22	4.0	46.2	22.2	4.3	4.1	4.2	4.3	4.3	4.1	4.1	4.1	4.1
23	4.0	62.3	4.4	4.4	4.1	4.2	4.3	4.2	4.1	4.1	4.0	4.1
24	4.0	45.0	4.4	4.4	4.1	4.2	48.2	4.2	4.4	4.1	4.1	4.1
25	4.0	20.2	17.0	4.4	4.1	4.2	4.3	4.2	173.7	4.1	4.0	4.1
26	4.0	15.9	4.4	4.4	4.1	4.2	4.3	4.2	80.0	4.1	4.0	4.1
27	4.0	13.6	8.5	4.4	4.1	4.2	4.3	4.2	4.3	4.1	4.0	4.1
28	4.0	150.9	8.3	4.3	4.1	4.2	4.3	4.2	4.3	4.1	4.0	4.1
29	4.0		87.7	4.3	4.1	4.2	4.3	4.2	4.2	4.1	4.0	4.1
30	4.0		39.3	4.3	4.1	4.1	4.3	4.3	4.2	4.1	4.0	4.1
31	4.1		4.4		4.1		4.2	4.2		4.1		4.1
Average	4.0	200.6	81.5	9.2	7.3	4.2	5.7	8.6	12.4	4.1	4.1	4.1
Maximum	4.1	3,304.6	965.5	84.0	102.0	4.3	48.2	90.8	173.7	4.2	4.1	4.2
Minimum	4.0	4.0	4.4	4.3	4.1	4.1	4.1	4.1	4.1	4.1	4.0	4.0

Average annual discharge = 28 (m^3/sec)

Annual inflow volume = 871 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2004

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.3	4.2	4.1	141.8	4.1	4.1	4.4	4.1	4.1	4.1	4.2
2	4.1	4.2	4.1	4.1	4.4	4.1	4.2	4.2	4.2	4.1	4.1	4.1
3	4.1	4.2	4.1	4.1	4.3	4.1	4.1	5.2	4.1	4.1	4.1	4.1
4	4.1	4.2	4.1	4.1	4.2	4.1	4.2	4.3	4.1	4.1	4.1	4.1
5	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.1
6	4.1	4.1	4.1	4.1	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.1
7	4.1	4.1	4.1	4.1	4.2	4.2	4.1	108.9	4.1	4.1	4.1	4.1
8	4.1	4.1	4.1	4.1	4.2	4.1	4.2	38.2	4.1	4.1	4.1	4.1
9	4.1	4.2	4.1	4.1	4.2	4.2	9.3	4.3	4.1	4.1	4.1	4.1
10	4.1	4.2	4.2	4.1	4.2	4.1	4.2	4.2	4.1	4.1	4.1	4.1
11	4.1	4.2	4.1	4.1	4.2	4.1	4.2	4.3	4.1	4.3	4.1	4.1
12	4.1	4.2	4.1	4.1	4.2	4.1	4.3	4.2	4.1	4.2	4.1	4.1
13	4.1	4.2	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.2	4.1	4.1
14	4.1	4.2	4.1	4.1	4.2	4.1	4.3	4.1	4.1	4.2	4.1	4.1
15	4.1	4.2	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.1	4.1	4.1
16	4.1	4.2	4.1	4.1	4.2	4.1	4.2	4.2	4.3	4.1	4.1	4.1
17	4.1	4.2	4.1	4.1	4.2	4.1	4.1	27.2	4.2	4.1	4.1	4.1
18	4.2	4.3	4.1	4.1	4.2	4.2	4.2	4.3	4.1	4.1	4.1	4.1
19	4.1	4.2	4.1	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.1	4.1
20	4.1	4.2	4.1	4.1	4.2	4.2	4.1	4.2	4.1	4.1	4.1	4.2
21	4.1	4.2	4.1	4.1	4.2	4.2	4.1	4.2	4.2	4.1	4.1	4.1
22	4.4	4.2	4.1	4.1	4.2	4.2	4.1	4.2	4.1	4.1	4.1	4.1
23	44.3	4.2	4.1	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.1	4.1
24	4.3	4.2	4.1	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.1	4.1
25	4.2	4.2	4.1	4.1	4.1	4.3	4.1	4.2	4.1	4.1	4.1	4.1
26	4.2	4.2	4.1	4.1	4.1	4.2	4.1	4.2	4.1	4.1	4.1	4.1
27	4.2	4.2	4.1	4.1	4.1	4.2	4.1	4.1	4.1	4.1	4.1	4.1
28	4.2	4.2	4.1	4.2	4.1	4.1	4.1	4.2	4.1	4.1	4.1	4.1
29	4.2	4.2	4.1	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.1	4.1
30	4.2		4.1	144.1	4.1	4.1	4.3	4.1	4.1	4.1	4.4	4.1
31	4.4		4.1		4.1		4.3	4.1		4.1		4.1
Average	5.4	4.2	4.1	8.8	8.6	4.2	4.3	9.5	4.1	4.1	4.1	4.1
Maximum	44.3	4.3	4.2	144.1	141.8	4.3	9.3	108.9	4.3	4.3	4.4	4.2
Minimum	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1

Average annual discharge = 5 (m^3/sec)

Annual inflow volume = 173 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2005

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	152.3	4.1	4.4	4.4	4.4	4.2	34.4	4.2	4.1	4.1	4.1	4.1
2	4.3	4.1	4.4	12.9	4.3	4.2	39.4	4.2	4.1	4.1	4.1	4.1
3	4.2	4.1	4.4	17.6	4.4	4.2	4.4	4.2	4.1	4.1	4.1	4.1
4	4.2	4.1	12.1	22.5	4.4	4.2	4.3	4.2	4.1	4.1	4.1	4.1
5	4.2	4.2	32.0	31.5	4.4	4.2	4.4	4.3	4.1	4.1	4.1	4.1
6	4.1	4.2	35.1	22.9	4.4	4.2	4.4	4.2	4.1	4.1	4.1	4.1
7	4.1	4.4	28.6	28.2	4.4	4.2	4.3	4.2	4.3	4.1	4.1	4.1
8	4.1	4.3	15.7	32.0	4.4	4.2	4.3	4.2	4.2	4.1	4.1	4.1
9	4.1	414.1	24.0	19.4	4.4	4.2	4.4	4.2	4.2	4.1	4.1	4.1
10	4.1	182.1	9.6	4.4	4.3	4.2	4.4	4.2	4.2	4.1	4.1	4.1
11	4.1	451.3	16.3	4.3	4.3	4.2	106.3	4.2	4.1	4.1	4.1	4.1
12	4.1	503.2	11.7	4.3	4.3	4.2	223.6	4.2	4.2	4.2	4.1	4.1
13	4.1	208.5	22.3	4.3	4.3	4.2	207.0	4.3	4.1	4.1	4.1	4.1
14	4.1	128.6	15.9	4.4	4.3	4.2	100.9	4.2	4.1	4.1	4.1	4.1
15	4.1	107.9	36.5	4.4	4.2	4.2	83.9	4.2	4.1	4.1	4.1	4.1
16	4.1	109.8	74.0	4.4	4.2	4.2	136.2	4.3	4.1	4.1	4.1	4.1
17	4.1	55.1	111.6	4.4	4.2	4.2	21.8	4.3	4.2	4.2	4.1	4.1
18	4.1	74.1	158.9	4.4	4.2	4.2	4.4	4.2	108.5	4.1	4.1	4.1
19	4.1	173.8	412.1	4.4	4.2	4.2	4.4	4.2	4.3	4.1	4.1	4.1
20	4.1	65.7	289.0	4.4	4.2	4.3	4.4	4.2	4.2	4.1	4.1	4.1
21	4.1	19.4	239.3	4.4	4.2	4.3	6.3	4.2	4.2	4.1	4.1	4.1
22	4.1	21.7	363.3	4.4	4.2	4.3	4.4	4.2	4.1	4.1	4.1	4.1
23	4.2	25.2	226.5	30.0	4.2	4.3	4.3	4.1	4.2	4.1	4.1	4.1
24	4.1	15.7	184.1	9.2	4.2	4.4	4.3	4.1	4.1	4.1	4.1	4.1
25	4.1	4.4	118.6	13.7	4.2	4.4	4.3	4.2	4.1	4.1	4.1	4.1
26	4.1	4.4	90.6	40.9	4.2	4.4	4.3	4.1	4.1	4.1	4.1	4.1
27	4.1	4.4	100.9	10.0	4.2	4.4	4.4	4.2	4.1	4.1	4.1	4.1
28	4.1	4.4	93.5	4.4	4.2	4.4	4.3	4.2	4.1	4.1	4.1	4.1
29	4.1		56.2	4.4	4.2	4.4	4.2	4.1	4.1	4.1	4.1	4.1
30	4.1		27.2	4.3	4.2	4.4	4.3	4.1	4.1	4.1	4.1	4.1
31	4.1		12.3		4.2		4.2	4.1		4.1		4.1
Average	8.9	93.1	91.3	12.2	4.3	4.2	33.9	4.2	7.6	4.1	4.1	4.1
Maximum	152.3	503.2	412.1	40.9	4.4	4.4	223.6	4.3	108.5	4.2	4.1	4.1
Minimum	4.1	4.1	4.4	4.3	4.2	4.2	4.2	4.1	4.1	4.1	4.1	4.1

Average annual discharge = 22 (m^3/sec)

Annual inflow volume = 702 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2006

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.3	4.3	4.2	4.1	4.2	55.7	77.7	4.1	4.1	4.1
2	4.1	4.1	4.3	4.3	4.2	4.1	4.1	29.7	182.4	4.1	4.1	4.1
3	4.2	4.1	4.2	4.3	4.2	4.1	4.2	76.0	285.3	4.1	4.1	4.1
4	4.1	4.1	4.2	4.2	4.2	4.2	4.1	925.4	213.4	4.1	4.1	4.2
5	4.1	4.1	4.2	4.3	4.3	4.2	4.2	769.0	92.4	4.1	4.1	1,203.0
6	4.1	4.1	4.1	4.3	4.3	4.2	4.2	505.6	32.9	4.1	4.1	420.5
7	4.1	4.1	4.1	4.3	4.3	4.1	4.3	319.1	4.4	4.1	4.1	105.2
8	4.1	4.1	4.1	4.3	4.3	4.1	4.3	492.7	4.4	4.1	4.1	43.4
9	4.1	4.1	4.1	4.3	4.3	4.1	4.3	286.6	4.4	4.1	4.1	18.9
10	4.1	4.1	4.1	44.5	4.3	4.1	4.4	207.7	4.3	4.1	4.1	18.2
11	4.1	4.1	4.1	4.3	4.3	4.1	4.4	101.6	4.3	4.1	4.1	17.8
12	4.1	4.1	4.1	4.2	4.3	4.1	84.1	56.0	4.4	4.1	4.1	4.4
13	4.1	4.1	4.2	4.2	4.3	4.1	270.7	53.9	4.3	4.1	4.3	4.4
14	4.1	4.1	4.3	4.2	4.3	4.1	44.6	74.1	4.3	4.1	4.2	4.4
15	4.1	4.4	4.3	4.2	4.2	4.1	4.4	104.5	4.3	4.1	4.1	4.3
16	4.3	4.3	4.3	4.2	4.3	4.3	4.3	60.4	4.3	4.1	4.2	4.3
17	61.8	4.2	4.2	4.2	4.4	4.4	4.2	49.1	4.2	4.1	4.2	4.3
18	4.4	4.2	4.2	4.2	4.3	4.2	4.2	25.9	4.2	4.1	6.1	4.3
19	4.2	4.2	4.2	4.2	4.2	4.2	4.1	4.4	4.2	4.1	4.4	4.3
20	4.1	4.1	4.3	4.2	4.2	4.2	4.2	147.8	4.3	4.2	4.3	4.3
21	4.1	4.1	14.7	4.2	4.3	4.1	4.2	70.1	4.2	4.1	4.2	4.3
22	4.1	4.1	4.3	4.2	4.2	4.1	4.3	29.0	4.2	4.1	4.2	4.3
23	4.1	4.1	4.3	4.2	4.3	4.1	122.6	50.4	4.2	4.1	4.2	4.2
24	4.1	4.1	4.3	4.2	4.3	4.1	299.1	8.9	4.2	4.1	4.2	4.2
25	4.1	4.2	4.3	4.2	4.3	4.2	43.8	13.9	4.2	4.1	4.1	4.2
26	4.1	155.1	4.3	4.2	4.2	4.2	112.8	6.3	4.2	4.1	4.1	4.2
27	4.1	61.1	4.3	4.3	4.2	4.3	314.2	41.7	4.2	4.1	4.1	4.2
28	4.1	4.4	4.3	4.3	4.2	4.4	417.6	77.2	4.2	4.1	4.1	4.2
29	4.1		4.2	4.2	4.2	4.3	195.9	29.9	4.2	4.1	4.1	4.2
30	4.1		4.2	4.3	4.2	4.4	124.3	46.2	4.1	4.1	4.1	4.2
31	4.1		4.2		4.2		51.5	14.3		4.1		4.2
Average	6.0	11.6	4.6	5.6	4.3	4.2	69.7	152.7	32.9	4.1	4.2	62.2
Maximum	61.8	155.1	14.7	44.5	4.4	4.4	417.6	925.4	285.3	4.2	6.1	1,203.0
Minimum	4.1	4.1	4.1	4.2	4.2	4.1	4.1	4.4	4.1	4.1	4.1	4.1

Average annual discharge = 31 (m^3/sec)

Annual inflow volume = 962 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2007

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	11.6	217.3	4.4	4.2	28.3	4.3	4.2	4.1	4.0	4.0
2	4.1	4.1	4.4	172.7	4.3	4.2	100.6	4.2	4.2	4.1	4.1	4.0
3	4.1	4.1	4.3	138.4	4.3	4.3	11.3	4.2	4.2	4.1	4.1	4.0
4	4.1	4.1	4.3	97.0	4.4	4.3	4.4	4.2	4.1	4.1	4.1	4.0
5	4.1	4.1	4.4	74.9	4.4	4.3	4.3	4.2	4.2	4.1	4.1	4.0
6	4.1	4.1	4.3	62.5	4.3	4.3	4.3	4.3	4.2	4.1	4.1	4.0
7	4.1	4.1	4.3	55.5	4.3	4.3	4.3	4.2	4.2	4.1	4.1	4.0
8	4.1	4.1	4.3	41.5	4.4	4.3	209.6	4.2	4.2	4.1	4.1	4.0
9	4.1	4.1	4.3	39.2	4.4	4.3	21.6	4.2	4.2	4.1	4.1	4.0
10	4.1	4.1	4.3	32.3	4.4	4.3	4.3	4.2	4.2	4.1	4.1	4.0
11	4.1	4.3	4.3	28.5	4.3	4.3	4.3	4.1	4.2	4.1	4.0	4.0
12	4.1	4.4	299.7	27.9	4.3	4.3	4.4	4.1	4.2	4.1	4.0	4.0
13	4.1	4.3	434.3	27.3	4.3	4.4	4.3	4.2	4.1	4.1	4.0	4.0
14	4.1	4.2	190.7	25.7	4.3	9.7	4.2	282.4	4.1	4.1	4.0	4.0
15	4.1	4.2	107.5	31.1	4.4	9.6	4.4	93.5	4.1	4.1	4.0	4.0
16	4.1	4.2	77.3	30.1	4.4	4.4	4.3	4.4	4.2	4.1	4.0	4.0
17	4.1	4.2	59.4	29.4	4.4	4.4	4.2	4.3	4.2	4.1	4.0	4.0
18	4.1	4.2	59.8	50.2	4.4	4.4	4.2	4.3	4.2	4.1	4.0	4.0
19	4.1	4.1	80.6	33.9	63.2	4.3	4.2	4.2	4.1	4.1	4.0	4.0
20	4.1	4.1	2,116.0	34.7	40.6	4.3	4.4	4.3	4.2	4.1	4.0	4.0
21	4.1	4.1	1,085.8	24.5	4.4	4.3	37.7	4.2	4.3	4.1	4.0	4.0
22	4.1	4.2	469.8	9.7	4.4	4.3	15.0	4.3	4.2	4.1	4.0	4.0
23	4.1	4.2	271.0	7.3	4.3	4.3	4.4	4.3	4.2	4.1	4.0	4.0
24	4.1	4.1	220.5	12.6	4.3	4.3	36.3	22.7	4.2	4.1	4.0	4.0
25	4.1	4.1	197.7	4.4	4.3	4.3	4.3	4.3	4.1	4.1	4.0	4.0
26	4.1	4.1	185.7	4.4	4.3	4.4	4.3	4.3	4.1	4.1	4.0	4.0
27	4.1	4.4	182.5	4.4	4.3	4.3	4.3	4.2	4.1	4.1	4.0	4.0
28	4.1	105.3	184.5	4.4	4.3	21.7	4.2	4.2	4.1	4.1	4.0	4.0
29	4.1		196.1	4.4	4.3	116.9	7.5	4.2	4.1	4.1	4.0	4.0
30	4.1		206.9	4.4	4.2	31.4	4.3	4.2	4.1	4.1	4.0	4.0
31	4.1		210.1		4.2		4.3	4.2		4.1		4.0
Average	4.1	7.8	222.3	44.4	7.4	9.9	18.1	16.7	4.2	4.1	4.0	4.0
Maximum	4.1	105.3	2,116.0	217.3	63.2	116.9	209.6	282.4	4.3	4.1	4.1	4.0
Minimum	4.1	4.1	4.3	4.4	4.2	4.2	4.2	4.1	4.1	4.1	4.0	4.0

Average annual discharge = 29 (m^3/sec)

Annual inflow volume = 922 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2008

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.1	4.3	4.2	4.2	4.2	4.4	90.3	4.3	4.1	4.1	4.1
2	4.0	4.1	4.3	4.2	4.2	4.3	4.3	102.9	4.3	4.1	4.1	4.1
3	4.0	4.1	4.3	4.2	4.2	4.2	4.3	715.2	4.3	4.1	4.1	4.1
4	4.0	4.1	4.2	4.3	4.2	4.2	4.3	352.9	4.4	4.1	4.1	4.1
5	4.0	4.2	4.2	4.4	4.2	4.2	4.3	308.8	4.3	4.1	4.1	4.1
6	4.0	4.1	4.2	204.8	4.2	4.3	114.3	206.0	4.3	4.1	4.1	4.1
7	4.0	4.1	4.3	4.3	4.2	4.4	57.7	136.4	4.4	4.1	4.1	4.1
8	4.1	4.2	4.2	4.3	4.2	4.4	4.4	132.1	4.3	4.1	4.1	4.1
9	4.3	4.1	4.2	4.3	4.2	4.4	4.3	181.4	4.3	4.1	4.1	59.7
10	4.4	4.1	4.2	4.3	4.2	4.3	4.3	96.0	4.3	4.1	4.1	4.2
11	4.2	4.1	4.2	18.1	4.2	4.4	4.4	136.9	4.3	4.1	4.1	4.2
12	4.1	4.1	4.2	42.7	4.2	68.0	5.0	133.1	4.3	4.1	4.1	4.1
13	4.1	4.1	4.2	4.4	4.2	4.4	4.4	100.7	4.3	4.1	4.1	4.1
14	4.1	4.1	4.2	4.3	4.2	62.9	16.0	94.2	4.2	4.1	4.1	4.1
15	4.1	4.1	4.2	4.3	4.2	442.7	4.4	106.1	4.2	4.2	4.1	4.1
16	4.1	4.1	4.2	86.2	4.2	192.8	4.3	102.9	4.2	4.2	4.1	4.1
17	17.3	4.1	4.2	4.4	4.3	49.9	4.3	56.4	4.2	4.2	4.1	4.1
18	413.4	4.1	4.2	4.3	4.2	7.3	4.4	13.5	4.2	4.1	4.1	4.1
19	4.3	4.1	4.2	4.3	4.2	46.6	4.3	5.6	4.2	4.1	4.1	4.1
20	4.2	4.2	4.2	4.3	4.3	27.5	63.7	15.1	4.2	4.1	4.1	151.4
21	4.2	4.2	4.2	4.3	4.2	4.4	38.9	7.8	4.2	4.1	4.1	150.4
22	4.1	4.2	4.2	4.3	4.3	36.0	48.7	42.8	4.2	4.1	4.1	4.4
23	4.1	4.3	4.1	4.3	4.4	4.4	4.4	4.4	4.2	4.1	4.1	4.3
24	4.1	4.3	4.1	4.2	4.3	4.4	4.3	4.4	4.2	4.1	4.1	4.2
25	4.1	4.2	4.1	4.2	4.4	4.3	4.3	4.3	4.1	4.1	4.1	4.2
26	4.1	4.2	4.1	4.2	4.3	4.3	32.8	4.3	4.1	4.1	4.1	4.2
27	4.1	4.2	4.1	4.2	4.2	4.4	4.4	4.3	4.1	4.1	4.1	4.2
28	4.1	4.2	4.1	4.2	4.2	63.5	4.4	4.3	4.1	4.1	4.1	4.1
29	4.1	4.3	4.1	4.2	4.2	17.9	4.4	4.3	4.1	4.1	4.1	4.1
30	4.1		4.1	4.2	4.2	13.1	221.3	4.3	4.1	4.1	4.1	4.1
31	4.1		4.2		4.2		31.1	4.3		4.1		4.1
Average	17.7	4.2	4.2	15.4	4.2	36.9	23.3	102.5	4.2	4.1	4.1	15.4
Maximum	413.4	4.3	4.3	204.8	4.4	442.7	221.3	715.2	4.4	4.2	4.1	151.4
Minimum	4.0	4.1	4.1	4.2	4.2	4.2	4.3	4.3	4.1	4.1	4.1	4.1

Average annual discharge = 20 (m^3/sec)

Annual inflow volume = 627 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2009

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.1	4.2	4.2	4.3	4.2	4.2	4.2	4.4	4.1	4.1	4.0
2	4.1	4.1	4.2	4.2	4.3	4.2	4.2	4.2	4.4	4.1	4.1	4.1
3	4.1	4.1	4.2	4.4	4.3	4.2	4.2	4.3	20.8	4.1	4.1	4.0
4	4.1	4.1	4.4	4.4	4.3	4.2	4.2	4.2	19.7	4.2	4.1	4.1
5	4.1	4.2	4.3	4.3	4.3	4.2	4.2	4.2	4.3	4.1	4.1	4.1
6	4.1	4.3	4.3	4.4	4.3	4.2	4.2	4.3	4.2	4.1	4.1	4.1
7	4.1	4.3	4.3	150.6	4.2	4.1	4.1	4.4	4.2	4.1	4.1	4.1
8	4.1	4.2	4.2	92.4	4.2	4.1	4.1	4.3	4.2	4.1	4.1	4.0
9	4.1	4.2	4.2	113.4	4.2	4.1	4.1	4.2	4.2	4.1	4.1	4.0
10	4.1	4.2	4.2	28.4	4.2	4.1	4.2	4.3	4.2	4.1	4.2	4.1
11	4.1	4.3	4.2	4.4	4.2	4.1	4.2	4.2	4.2	4.1	4.1	4.1
12	4.1	4.3	4.2	4.4	4.2	4.1	4.2	4.2	4.2	4.1	4.1	4.1
13	4.1	4.3	4.2	4.3	4.2	4.1	4.4	4.3	4.2	4.1	4.1	4.1
14	4.1	223.1	4.2	4.3	4.2	4.1	4.3	4.3	4.2	4.1	4.1	4.1
15	4.1	22.9	4.2	4.3	4.2	4.1	4.2	150.8	4.2	4.1	4.1	4.0
16	4.1	4.4	4.2	4.3	4.2	4.3	4.2	134.0	4.2	4.1	4.1	4.0
17	4.1	4.3	4.2	4.3	4.2	4.3	4.2	71.2	4.2	4.1	4.1	4.0
18	4.2	4.3	4.2	4.3	4.3	4.2	4.4	4.4	4.1	4.1	4.1	4.0
19	4.3	4.3	4.2	4.3	4.3	4.1	4.2	4.3	4.1	4.1	4.1	4.0
20	4.2	4.3	4.2	4.3	4.3	4.1	4.2	4.3	4.1	4.1	4.1	4.0
21	4.2	4.3	4.2	4.3	4.3	4.1	4.3	4.2	4.1	4.1	4.1	4.0
22	4.1	4.3	4.2	4.3	4.2	4.1	23.0	4.3	4.1	4.1	4.1	4.0
23	4.1	4.3	4.2	4.3	4.2	4.1	5.1	4.2	4.1	4.1	4.1	4.0
24	4.1	4.4	4.2	4.2	4.2	4.1	4.4	4.2	4.1	4.1	4.1	4.0
25	4.1	4.3	4.2	4.2	4.2	4.1	4.3	4.2	4.1	4.1	4.1	4.0
26	4.2	4.3	4.3	4.2	4.2	4.1	4.2	4.4	4.1	4.1	4.1	4.0
27	4.3	4.3	4.2	4.2	4.2	4.1	4.3	4.3	4.1	4.1	4.1	4.0
28	4.2	4.2	4.2	4.2	4.2	4.2	56.0	4.2	4.1	4.1	4.1	4.0
29	4.2		4.2	4.3	4.2	4.2	62.3	4.2	4.1	4.1	4.1	4.0
30	4.1		4.3	4.2	4.2	4.2	22.5	4.2	4.1	4.1	4.1	4.0
31	4.1		4.2		4.2		4.3	4.3		4.1		4.0
Average	4.1	12.7	4.2	16.5	4.2	4.2	9.0	15.3	5.2	4.1	4.1	4.0
Maximum	4.3	223.1	4.4	150.6	4.3	4.3	62.3	150.8	20.8	4.2	4.2	4.1
Minimum	4.1	4.1	4.2	4.2	4.2	4.1	4.1	4.2	4.1	4.1	4.1	4.0

Average annual discharge = 7 (m^3/sec)

Annual inflow volume = 229 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2010

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.0	4.0	75.8	4.2	4.2	4.3	4.2	298.6	64.8	4.2	4.1	4.1
2	4.0	4.0	15.4	4.2	4.2	4.2	4.2	537.7	4.4	4.2	4.1	4.1
3	4.0	4.0	4.4	4.2	4.2	4.2	4.2	376.0	4.4	4.1	4.1	4.1
4	4.0	4.0	4.3	4.2	4.2	4.3	4.2	207.1	4.3	4.1	4.1	4.1
5	4.0	4.0	4.4	4.2	4.3	4.3	4.2	337.3	4.3	4.1	4.1	4.1
6	4.0	4.0	4.3	4.2	4.4	4.2	4.2	487.3	4.3	4.1	4.1	4.0
7	4.0	4.2	4.3	4.2	4.3	4.2	4.2	319.5	4.3	4.1	4.1	4.0
8	4.0	410.2	4.3	4.2	4.3	4.2	4.2	174.6	4.3	4.1	4.1	4.0
9	4.0	980.5	4.3	4.2	4.3	4.2	4.2	132.5	4.3	4.1	4.1	4.0
10	4.0	150.9	4.3	4.2	4.2	4.2	4.2	84.4	4.3	4.1	4.1	4.1
11	4.0	33.6	4.3	4.2	4.2	4.2	4.3	108.5	4.3	4.1	4.1	4.1
12	4.0	4.4	4.3	4.2	4.2	4.2	4.3	152.3	4.3	4.1	4.1	4.1
13	4.0	4.3	4.3	4.2	4.2	4.2	4.2	161.1	4.3	4.1	4.1	4.1
14	4.0	4.3	4.3	4.2	4.2	4.2	4.2	142.1	4.3	4.1	4.1	4.1
15	4.0	4.2	4.3	4.2	4.2	4.2	4.2	306.4	4.3	4.1	4.1	4.1
16	4.0	4.2	4.3	4.2	4.2	4.2	4.2	220.7	4.3	4.1	4.1	4.1
17	4.0	4.2	4.3	4.2	4.2	4.2	4.2	131.5	4.2	4.1	4.1	4.1
18	4.0	4.2	4.3	4.2	4.2	4.2	4.3	124.3	4.2	4.1	4.1	4.1
19	4.0	4.2	4.3	4.3	4.3	4.2	4.3	108.9	4.2	4.1	4.1	4.0
20	4.0	4.2	4.3	4.3	4.2	4.2	80.3	163.8	4.2	4.1	4.1	4.0
21	4.0	4.2	4.3	4.3	4.2	4.2	99.6	102.8	4.2	4.1	4.1	4.0
22	4.0	4.2	4.3	4.2	4.3	4.2	131.9	66.5	4.2	4.4	4.1	4.0
23	4.0	4.2	4.3	4.2	4.2	4.2	58.7	61.3	4.3	4.2	4.1	4.0
24	4.0	4.2	4.3	4.2	4.2	4.2	4.3	97.2	4.3	4.2	4.1	4.0
25	4.0	4.2	4.3	4.2	4.2	4.2	4.2	96.0	4.2	4.1	4.1	4.0
26	4.0	4.2	4.3	4.1	4.2	4.3	49.8	78.8	4.2	4.1	4.1	4.0
27	4.0	4.3	4.3	4.2	4.2	4.2	242.6	28.8	4.2	4.1	4.1	4.0
28	4.0	4.3	4.3	4.2	26.0	4.2	1,272.2	4.4	4.2	4.1	4.1	4.0
29	4.0		4.3	4.2	28.4	4.2	601.9	4.4	4.2	4.1	4.1	4.0
30	4.1		4.3	4.2	4.3	4.2	495.7	4.4	4.2	4.1	4.1	4.1
31	4.1		4.3		4.3		262.9	4.3		4.1		4.1
Average	4.0	59.8	7.0	4.2	5.7	4.2	109.2	165.3	6.3	4.1	4.1	4.1
Maximum	4.1	980.5	75.8	4.3	28.4	4.3	1,272.2	537.7	64.8	4.4	4.1	4.1
Minimum	4.0	4.0	4.3	4.1	4.2	4.2	4.2	4.3	4.2	4.1	4.1	4.0

Average annual discharge = 32 (m^3/sec)

Annual inflow volume = 995 (Mm^3)

River: Poonch **Station:** EFlow Site 2 **Year:** 2011

Synthetic Mean Daily Discharges (with Project) (m^3/sec)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	4.1	4.0	4.2	4.3	4.4	4.3	4.3	4.2	135.7	4.3	4.2	4.1
2	4.0	4.0	4.2	4.3	4.4	4.2	4.2	4.1	19.5	4.3	4.2	4.1
3	4.0	4.0	56.2	4.3	4.4	4.2	4.2	4.2	4.3	4.3	4.2	4.1
4	4.0	4.0	242.5	4.3	4.4	4.2	4.2	4.3	16.7	4.3	4.2	4.1
5	4.1	4.0	78.4	4.3	4.4	4.2	4.2	4.2	6.4	4.3	4.2	4.1
6	4.1	4.0	15.1	4.2	4.4	4.2	4.1	4.1	4.4	4.3	4.2	4.1
7	4.1	254.3	4.4	4.2	4.4	4.2	4.2	75.9	13.5	4.3	4.2	4.1
8	4.1	70.4	4.4	4.2	4.3	4.2	4.2	4.4	175.7	4.3	4.2	4.1
9	4.1	4.3	4.4	4.2	4.3	4.2	4.2	4.5	138.3	4.3	4.2	4.1
10	4.1	4.2	4.4	4.2	4.3	4.3	4.3	4.4	149.4	4.3	4.2	4.1
11	4.1	4.1	4.4	41.6	4.4	4.2	4.2	71.2	42.8	4.2	4.2	4.1
12	4.0	4.1	4.4	44.1	4.3	4.3	4.1	110.2	4.4	4.2	4.2	4.1
13	4.0	41.2	4.3	8.1	4.3	4.3	4.1	49.2	4.4	4.2	4.2	4.1
14	4.0	498.7	4.3	4.4	4.3	4.2	4.3	4.4	19.5	4.2	4.1	4.1
15	4.1	97.6	4.4	4.4	4.3	4.2	4.2	4.4	176.9	4.2	4.2	4.1
16	4.1	4.4	4.4	4.3	4.3	4.2	73.6	4.4	1,005.6	4.2	4.2	4.1
17	4.1	4.4	4.4	389.4	4.3	4.2	4.3	4.4	231.7	4.2	4.2	4.1
18	4.1	4.3	7.2	256.8	4.3	4.3	4.2	4.4	107.4	4.2	4.2	4.1
19	4.1	4.3	378.6	123.3	4.3	4.2	4.2	4.3	65.2	4.2	4.2	4.1
20	4.1	4.2	207.3	72.7	4.3	4.2	4.1	4.4	43.6	4.2	4.2	4.1
21	4.1	4.2	44.3	48.0	4.3	4.2	4.2	4.4	31.1	4.2	4.2	4.1
22	4.1	4.2	4.4	16.4	4.3	4.2	4.2	4.3	27.8	4.2	4.1	4.1
23	4.1	4.2	4.4	21.2	4.3	4.2	4.2	4.3	30.8	4.2	4.2	4.1
24	4.1	4.2	4.4	25.0	4.2	4.2	20.4	48.0	16.8	4.2	4.2	4.1
25	4.1	4.2	4.4	19.8	4.3	4.3	4.4	127.0	4.4	4.2	4.2	4.1
26	4.1	4.2	4.4	17.8	4.3	4.4	4.3	4.4	4.4	4.2	4.2	4.1
27	4.1	4.2	4.4	13.5	4.3	4.3	4.2	100.4	4.3	4.2	4.2	4.1
28	4.1	4.2	4.4	12.8	4.3	4.4	4.2	121.3	4.3	4.2	4.1	4.1
29	4.0		14.1	7.9	4.2	4.3	4.4	63.2	4.3	4.2	4.1	4.1
30	4.0		4.4	4.4	4.3	4.3	4.2	5.1	4.3	4.2	4.1	4.1
31	4.0		4.3		4.3		4.2	4.4		4.2		4.1
Average	4.1	37.8	36.8	39.3	4.3	4.2	7.0	27.8	83.3	4.2	4.2	4.1
Maximum	4.1	498.7	378.6	389.4	4.4	4.4	73.6	127.0	1,005.6	4.3	4.2	4.1
Minimum	4.0	4.0	4.2	4.2	4.2	4.2	4.1	4.1	4.3	4.2	4.1	4.1

Average annual discharge = 21 (m^3/sec)

Annual inflow volume = 667 (Mm^3)

Appendix E: Geomorphology Specialist Report

See following pages.

GULPUR HYDROPOWER PLANT

ENVIRONMENTAL FLOW ASSESSMENT

GEOMORPHOLOGY SPECIALIST REPORT

M. W. Rountree, Fluvius Environmental Consultants

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1 INTRODUCTION

This report provides the technical supporting information used in the geomorphological component of the Environmental Flow Assessment (EF) undertaken to evaluate the potential impacts of the proposed 100-MW Gulpur Hydropower Project on the Poonch River near Kotli in Azad Jammu and Kashmir, Pakistan as part of a wider Environmental and Social Impact Assessment (ESIA).

1.1 OBJECTIVES OF THIS SECTION

Geomorphology provides a critical link between the hydrology and hydraulic processes at a site and how these are translated into the persistence, development or decline of specific instream, riparian or floodplain physical habitats upon which the biota are dependent. The translation of the hydrological changes associated changes in sedimentological and river morphological processes into physical habitat alterations, allows for more integrated predictions of likely changes under different flow scenarios than if only the biota were considered.

The main objectives of the geomorphological study were to:

- document the implications of flow change for channel form and instream habitat;
- integrate the additional effects of Gulpur HPP, in particular those related to sediment trapping, into predictions of change associated with different flow scenarios.

Fifteen days were allocated to the geomorphological component of the EF assessment: Within these the activities included:

- two days allocated to the a literature review of available information, including sourcing of historical information of the region;
- six days allocated to a site visit in November 2013;
- four days allocated to data analysis of the site information collected in the field; identification of appropriate habitat indicators and generation of response curves for the DRIFT DSS (Southern Waters 2014), and;
- three days to the compilation of a specialist report (this document).

2 *LITERATURE REVIEW*

The form (morphology) of a river channel is a product of the interaction between the supply of sediment from its catchment and the ability to transport that sediment. The ability of the river to move sediment is referred to as its sediment transport capacity. Sediment supply and sediment transport capacity interact such that:

- where sediment supply is less than the sediment transport capacity, there is an excess of erosive energy, resulting in net erosion, causing the river channel to erode its bed/banks and incise, and;
- where sediment supply is greater than sediment transport capacity, there is an excess of sediment, resulting in net deposition and the development of an aggrading river/floodplain environment.

Sediment transport capacity is largely a function of river flow whereas sediment supply is a function of catchment and riverine erosion and deposition processes. The ability of a river to move water and sediment downstream is a function of its longitudinal connectivity. Large dams disrupt the longitudinal connectivity of rivers, causing changes in the sediment supply and transport characteristics in the downstream river.

2.1 *EFFECTS OF DAMS AND HYDROPOWER OPERATIONS ON RIVER MORPHOLOGY*

Dams act as sediment traps, causing a loss of sediment supply and distribution downstream (Ibanez et al. 1996; Vorosmarty et al. 2003; Wohl 2004; Anselmetti et al. 2007; Wang et al. 2007). Large dams also have important direct biological consequences such as the fragmentation of communities and reduced migration/dispersal (Anderson et al. 2006; Coutant and Whitney 2000; Jansson et al. 2000; Lundqvist et al. 2008) and increased retention of nutrients and organic matter in within the reservoirs resulting in eutrophication and nutrient loss downstream (Humborg et al. 2006). Traditionally most impact assessment studies have focussed on the impacts of dams within the reservoir basin and the downstream impacts have not received the same focus or detail despite the spatial extent of impacts being much greater.

Downstream of large dams, water releases are largely sediment free due to the deposition of bedload and suspended load within the reservoir. Sediment is replaced in the water column through erosion of the beds, banks, bars and islands, but with no opportunity for sediment replenishment from upstream the reaches downstream of dams experience vastly enhanced erosive action relative to the pre-dam situation in the river. Changes downstream of dams typically include:

- decreased suspended sediment loads;
- coarsening of the bed material and consequent changes to the instream physical habitat conditions;
- incision of the active channel/s;
- net erosion of the beds and banks of rivers due to clean water releases from dams; and

- abandonment of secondary channels and associated loss of islands (islands frequently become joined to the main banks due to active channel incision).

These morphological impacts below large dams arise primarily due to the disruption of longitudinal connectivity – specifically the reduced sediment loads downstream of dams – but the changes in hydrology (specifically the magnitude, frequency and rate of change of floods downstream of dams) can play an equally or more significant role.

Some hydropower dams include peak power generation - the release of daily elevated flows to allow for enhanced power generation for peak loads. Peak hydropower generation typically involves even more extreme changes to the natural hydrology, including rapid changes in discharge and often highly elevated flood frequencies. In order to maximize power generation, it is possible that peak power generation would be considered for portions of at least the dry season in this system.

Where these associated rapid changes in discharge, and increased frequencies of floods, are implemented, the changes to the natural hydrology can be extreme, including rapid changes in discharge and often highly elevated flood frequencies, which can have severe implications for the morphology in the downstream river, such as vegetation loss (Grelsson 1985), extensive bank slumping (Grelsson 1985; Rountree 2009), increased channel width and decreased depth.

Not all reaches of a river are equally sensitive to the changes in hydrology and sediment alterations. Different river reaches have been shown to respond at different rates, and occasionally with different trends, to the same alterations of hydrology and sediment (Rountree et al. 2001; 2004). Thus, the rate and nature of the morphological changes downstream of an HPP is a combination of dam size, dam operation and the sensitivity of the downstream river reaches to flow-induced change.

An assessment of the study area was thus undertaken to describe the morphological character of the river and also assess the potential sensitivity to upstream hydropower dams and the associated changes caused to sediment loads and hydrology.

2.2 *CHARACTERISTICS OF THE POONCH BASIN*

The Poonch drains the southern sides of Pir Panjal, a range of mountains at altitudes of 10,000 to 12,000 feet which become snow bound during winter. The spring snow melts, usually associated with relatively sediment free waters, initiate the first floods of the wet season. The middle and lower catchment is strongly monsoonal, with mean annual rainfall in the area of about 1310 mm. A long period of observed hydrological and sediment data, from 1960 to 2002, were available from the Rahman Bridge gauging station (Mira-Power 2013). These records indicate the monsoon months of July and August are the months of maximum flow, accounting for nearly 30% of the annual 4 MCM flow.

The geology of the upper catchment is a mix of volcanic rocks, whose layers can be several thousand metres thick, as well as sedimentary rocks and occasional limestones. Lacustrine clays and shales occur near Pir Panjal (Raina 2002). This is a region of geologically rapid uplift, and the steep, deeply incised rivers are characterised by very high sediment transport potentials. Landslides on the slopes of the very steep valleys are common and represent a significant source of sediment introduction to the channels.

The valleys of the upper catchment are dominated by forests and characterised by a very steep, fast channel within a narrow, confined valley. From the Line of Control (LOC) to the town of Kotli the river gradient remains very steep (6.9-8.3 m/km), but the gradient begins to decrease below Kotli andthe river eventually flows in to the Mangla Lake (Reservoir) in the Mirpur district of Azad Jammu and Kashmir. At the proposed dam site, the Poonch River drains a catchment area of about 3625 km^2. The upper reaches of this catchment are in the lower Himalayas and are covered by dense forests. These regions are relatively inaccessible, whereas the more accessible middle and lower reaches are under increasing development pressure.

3 LONGITUDINAL PROFILE OF THE POONCH RIVER

Geomorphology provides an appropriate basis of classification for describing the physical habitat of riparian and aquatic ecosystems, since the geomorphological processes that shape river channel determine the material from which the channel is formed, the shape of the channel, and the stability of its bed and banks. The channel geomorphology in turn determines the substrate conditions for the riverine fauna and flora and the hydraulic conditions at any given flow discharge. Structural changes to the river channel (damage to the riparian zone, sediment inputs from catchment erosion or reservoir induced changes in the flow regime) can cause long-term irreversible effects for biota (O'Keeffe 2000; Kochel 1988). Rowntree and Wadeson (1999) developed a hierarchical classification system for southern African rivers which aims to provide a scale-based framework linking the various components of the river system, ranging from the catchment to the instream habitat (Table 3.1).

Table 3.1 A spatially scaled classification of river units (after Rowntree and Wadeson 1999)

Hierarchical unit	Description	Scale
Catchment	The catchment is the land surface which contributes water and sediment to any given stream network.	Can be applied to the whole river system, from source to mouth, or to a lower order catchment above a specified point of interest.
Segment	A segment is a length of channel along which there is no significant change in the flow discharge or sediment load.	Segment boundaries will tend to be co-incident with major tributary junctions or major continental-scale geomorphological features.
Longitudinal zone	A zone is a sector of the river long profile which has a distinct valley form and valley slope.	Sectors of the river long profile (generally tens to sometimes hundreds of kilometres)
Reach	A length of river characterised by particular channel pattern and morphology, resulting from a uniform set of local constraints on channel form.	Hundreds to thousands of meters.
Morphological Unit	The morphological units are the basic structures comprising the channel morphology and may be either erosional or depositional features.	Morphological units occur at a scale of an order similar to that of the channel width.
Hydraulic biotope	Hydraulic biotopes are spatially distinct instream flow environments with characteristic hydraulic attributes.	Hydraulic biotopes occur at a spatial scale of the order of 1 m^2 to 100 m^2 and are discharge dependent.

When examining the longitudinal profile of a river, channel gradient is well correlated with many channel properties including channel planform or type, bed material and reach type (Rowntree et al. 2000) and changes in gradient usually mark morphological changes and thus provide the basis for the delineation of longitudinal zones. These breaks can be associated with changes in lithology, or result from tectonic activity or the upstream migration of knick points (Dollar 1998). The longitudinal profile of the Poonch River within the study area (from the LOC to Mangla reservoir) is characterised by a relatively uniformly steep (Figure 3.1), narrow valley. The uniformity is likely to relate to the regional response of incision due to uplift. Four EF sites were located along the study reach to examine the impacts of the proposed dam, and these sites similarly display a relatively high degree of similarity in terms of planform and morphological characteristics.

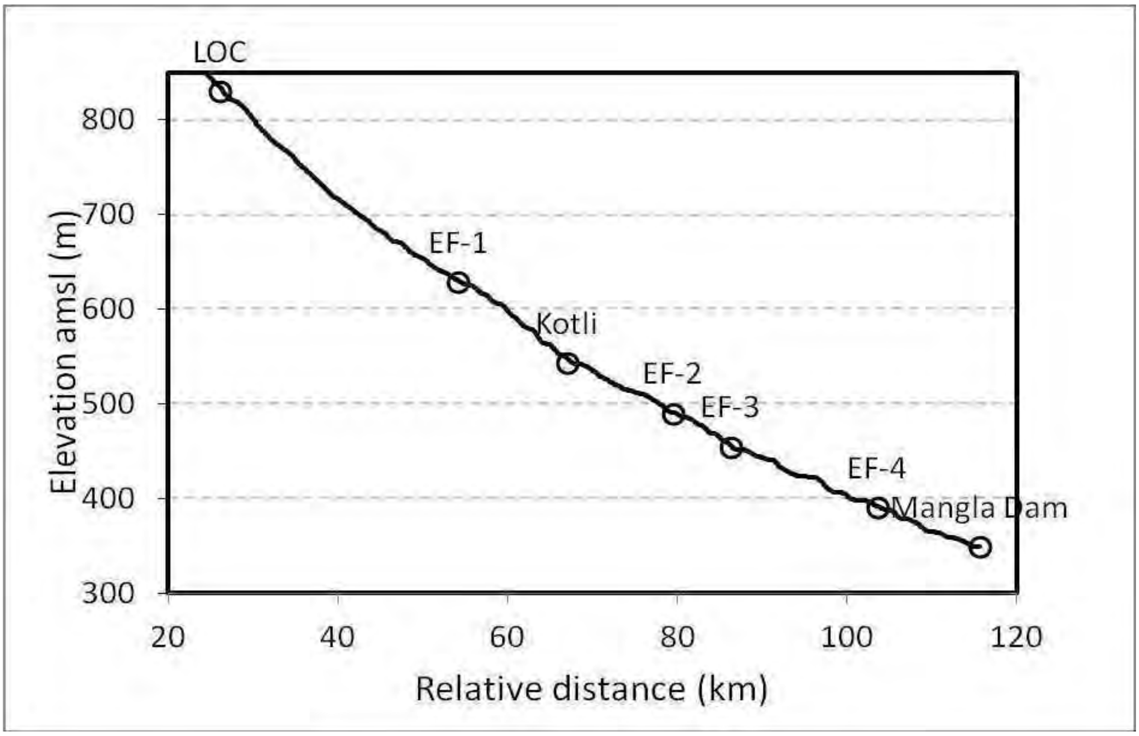


Figure 3.1 **Longitudinal profile of the Poonch River indicating the relatively uniform gradient and position of the EF sites, Kotli town and Mangla Dam.**

4 DESCRIPTION OF EF SITES

4.1 GULPUR EF SITE 1 (KALLAR BRIDGE)

EF Site 1 is characterised by a large vegetated island and secondary (seasonally activated) channel upstream of the bridge (Figure 4.1).

The active channel is fast flowing and dominated by large cobbles and boulders. Backwaters and areas of slower velocity flow are created by back-flooding up the tributaries, as well as in the lee of occasional large bars/islands with secondary channels.

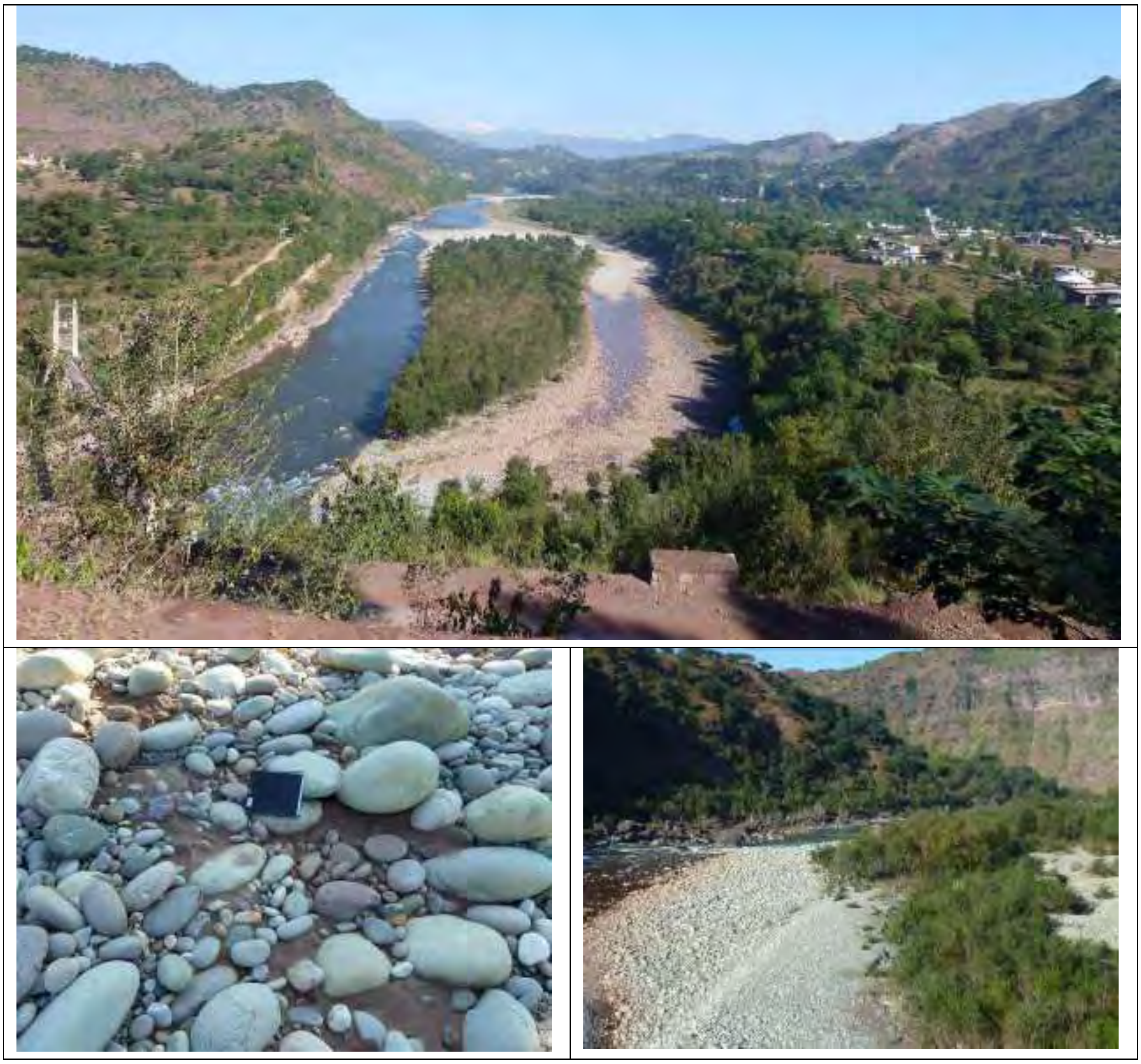


Figure 4.1 **Photographs of EF Site 1 at Kallar Bridge. A secondary channel, created by a vegetated island upstream of the bridge at the site, as well as the vegetated lower zones of the channel (inundated during the wet season) create important habitat for fish which breed in these lower velocity areas.**

4.2 *GULPUR EF SITE 2 (BORALI BRIDGE)*

EF Site 2 is characterised by bedrock controlled banks and bends.

The wider reach is has well sorted cobble lateral bars (Figure 4.2), but at the site there has been extensive removal of silt and sand at this site enabled by the road access. The lateral bars of cobble, boulders and gravels at the site are thus are largely free of fine material; this being found only in very small lee deposits; but the upper banks of the river are composed of finer material (sand and silts) with underlying extensive cobble deposits. Trees and shrubs are present in this upper seasonally inundated zone of the riparian area.

Figure 4.2 **Photographs of EF Site 2 at Borali Bridge indicating the extensive, sorted cobble deposits, absence of fine material and bedrock exposures on the banks.**

4.3 *GULPUR EF SITE 3 (GULPUR BRIDGE)*

EF Site 3 is characterised by large cobble and boulder riffle features and pools in the low flow active channel with cobble and boulder lateral bars, all within a steep, often bedrock cliff, valley sides (Figure 4.3).

Downstream of the site there is a large bedrock control outcrop - a bedrock pavement with a narrowly incised channel cut through it. During large floods this is likely to cause backup in to the site, possibly creating enhanced sediment deposition conditions.

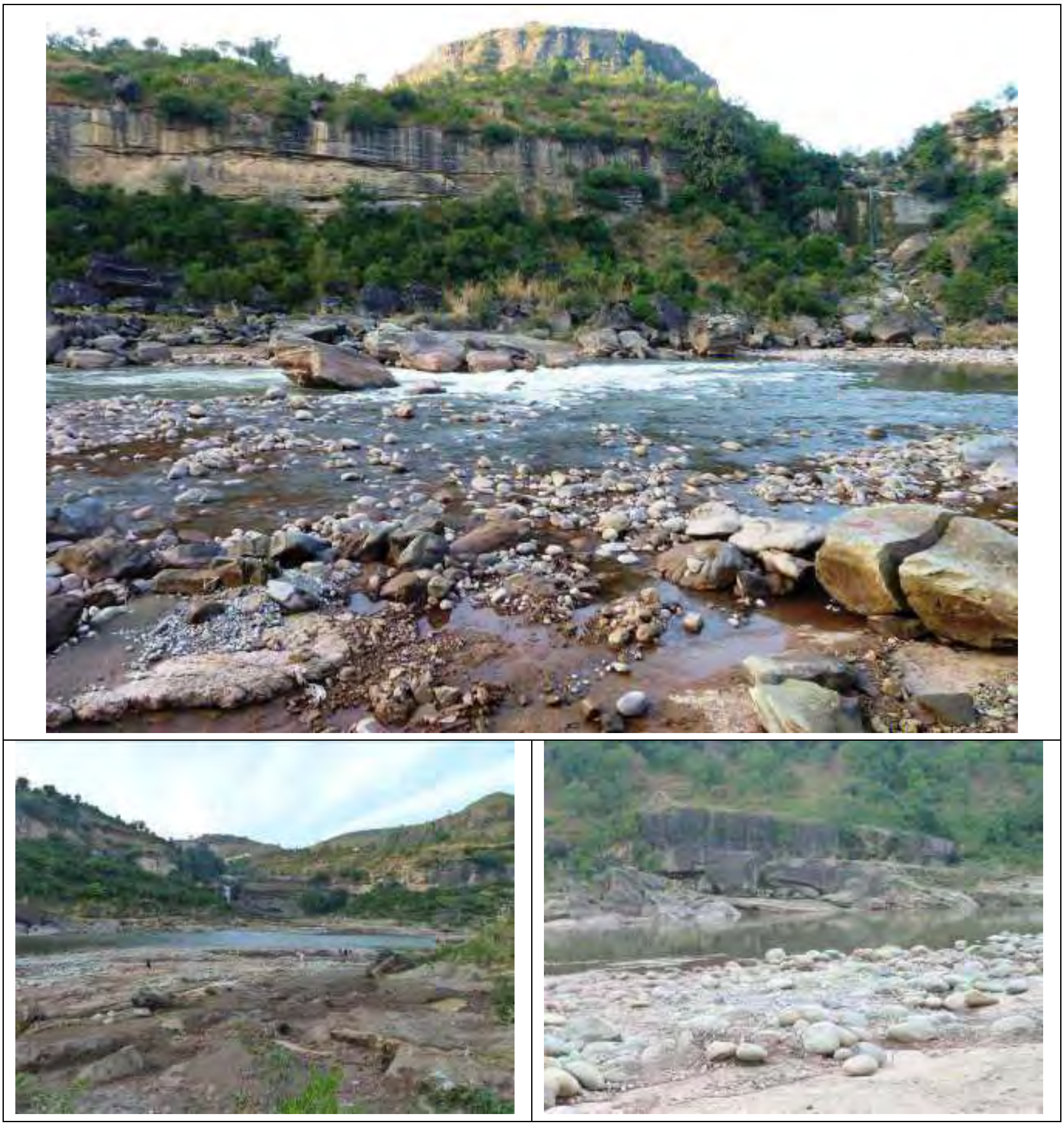


Figure 4.3 Photographs of EF Site 3 at Gulpur Bridge showing the cobble and boulder bed, bedrock controlled banks and cliff valley sides, and finer sands on the uppermost banks.

There was evidence of large-scale sand and cobble mining at and immediately upstream of EF Site 3 (Figure 4.4). This site may be a preferential site for sand extraction due to the potential backup created by the large bedrock control downstream, since such conditions would promote enhanced deposition of fines during large flood events.

Figure 4.4 Extraction of fine sands (left) and cobbles (right) is widespread at EF Site 2.

4.4 GULPUR EF SITE 4 (BILLIPORIAN BRIDGE)

The reach represented by EF Site 4 (Figure 4.5) is dominated by alternating cobble lateral bars (composed primarily of cobbles, with small boulder and fines proportions). There is also a small silt deposit located on cross-section 4.5 (see Birkhead 2014).

The high energy cobble/boulder rapids are deep and fast flowing, with small pools between the rapids. At the time of the site visit, local experts confirmed that the suspended loads had recently increased in response to a rainfall less than two days earlier. Suspended sediment loads during the dry season are thus considered to be generally lower those experienced during the site visit due to the anomalous early rainfall event.

This lower reach of the river has numerous seasonal lateral bars and occasional gravel/cobble bars. Very small backwaters are occasionally present. The seasonal cobble bars are largely free of vegetation, as the river flows bank to bank during the wet monsoon season. There is frequent evidence of landslides on the valley sides.

Figure 4.5 **Photographs of EF Site 4 at Billiporian Bridge. The alternating cobble lateral bars are well vegetated.**

5 ECOCLASSIFICATION OF RIVER REACH REPRESENTED BY THE EF SITES

An assessment of the 2013 geomorphological status of the river at the EF sites was done using observations and data collected during the site visit (November 2013), available maps, high resolution historical and current satellite imagery, literature sources, data from previous studies and discussions with regional experts[1]. The Geomorphological Assessment Index (GAI) prescribed by the South African Department of Water Affairs and Forestry (Rowntree and du Preez in press) was used for this assessment.

The GAI generates a percentage score that enumerates the deviation of the condition of the site from the expected natural (or Reference) condition. The output percentage scores are grouped into 6 Categories (Table 5.1), ranging from A (essentially in the Reference or historic natural Condition) to F (representing the most extremely degraded condition possible). For the purposes of this study, **the Reference Condition was set as that condition of the river approximately 30 years ago, prior to the recent expansion of residential areas, sediment mining and roads within the catchment.**

Table 5.1 Descriptions of the categories used to describe and classify the ecological condition of rivers (adapted from Kleynhans 1996; 1999).

Ecological Category	% Score	Description of the habitat
A	90-100%	Still in a Reference Condition.
B	80-90%	Slightly modified from the Reference Condition. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified from the Reference Condition. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified from the Reference Condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	20-40%	Seriously modified from the Reference Condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically / Extremely modified from the Reference Condition. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

The EF sites are located in a single long steep reach of the river. Hydrological and land-use impacts are ubiquitous in this region, and the geomorphological condition of all sites is thus considered to be comparable. The Present Ecological State for the geomorphological component of the ecosystem is in an A/B category (close to natural). The slight reduction in

[1] Field and office discussions with Mr Vaqar Zakaria from Hagler Bailly Pakistan and Dr. Muhammad Rafique from the Pakistan Museum of Natural History, Islamabad.

condition, relative to the condition that could have been expected to occur 30 years ago, is due to non-flow related anthropogenic activities in the catchment and within the riparian zone:

1. The most important anthropogenic activities with regard to changes in habitat and sediment availability are due to sand and cobble/boulder mining from the river bed and banks (Figure 5.1).
2. Of much lesser importance is the increase in suspended load/sediment yield (relative to the expected condition 30 years ago) from the catchment due to landuse changes.

Figure 5.1 **Mining operation in the bed of a tributary (nullah). The extraction of river sediment for construction and road building is degrading the instream and riparian habitat of these reaches.**

6 FIELD DATA COLLECTION AND MODELLING

Data were collected from the four study sites during the low-flow period of November 2013. Visual assessments of the morphology of the reaches and EF Sites were undertaken in the field. This involved notes on the sediment character of the banks and islands, location of reaches relative to the proposed HPP and condition of the beds and banks, in order to determine dominant processes and sensitivities to the sorts of sediment and hydrological changes likely to result from the HPP.

Rapid morphological assessments and topographical surveys at the EF Sites were also done to identify morphological cues to aid in the determination of geomorphologically-significant flows. Identification of such cues relies on specialist knowledge and experience to identify alluvial (depositional) morphological cues and flow inundation zones at the site and within the reach associated with regular flooding return frequencies. Using hydraulically rated cross-sections, these zones and features can be translated to discharges and linked to the flow record and flow scenarios.

Discussions with the ecological experts on the EF team were used to identify physical habitat conditions and features that are important for the instream fauna, which informed the selection of geomorphological indicators for the EF assessment.

6.1 ESTIMATING THE IMPACTS OF THE PROPOSED DAM ON SEDIMENT LOADS

The form (morphology) of a river channel is dependent on the interaction between the supply of sediment from its catchment, and the ability, or capacity, of that section of the river to transport the sediment it is supplied with. The proposed Gulpur HPP will affect both the sediment supply (through trapping in the reservoir) and transport potential (through the proposed reduced flows). An understanding of the present day sediment yield conditions was necessary to enable the prediction of changes that could be expected under different releases scenarios.

There are three components of sediment load:

- The dissolved load: the salts and nutrients which are dissolved in the water and moved downstream in solution.
- The suspended load: the sediment (usually very fine material) carried in suspension in the water column.
- The bedload: that component of the sediment load (the larger sediment fractions) transported along the bed of the river.

The dissolved load is has no impact on the geomorphology and is thus not considered further in this report.

6.1.1 Suspended sediments

The 1960 to 2011 record of observed suspended sediment at the Rehman Bridge gauge station on the Poonch River near Kotli was made available by the Surface Water Hydrology Project (SWHP) of the Water and Power Development Authority (WAPDA) to Hagler-Bailly Pakistan for use in this study. Since applying sediment rating curves to discharge records often yields inconsistent correlations (Leopold et al. 1964), annualized suspended sediment-discharge rating curves were generated (Appendix A) to account for variable rainfall, changing catchment vegetation cover and the consequent inter-annual variability of sediment-discharge relationships (Figure 6.1).

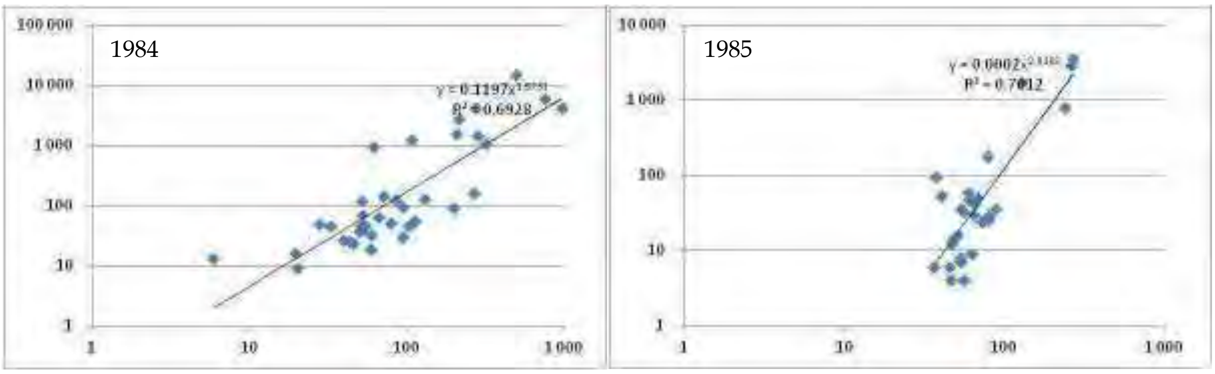


Figure 6.1 **Annual suspended sediment-discharge relationships in 1984 and 1985. Suspended sediment loads (vertical axis) are indicated in ppm, with discharge (m^3s^{-1}) on the horizontal axis.**

The annual suspended sediment-discharge correlations were used to generate a time series of suspended sediment for the various flow scenarios that were generated, with rules used to simulate the expected operation of the dam (such as occasional wet season flushing of the reservoir; Figure 6.2). In addition to the changes in suspended sediment loads, some shifts in the composition of the suspended sediment can be expected. Based on observed sediment fraction distributions, sand accounts for approx 10% and silt and clay 90% of the total suspended sediment load under present day conditions. The heavier sands are more likely to be trapped in the reservoir, and a consequent decrease in the sand fraction can be expected at the EF sites downstream of the dam. The changes in suspended load fractions were estimated to account for this process (Table 6.1).

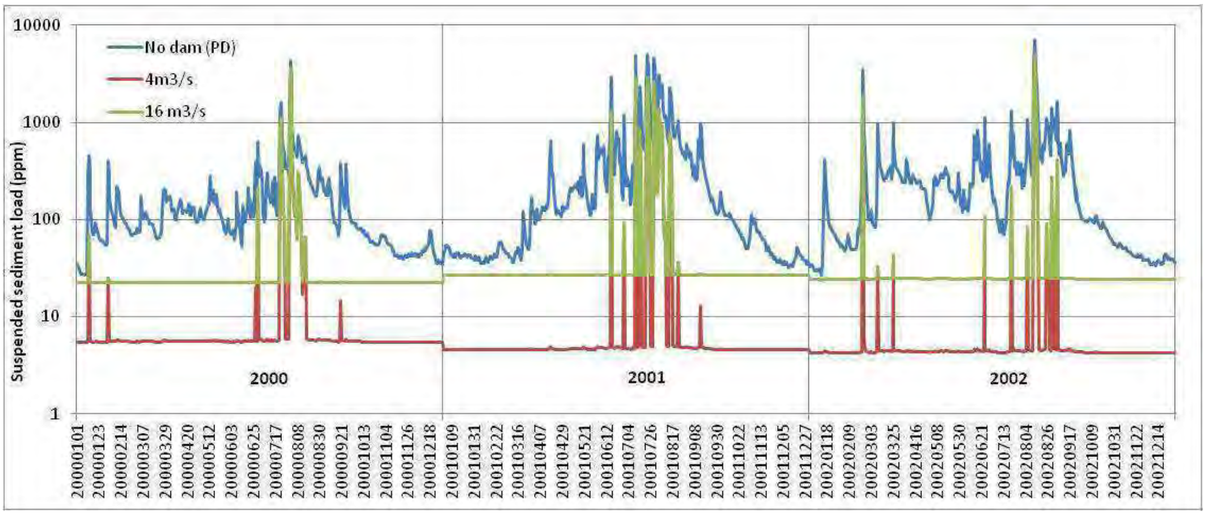


Figure 6.2 **Suspended sediment loads generated for the present day (no dam), 4 and 16 m^3s^{-1} baseflow release flow scenarios. The critical reductions in suspended sediment are linked to the large declines in baseflows, whereas the large peaks in the 4 and 16 m^3s^{-1} scenarios are associated with proposed periodic flushing of the reservoir.**

Table 6.1 **Estimated changes in the suspended sediment fractions.**

At EF Site 2:	Silt and clay fraction	Sand fraction
2013	90%	10%
With dam in place	95%	5%

6.1.2 Bedload

The bedloads are critically important for the creation and maintenance of the Poonch River morphology, such as the cobble and boulder bars present along the river, but records of sediment in rivers usually only measure and examine the suspended load because of the difficulty of measuring bedload. Moreover, suspended load is the dominant proportion of total sediment loads in rivers, so there is usually little focus on the bedload component.

Predicting sediment yield at the catchment scale is one of the main challenges in geomorphologic research (de Vente et al. 2006) and, depending on what data are available, there are several approaches that can be used. These include sediment yields based on sediment-discharge rating relationships, sediment yields derived from the sediment trapped within large reservoirs in the catchment, and catchment analysis and application of sediment yield data from similar environments.

Changes in bedload are thus more difficult to estimate as there are often no observed records, but in the case of a dam immediately upstream, supply can be considered to be totally severed as no cobbles or large bed sediments can be expected to pass through the reservoir. However, some amelioration of the trapping impact of the dam will be found in bedload supply from the bed and banks of the river system downstream of the dam. The estimated changes in bedload supply, taking in to account the impacts of the dam and potential availability from the river bed and banks downstream of the reservoir, are tabulated below (Table 6.2).

Table 6.2 **Estimated changes in bed sediment supply due to the dam.**

EF Site	Catchment area (km^2)	% of catchment affected (cut off) by dam	Bedload at EF Site	
			Present Day (%)	After dam (% of Present Day)
EF Site 1	2540	0	100	100
Gulpur HPP	3732	100	-	-
EF Site 2	3741	100	100	10
EF Site 3	3815	98	100	15
EF Site 4	4097	93	100	25

7 GEOMORPHOLOGICAL INDICATORS

Several indicators have been identified that are likely to respond to changes in the river flow and/or sediment loads associated with the proposed dams. These have been identified and selected based on site visit information, international literature, experience from previous studies and the discussions with regional ecological experts regarding key physical habitats for biota. Some of these physical habitats are important for red data fish species (see text box below).

The geomorphological indicators are:

- **Area of cobble bars** - Large scale lateral and/or point bars composed predominantly of large cobbles and boulders, that are exposed at low flows;
- **Area of mixed silt/sand deposits** - Very small deposits of fine sediments and gravels, usually deposited in the lee of bars and large boulders;
- **Active channel width** – Width of the main channel at low flow conditions. These could be reduced by cobble sediment reductions;
- **Area of backwaters and secondary channels** – Backwaters created in secondary flood channels and especially at tributary junctions (backflooding up the tributaries);
- **Size of active channel sediment** – Average sediment size on the active channel bed during the dry season; and
- **Depth of pools** – Depth of the pools in the main channel. These could be reduced by cobble sediment reductions.

The descriptions and location within the river of these geomorphological indicators, as well as the characteristics of the sediment and hydrology required to maintain these indicators, are briefly discussed below.

7.1 AREA OF COBBLE BARS

Description:	Large scale lateral and/or point bars composed predominantly of large cobbles and boulders, which are exposed at low flows (Figure 7.1). The extent of the bars varies over time in response to inter-annual floods and baseflow conditions (Figure 7.2).
Flow-related location:	In and adjacent to the active channel (on the valley floor)
Hydrology needs:	High flows to episodically activate cobbles to maintain mobility.
Sediment needs:	Coarse bedload inputs from upstream and tributaries
Non-flow related pressures:	Cobble mining (Figure 7.1)
Present condition:	Very slight decline of the bars began in the last 10-20 years (associated with accelerated catchment development)
Trajectory:	Very slow decline.

Figure 7.1 **Lateral bars composed of predominantly cobble sediments are common throughout the study area. The cobbles and boulders are important construction material resources and sediment removal at road access points is common.**

Figure 7.2 **Areas of exposed cobble bars upstream of EWR 2 from the 27th July 2002 (A), 1st November 2005 (B), 12th September 2010 (C) and 21st March 2011 (D).**

7.2 *AREA OF MIXED SILT/SAND DEPOSITS*

Description: Very small deposits of fine sediments, usually deposited in the lee of bars and large boulders (Figure 7.3).

Flow-related location: Along the margins of the active channel and in lee of bedrock outcrops.

Hydrology needs: Low flows to allow deposition of suspended and bedload sands.

Sediment needs: Bedload and fines inputs from upstream catchment and tributaries

Non-flow related pressures: Sand mining, and to a much lesser extent, catchment erosion

Present condition: Very slight decrease may have occurred relative to natural conditions due to sand mining (during the last 10-20 years). It is unlikely that elevated erosion in the catchment has offset this.

Trajectory: Very slow decline

Figure 7.3: Small deposits of fine sediments are indicative of the fine (suspended) sediment load of the river. These fine sands represent an important resource for local people, being commonly mined from the river bed and banks for construction uses.

7.3 *ACTIVE CHANNEL WIDTH*

Description: Width of the main channel at low flow conditions. These could be reduced by cobble sediment reductions.

Flow-related location: The active channel

Hydrology needs: Occasional large floods to scour the channel and replenish sediment on the banks.

Sediment needs: Coarse bedload inputs from upstream catchment and tributaries

Non-flow related pressures: Sediment mining

Present condition: Very slight increase may have occurred 98% associated with cobble bar removal (the resultant lower bars are more easily eroded).

Trajectory: Very slowly increasing

7.4 *AREA OF BACKWATERS AND SECONDARY CHANNELS*

Description: Backwaters created in secondary flood channels and especially at tributary junctions (backflooding up the tributaries)

Flow-related location: Normally along the edge of the macro-channel, at tributary junctions at the base of periodically activated flood channels.

Hydrology needs: High peak flood flow

Sediment needs: None

Non-flow related pressures: Cobble mining, urban encroachment.

Present condition: Very slight decrease may have occurred as one or two backwater areas between EF Site 1 and 2 have been converted to agricultural areas (Figure 7.4).

Trajectory: Very slowly decreasing.

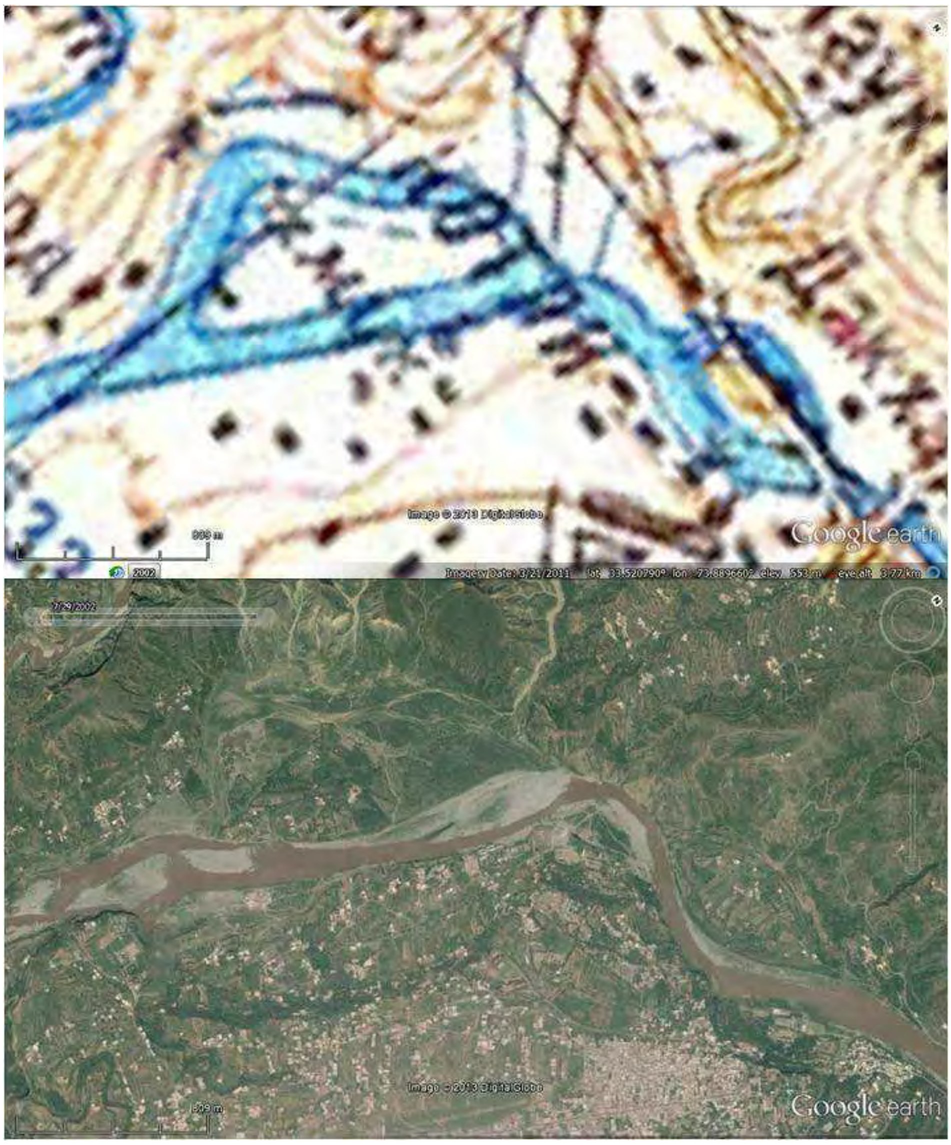


Figure 7.4 **The above map and imagery indicate a secondary channel, present in the 1950's (top), which has been converted to agriculture by 2002 (lower satellite image).**

7.5 *SIZE OF ACTIVE CHANNEL SEDIMENT*

Description: Average sediment size on the active channel bed during the dry season

Flow-related location: Within the active channel

Hydrology needs: Various floods, high flows and low flows interact to control bed sediment size distribution.

Sediment needs: Supply of bedload from upstream

Non-flow related pressures: Catchment erosion, then sediment mining

Present condition: Very slight decrease may have occurred in response to erosion in the catchment (accelerated in the last 10-20 years), as this could have slightly reduced the average sediment size of the bed (fines increasing).

Trajectory: Very slowly decreasing.

7.6 *DEPTH OF POOLS*

Description: Depth of the pools in the main channel. These could be reduced by cobble sediment reductions.

Flow-related location: Pools in the active channel

Hydrology needs: Floods to scour pools

Sediment needs: Bed sediment to maintain pool morphology.

Non-flow related pressures: Catchment erosion, then sediment mining

Present condition: Very slight, if any, decrease may have occurred due to catchment erosion during the last 10-20 years.

Trajectory: Very slowly decreasing

8 *EXPLANATIONS FOR GEOMORPHOLOGICAL RESPONSE CURVES*

As part of the population and calibration of the DRIFT DSS, response curves were constructed depicting the relationship between the geomorphological indicators (Section 7) and their driving variables (e.g., flow). This section provides the explanations and motivations for the shape for each of those response curves, using the curves for EF Site 2 as an example.

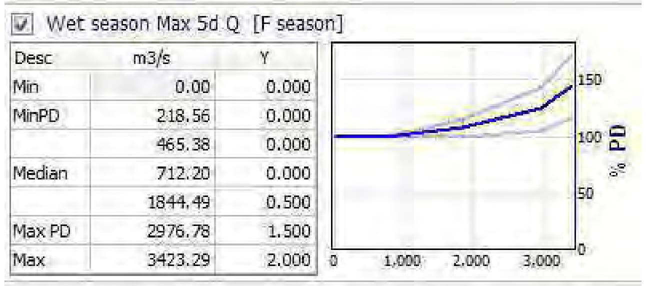
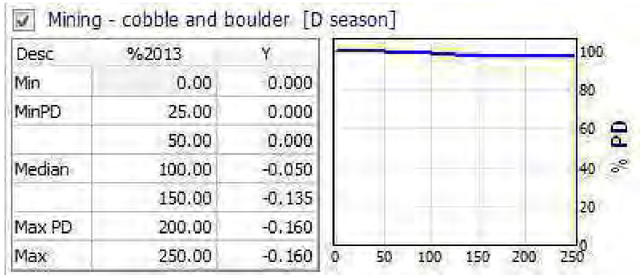
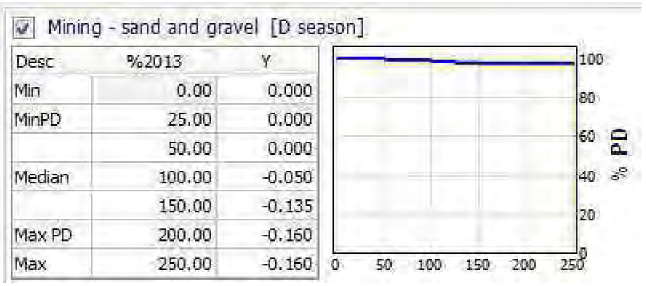
The explanations of the response curves are tabulated as follows:

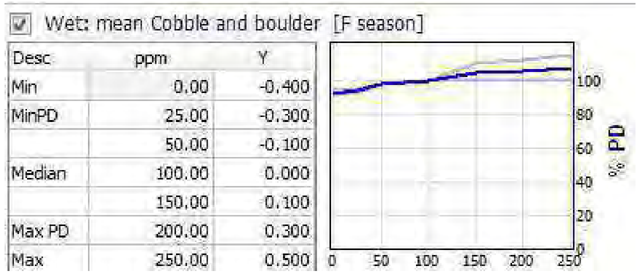
Table 8.1 Area of Cobble Bars

Table 8.2 Area of Mixed Silt/Sand Deposits
Table 8.3 Active Channel Width
Table 8.4 Area of Backwaters and Secondary Channels
Table 8.5 Size of Active Channel Sediment
Table 8.6 Depth of Pools.

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the response curves. In addition, each response curve assumes that all other conditions are at baseline.

Table 8.1 Area of Cobble Bars

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>
</td><td>Very big floods erode and redistribute sediment across the valley floor, covering bedrock and increasing the area of (albeit lower elevation) cobble bars. This action of stripping and redistribution of sediments is well documented (Dollar 2002; Rountree et al. 2001; Tooth 2000; Gupta et al. 1999; Bourke and Pickup 1999; Kochel 1988; Baker 1977).</td></tr>
<tr><td>
</td><td>Decreased mining should reduce bank disturbance, allowing for more stable (and higher elevation) bars to develop. This will reduce the active channel width and increase cobble bar areas. Increased mining will destabilise more of the riparian area, lower the lateral bars and thus allow more coble bars to be eroded (based on observations of mining activites and impacts seen on site)</td></tr>
<tr><td>
</td><td>To a lesser extent, the same issues (of bank disturbance causing increased erosion) apply in the case of sand and gravel mining. Decreased mining should reduce bank disturbance, allowing for more stable (and higher elevation) bars to develop (based on observations of mining activites and impacts seen on site)</td></tr>
</table>

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>
</td><td>The inflow of cobbles allows the channel bed to build up and the active channel to remain wider, and for cobble beds to be maintained. A reduction in cobbles (bedload) will reduce cobble beds (and bedrock areas would increase).</td></tr>
</table>

<table>
<tr><td>References</td><td>Baker, V.R. 1977. Stream-channel response to floods, with examples from central Texas. Geol. Soc. Am. Bull., 88: 1057-1071.

Bourke, M.C. and Pickup, G. 1999. Fluvial Form and Variability in Arid Central Australia. In Miller, A.J. and Gupta, A.(eds), Varieties of Fluvial Form. Wiley and Sons, Chichester, U.K, 249-272.

Dollar, E.S.J. 2002. Fluvial Geomorphology. Progress in Physical Geography, 26: 123-143.

Gupta, A., Kale, V.S. and Rajaguru, S.N. 1999. The Narmada River, India, through space and time. In Miller, A.J. and Gupta, A.(eds), Varieties of Fluvial Form. Wiley and Sons, Chichester, U.K, 113-144.

Kochel, R.C. 1988. Geomorphic Impact of Large Floods: review and new perspectives on magnitude and frequency. In Baker, V.R., Kochel, R.C. and Patton, P.C. (eds) Flood Geomorphology. Wiley-Interscience, New York, 169-87.

Rountree, M.W., Heritage, G.L. and Rogers, K.H. 2001. In-channel metamorphosis in a semi-arid, mixed bedrock/alluvial river system: Implications for Instream Flow Requirements In M.C. Acreman (ed) Hydro-ecology, IAHS Publ. no. 26.

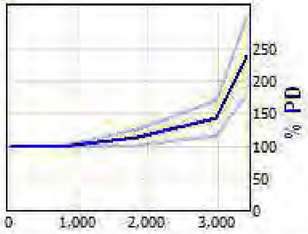
Tooth, S. 2000. Process, form and change in dryland rivers: a review of recent research. Earth Surface Reviews, 51: 67-107.</td></tr>
</table>

Table 8.2 Area of Mixed Silt/Sand Deposits

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>

☑ Wet season Max 5d Q [F season]

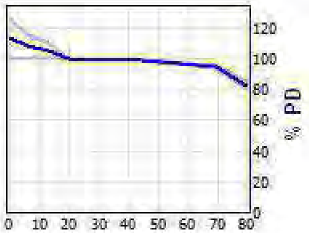
Desc	m3/s	Y
Min	0.00	0.000
MinPD	218.56	0.000
	465.38	0.000
Median	712.20	0.000
	1844.49	1.000
Max PD	2976.78	2.000
Max	3423.29	3.000



</td><td>Large floods reset the channel and redistribute sediment across the valley floor. This often creates backwaters and lee areas, facilitating fine sediment deposition (Baker 1977; Carter and Rogers 1995; Kochel 1988; Nanson 1986; Rountree et al. 2000; Rountree et al. 2001; Parsons et al. 2006).</td></tr>
<tr><td>

☑ Dry season Min 5d Q [D season]

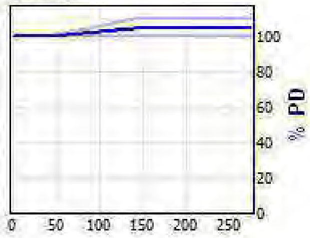
Desc	m3/s	Y
Min	0.00	1.000
MinPD	6.00	0.500
	13.07	0.100
Median	20.14	0.000
	44.83	-0.050
Max PD	69.52	-0.300
Max	79.95	-1.000



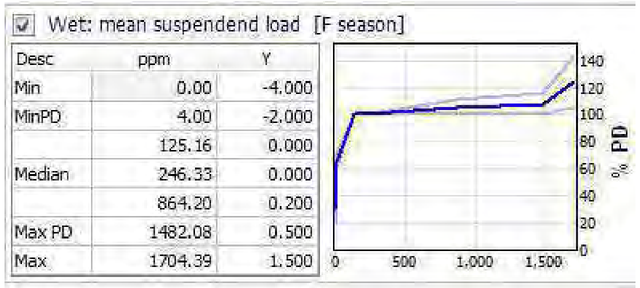
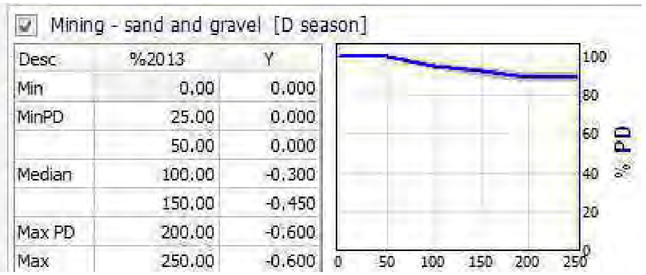
</td><td>Lower dry season flows will result in slower velocities. so the area of silt deposits should expand (based on field observations).</td></tr>
<tr><td>

☑ Dry: mean suspendend load [D season]

Desc	ppm	Y
Min	0.00	0.000
MinPD	4.39	0.000
	22.16	0.000
Median	39.93	0.000
	138.70	0.050
Max PD	237.47	0.070
Max	273.10	0.090



</td><td>The higher the dry season suspended load, the greater the deposits of fine sediment are likely to be, and the longer these deposits will remain. Reduced fines loads should create more sediment hungry flow conditions, and thus accelerating the erosion of fines.</td></tr>
</table>

Response curve	Explanation
	The higher the wet season suspended load, the greater the deposits of fine sediment are likely to be. Reduced fines loads should create more sediment hungry flow conditions, and thus reduce the potential for fines deposits.
	Increased mining of sand and gravel should reduce the availability of fines present at the site (they are already only found in small volumes). Reduced sediment mining should allow for the longer persistence of small patches of fine material.

References

Baker, V.R. 1977. Stream-channel response to floods, with examples from central Texas. *Geol. Soc. Am. Bull.*, 88: 1057-1071.

Carter, A.J. and Rogers, K.H. 1995. A markovian approach to investigating landscape change in the KNP rivers. Report no. 2/95, CWE, University of the Witwatersrand, Johannesburg.

Kochel, R.C. 1988. Geomorphic Impact of Large Floods: review and new perspectives on magnitude and frequency. In Baker, V.R.,

Nanson, G.C. 1986. Episodes of vertical accretion and catastrophic stripping: a model of disequilibrium flood-plain development. Geol. Soc. Am. Bull., 97: 1467-1475.

Rountree, M.W., Rogers, K.H. and Heritage, G.L. 2000. Landscape change in the semi-arid Sabie River in response to flood and drought. South African Geographical Journal, 82(3): 173-181.

Rountree, M.W., Heritage, G.L. and Rogers, K.H. 2001. In-channel metamorphosis in a semi-arid, mixed bedrock/alluvial river system: Implications for Instream Flow Requirements In M.C. Acreman (ed) Hydro-ecology, IAHS Publ. no. 26.

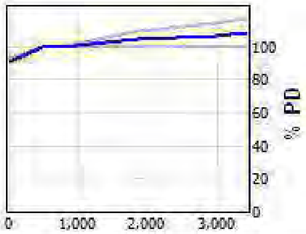
Parsons, M., McLoughlin, C. A., Rountree, M. W. and Rogers, K. H. (2006). The biotic and abiotic legacy of a large infrequent flood disturbance in the Sabie River, South Africa. *River Research and Applications*, 22:187-201.

Table 8.3 Active Channel Width

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>

☑ Wet season Max 5d Q [F season]

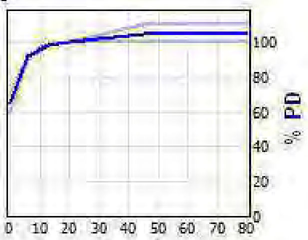
Desc	m3/s	Y
Min	0.00	-0.500
MinPD	218.56	-0.300
	465.38	-0.010
Median	712.20	0.000
	1844.49	0.010
Max PD	2976.78	0.400
Max	3423.29	0.600



</td><td>Active channel widths can be expected to increase with larger floods. Very big floods erode in to the lateral and point cobble bars, and redistribute sediment across the channel floor, resulting in a small widening (and often shallowing) of the active channels (Tooth 2000; Gupta et al. 1999; Bourke and Pickup 1999; Kochel 1988; Baker, 1977; Kochel, 1988; Nanson, 1986; Rountree et al. 2000; Rountree et al., 2001, Parsons et al. 2006)</td></tr>
<tr><td>

☑ Dry season Min 5d Q [D season]

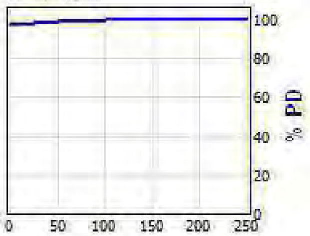
Desc	m3/s	Y
Min	0.00	-2.000
MinPD	6.00	-0.500
	13.07	-0.100
Median	20.14	0.000
	44.83	0.030
Max PD	69.52	0.050
Max	79.95	0.150



</td><td>This indicator represents the dry season baseflows. At EF Site 2, low flows in the dry season will result in a much smaller, narrower active channel, and may also facilitate slightly more bar stabilisation (through vegetation growth) - based on modelled hydraulic relationships at the EF sites.</td></tr>
<tr><td>

☑ Wet: mean Cobble and boulder [F season]

Desc	ppm	Y
Min	0.00	-0.150
MinPD	25.00	-0.100
	50.00	-0.050
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	0.000
Max	250.00	0.000



</td><td>The inflow of cobbles allows the channel bed to build up and the active channel to remain wider. A reduction in cobbles (bedload) will promote channel incision and narrowing.</td></tr>
<tr><td>References</td><td>

Baker, V.R. 1977. Stream-channel response to floods, with examples from central Texas. Geol. Soc. Am. Bull., 88: 1057-1071.
Dollar, E.S.J. 2002. Fluvial Geomorphology. Progress in Physical Geography, 26: 123-143.
Gupta, A., Kale, V.S. and Rajaguru, S.N. 1999. The Narmada River, India, through space and time. In Miller, A.J. and Gupta, A.(eds), Varieties of Fluvial Form. Wiley and Sons, Chichester, U.K, 113-144.
Kochel, R.C. 1988. Geomorphic Impact of Large Floods: review and new perspectives on magnitude and frequency. In Baker, V.R.,

</td></tr>
</table>

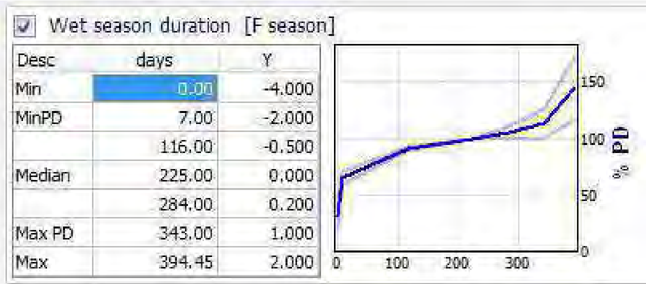
<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td></td><td>Kochel, R.C. and Patton, P.C. (eds) Flood Geomorphology. Wiley-Interscience, New York, 169-87.

Rountree, M.W., Rogers, K.H. and Heritage, G.L. 2000. Landscape change in the semi-arid Sabie River in response to flood and drought. South African Geographical Journal, 82(3): 173-181.

Rountree, M.W., Heritage, G.L. and Rogers, K.H. 2001. In-channel metamorphosis in a semi-arid, mixed bedrock/alluvial river system: Implications for Instream Flow Requirements In M.C. Acreman (ed) Hydro-ecology, IAHS Publ. no. 26.

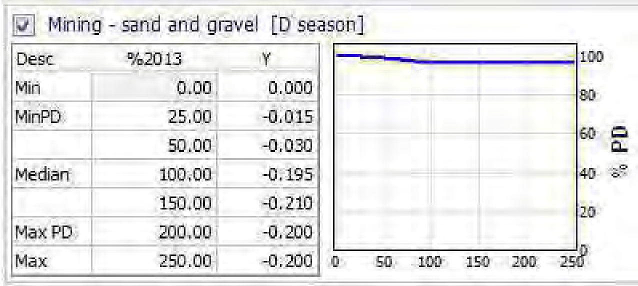
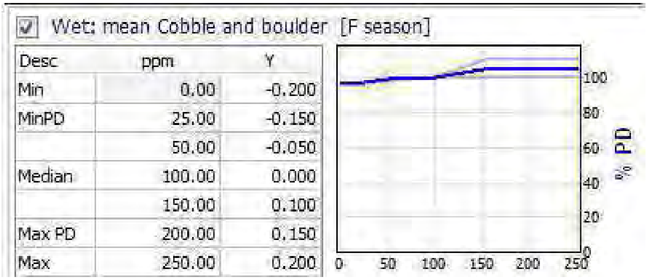
Parsons, M., McLoughlin, C. A., Rountree, M. W. and Rogers, K. H. (2006). The biotic and abiotic legacy of a large infrequent flood disturbance in the Sabie River, South Africa. River Research and Applications, 22:187-201.Tooth, S. 2000. Process, form and change in dryland rivers: a review of recent research. Earth Surface Reviews, 51: 67-107.</td></tr>
</table>

Table 8.4 **Area of Backwaters and Secondary Channels**

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>


</td><td>Longer wet seasons will inundate (backflood) tributaries for longer periods, creating more backwater habitats. Short or no wet seasons preclude most backwaters from being activated (based on modelled hydraulics and experience from other field sites).</td></tr>
<tr><td>

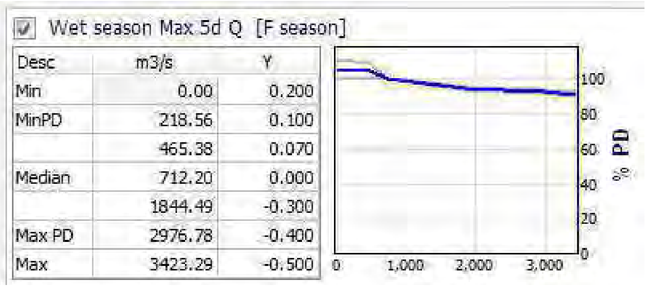
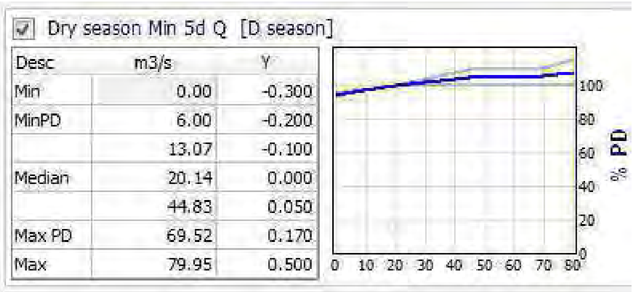
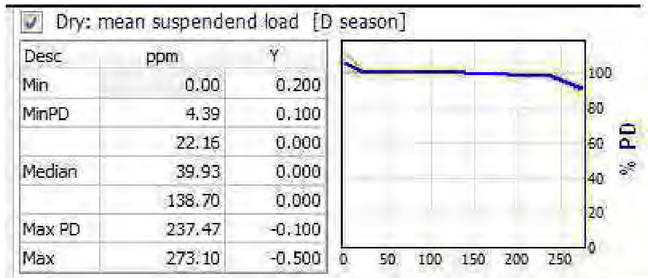

</td><td>Very big floods erode and redistribute sediment across the valley floor, creating many of the secondary channels and backwater environments (Rountree et al. 2000; Rountree et al. 2001, Parsons et al. 2006)</td></tr>
</table>

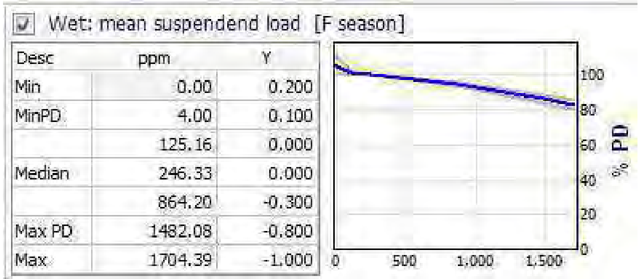
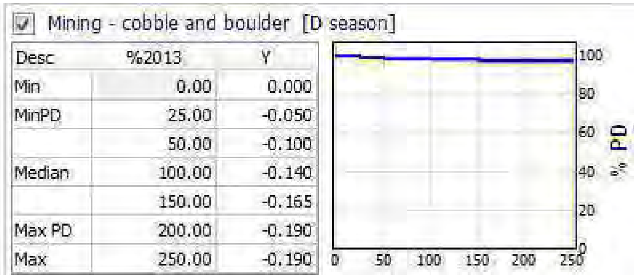
Response curve	Explanation
 Mining - cobble and boulder [D season] Desc | %2013 | Y Min | 0.00 | 0.000 MinPD | 25.00 | -0.015 | 50.00 | -0.030 Median | 100.00 | -0.195 | 150.00 | -0.210 Max PD | 200.00 | -0.220 Max | 250.00 | -0.220	As observed in the field and at other sediment mining sites, sediment mining disturbs the banks and secondary channel areas. The removal and loss of cobbles may cause incision of the active channel, further reducing the opportunity for backwaters and secondary channels to form. Urban encroachment is assumed at 2013 levels.
 Mining - sand and gravel [D season] Desc | %2013 | Y Min | 0.00 | 0.000 MinPD | 25.00 | -0.015 | 50.00 | -0.030 Median | 100.00 | -0.195 | 150.00 | -0.210 Max PD | 200.00 | -0.200 Max | 250.00 | -0.200	As observed in the field and at other sediment mining sites, sediment mining disturbs the banks and secondary channel areas (also often in the tributaries), and this reduces backwater and secondary channel areas that are important for fish species. Urban encroachment is assumed at 2013 levels.
 Wet: mean Cobble and boulder [F season] Desc | ppm | Y Min | 0.00 | -0.200 MinPD | 25.00 | -0.150 | 50.00 | -0.050 Median | 100.00 | 0.000 | 150.00 | 0.100 Max PD | 200.00 | 0.150 Max | 250.00 | 0.200	A reduction in cobble inflows will promote channel incision, and this will lead to a loss of some backwater and secondary channel areas. Increased sediment loads promote channel infilling, instability and more braided/bar sections (with more secondary channels).

References	
	Rountree, M.W., Rogers, K.H. and Heritage, G.L. 2000. Landscape change in the semi-arid Sabie River in response to flood and drought. South African Geographical Journal, 82(3): 173-181.
	Rountree, M.W., Heritage, G.L. and Rogers, K.H. 2001. In-channel metamorphosis in a semi-arid, mixed bedrock/alluvial river system: Implications for Instream Flow Requirements In M.C. Acreman (ed) Hydro-ecology, IAHS Publ. no. 26.
	Parsons, M., McLoughlin, C. A., Rountree, M. W. and Rogers, K. H. (2006). The biotic and abiotic legacy of a large infrequent flood disturbance in the Sabie River, South Africa. *River Research and Applications*, 22:187-201.Tooth, S. 2000. Process, form and change in

Response curve	Explanation
	dryland rivers: a review of recent research. *Earth Surface Reviews*, 51: 67-107.

Table 8.5 Size of Active Channel Sediment

Response curve	Explanation
	Very big floods erode and redistribute sediment across the valley floor, mixing cobbles on the bars with boulders in the channel and overall reducing bed sediment size. Small floods may just flush the active channel of smaller bed elements and serve to coarsen the bed.sediment size. These processes have been observed in free-flowing river systems.
	Lower flows in the dry season will allow for fines and gravels to accumulate in the interstitial spaces, reducing average bed sediment size. Higher dry season flows will maintain a coarser bed.
	Lowered dry season suspended loads would result in the cleaner channel (less fines) than under normal conditions - average bed sediment size should increase with decreased fines.

Response curve	Explanation
	Lowered wet season suspended loads would result in the cleaner channel (less fines) than under normal conditions - average bed sediment size should increase with decreased fines.
	Sediment mining removes cobbles and gravels and may, over the very long term, cause a tendency for bedrock and boulders to become proportionally more dominant. Catchment erosion is assumed at 2013 levels.
	Sediment mining removes sands and gravels and may, over the very long term, cause larger bed elements to become proportionally more dominant. Catchment erosion is assumed at 2013 levels.

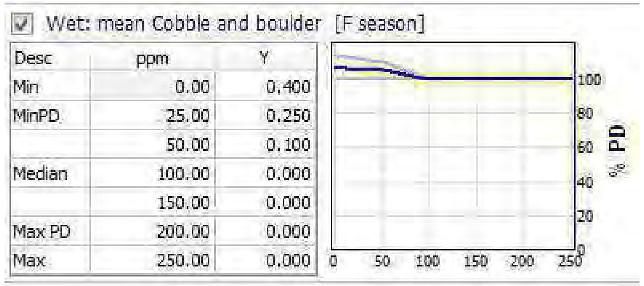
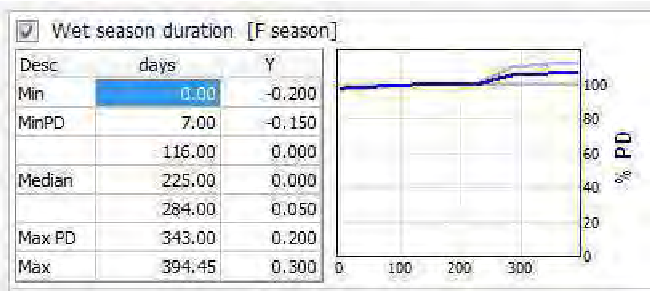
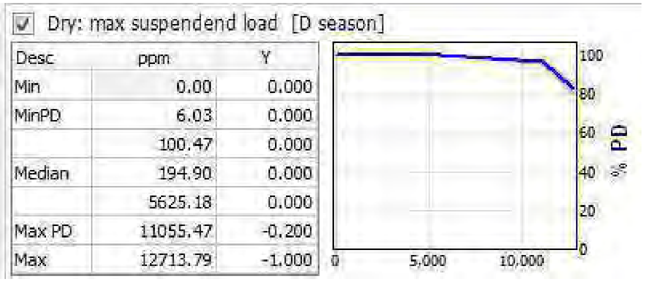
<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>
</td><td>A reduction in the inflow of cobbles will gradually cause an increase in mean bed sediment size as the smaller bed elements are washed out of the reach and only larger cobbles and boulders remain.</td></tr>
<tr><td>References</td><td></td></tr>
</table>

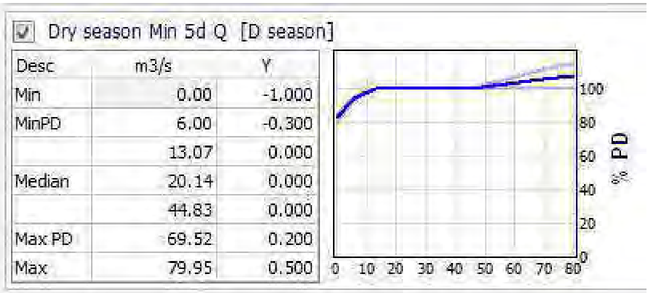
Table 8.6 Depth of Pools

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>
</td><td>Longer wet seasons will scour the pools for longer periods, increasing the pool depth.</td></tr>
<tr><td>
</td><td>Very big floods erode and redistribute sediment across the valley floor (and are also associated with large influxes of sediment) This will infill the pools (through the creation of wider, shallower active channels). These processes have been observed and measured by means of repeat cross-sectional surveys in river systems after very large floods (Rountree, unpublished data).</td></tr>
</table>

<table>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>

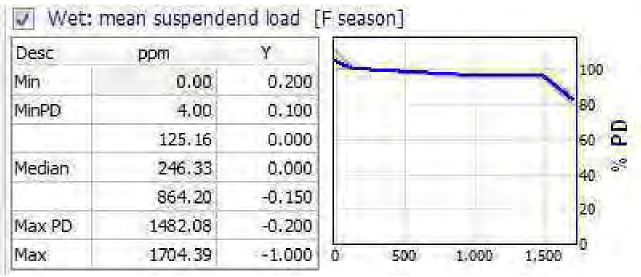
Dry: max suspendend load [D season]

Desc	ppm	Y
Min	0.00	0.000
MinPD	6.03	0.000
	100.47	0.000
Median	194.90	0.000
	5625.18	0.000
Max PD	11055.47	-0.200
Max	12713.79	-1.000

</td><td>High suspended loads of sediment should result in filling of some interstitial spaces and be linked to a reduction of average bed sediment size. Reduced suspended loads would promote winnowing of fines and an increase in average bed sediment size.</td></tr>
<tr><td>

Dry season Min 5d Q [D season]

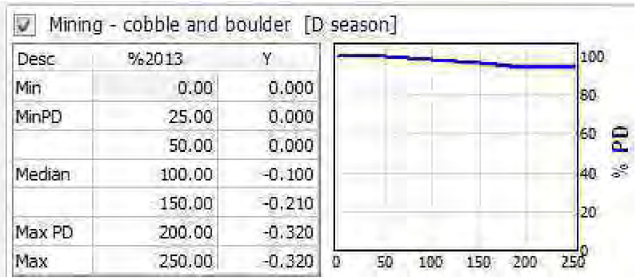
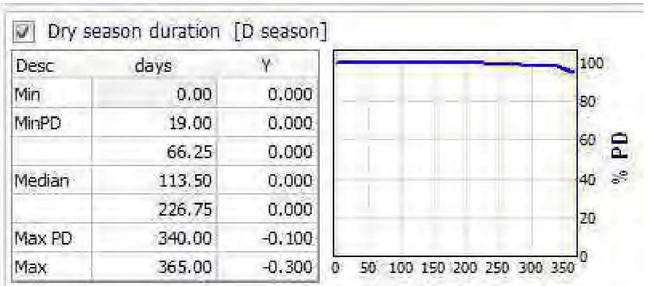
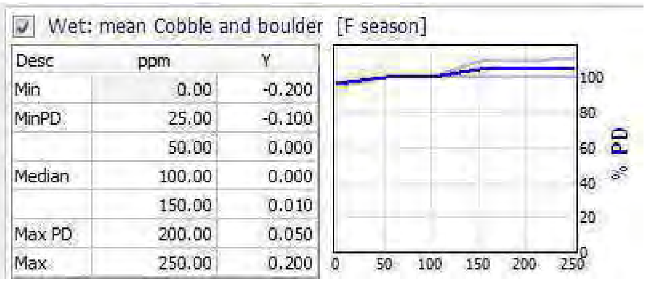
Desc	m3/s	Y
Min	0.00	-1.000
MinPD	6.00	-0.300
	13.07	0.000
Median	20.14	0.000
	44.83	0.000
Max PD	69.52	0.200
Max	79.95	0.500

</td><td>Lower dry season flows will result in smaller, shallower pools, and also allow more infilling of sediment. Zero flows would allow many pools to shrink and possible dry up</td></tr>
<tr><td>

Wet: mean suspendend load [F season]

Desc	ppm	Y
Min	0.00	0.200
MinPD	4.00	0.100
	125.16	0.000
Median	246.33	0.000
	864.20	-0.150
Max PD	1482.08	-0.200
Max	1704.39	-1.000

</td><td>Higher or lower wet season suspended loads could have a small impact on pool infilling or scour respectively.</td></tr>
</table>

<table>
<tr><th>Response curve</th><th colspan="2">Explanation</th></tr>
<tr><td>
</td><td colspan="2">Sediment mining removes cobbles and may, over the very long term, cause pools to deepen. Minor decrease in pool depth due to catchment erosion and sediment mining. Catchment erosion is assumed at 2013 levels.</td></tr>
<tr><td>
</td><td colspan="2">Longer dry season flows will result in smaller, shallower pools, and also allow more infilling of sediment.</td></tr>
<tr><td>
</td><td colspan="2">A reduction in the inflow of cobbles will gradually cause an increase in pool depth as the available sediments are removed from the reach.</td></tr>
<tr><td>References</td><td colspan="2">Rountree, unpublished data. Cross-sectional survey data of the Sabie and Letaba rivers in the Kruger National Park, South Africa, following extreme floods in 2000.</td></tr>
</table>

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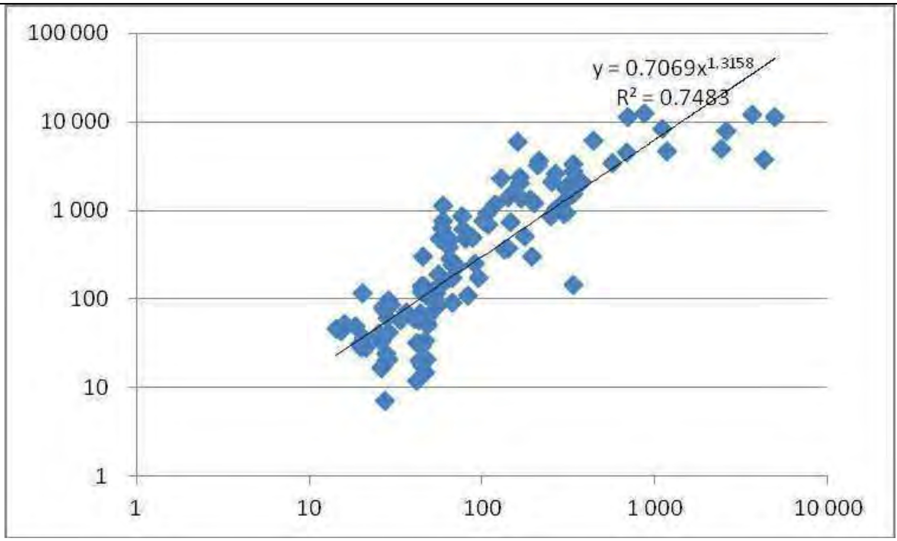
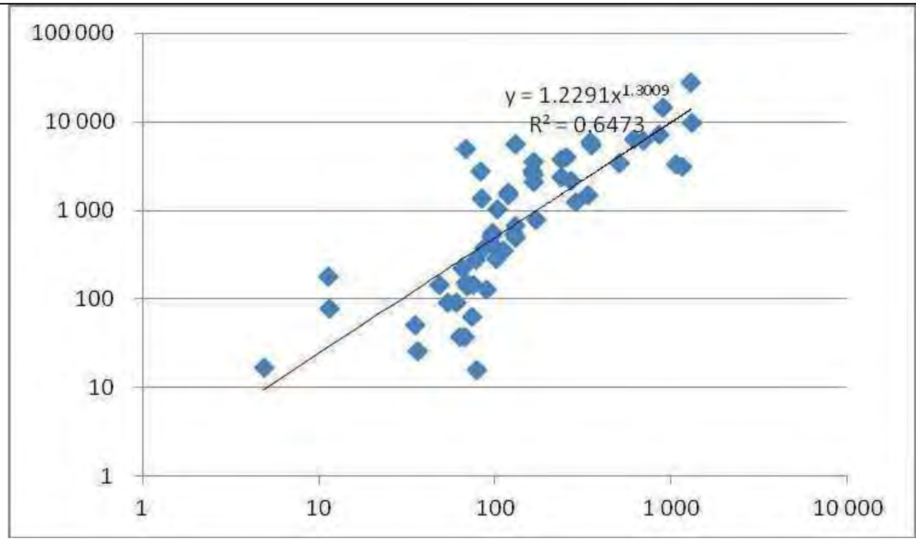
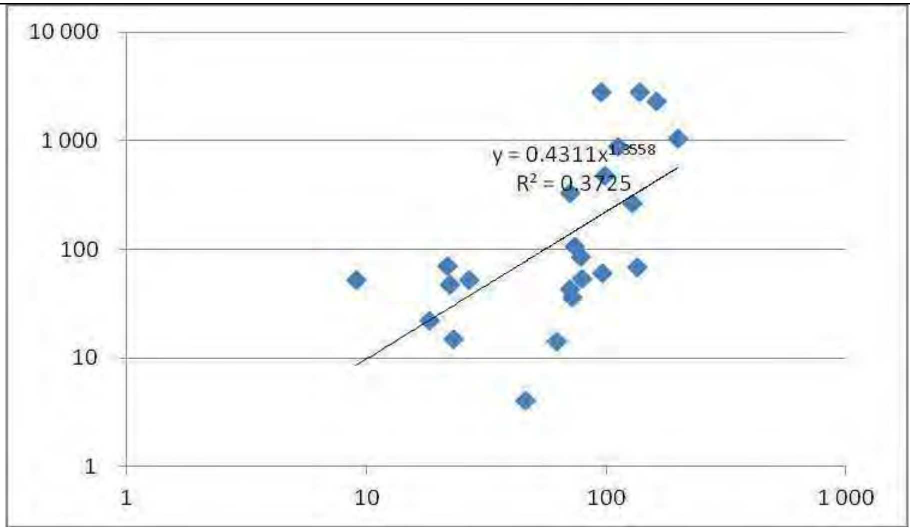
Appendix A. ANNUALISED SUSPENDED SEDIMENT-DISCHARGE RELATIONSHIPS



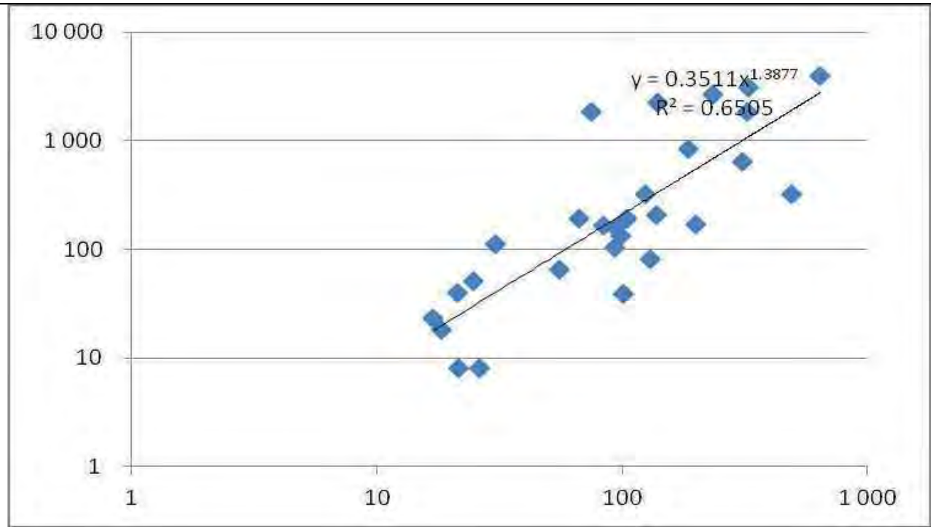
1960: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



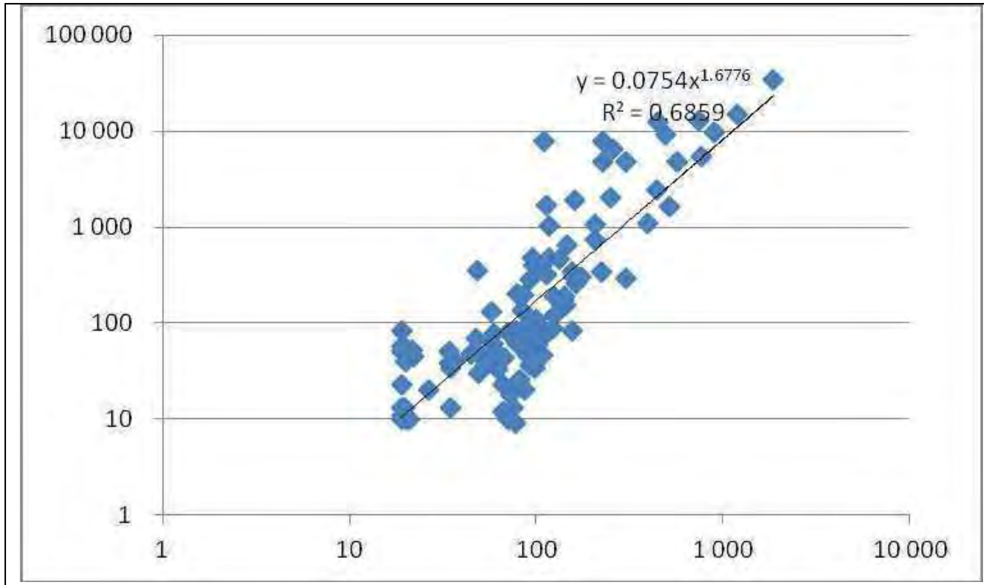
1961: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



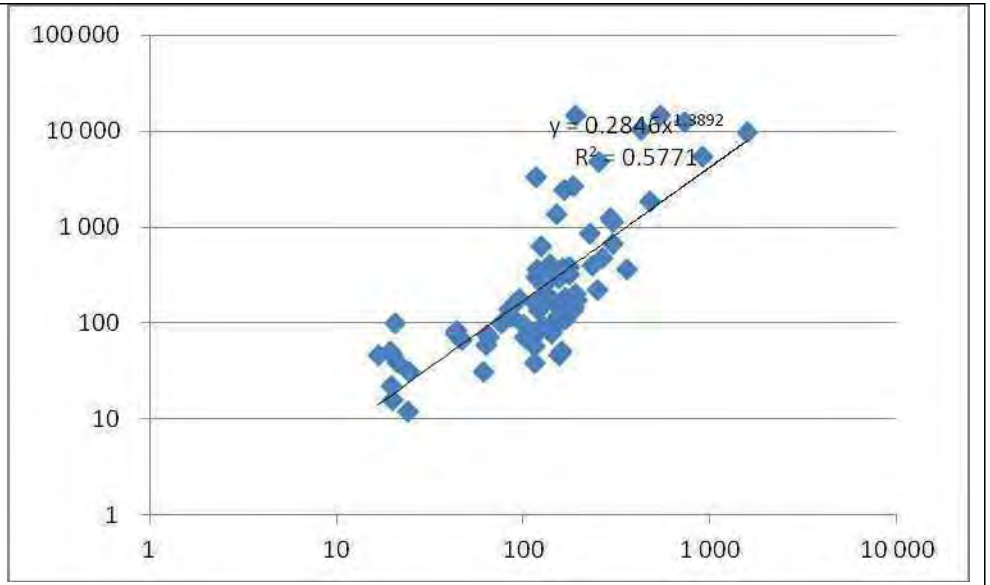
1962: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



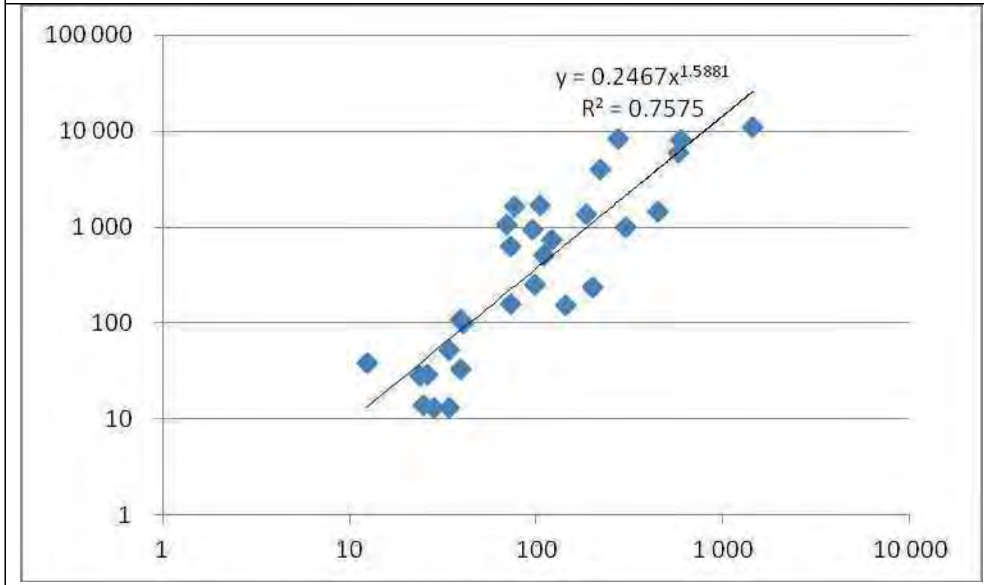
1963: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



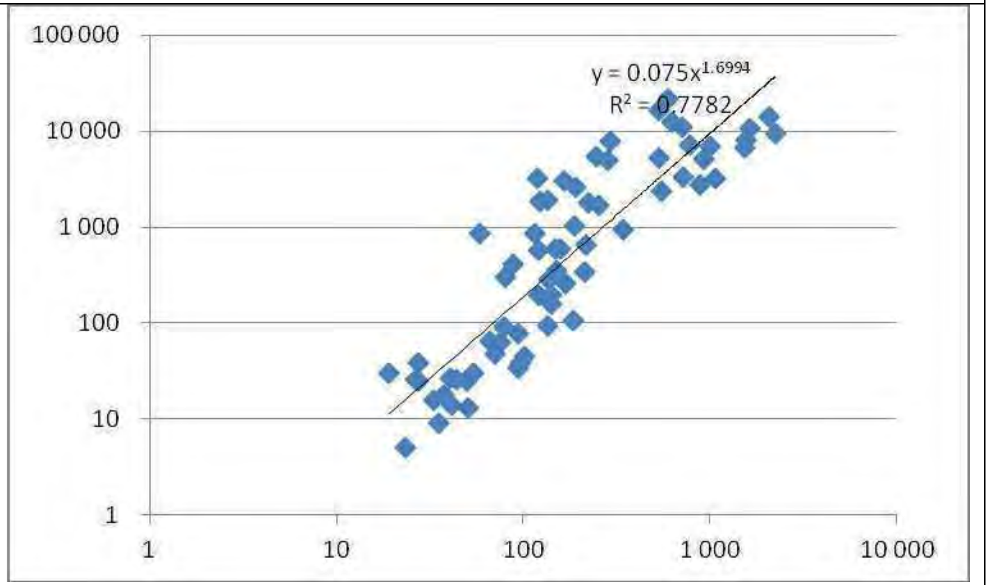
1964: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



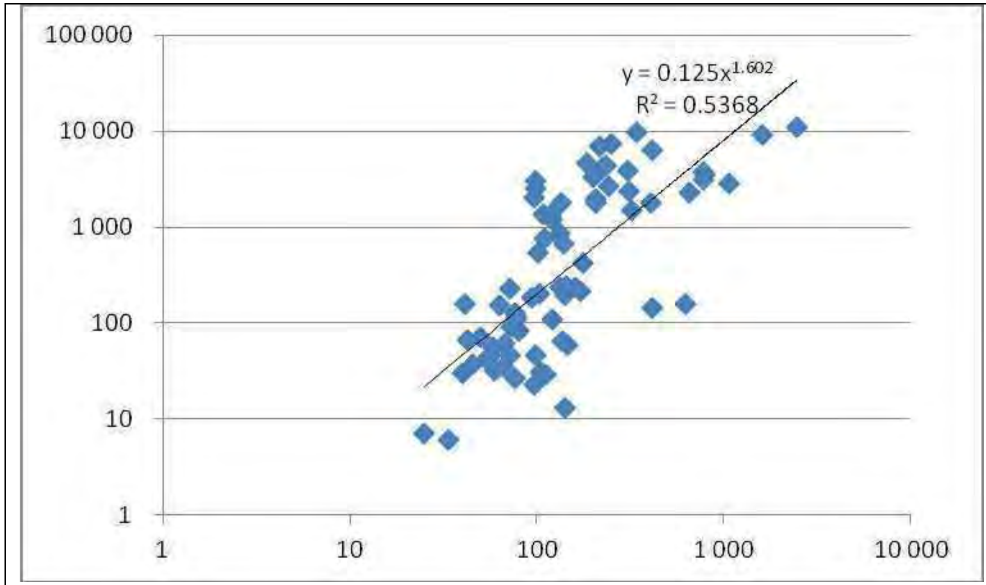
1965: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



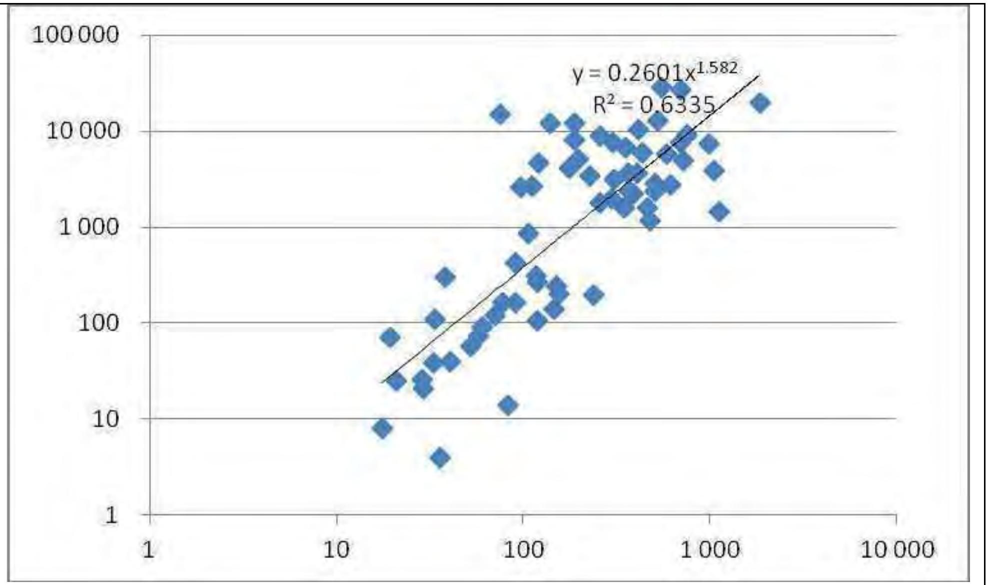
1966: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



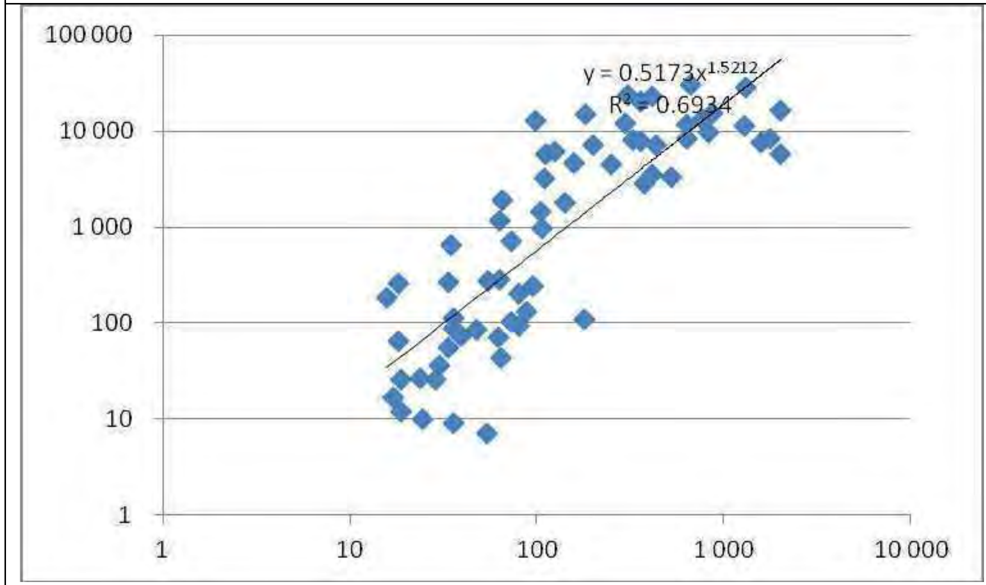
1967: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



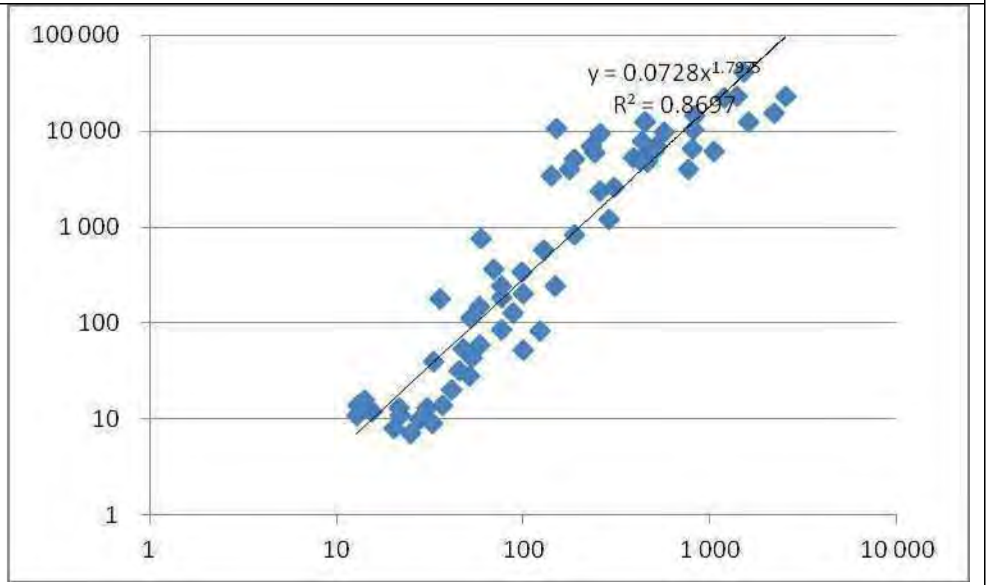
1968: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



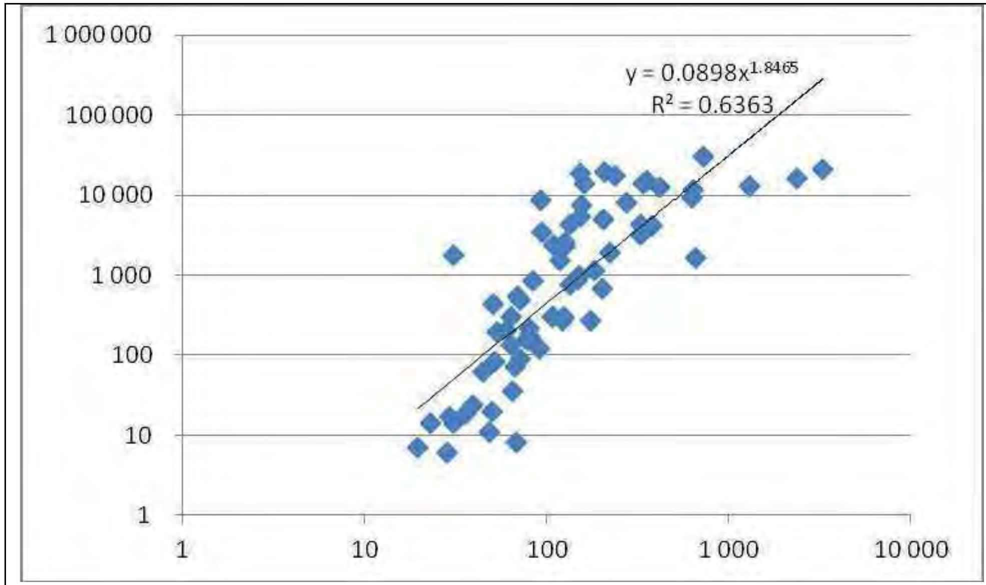
1969: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



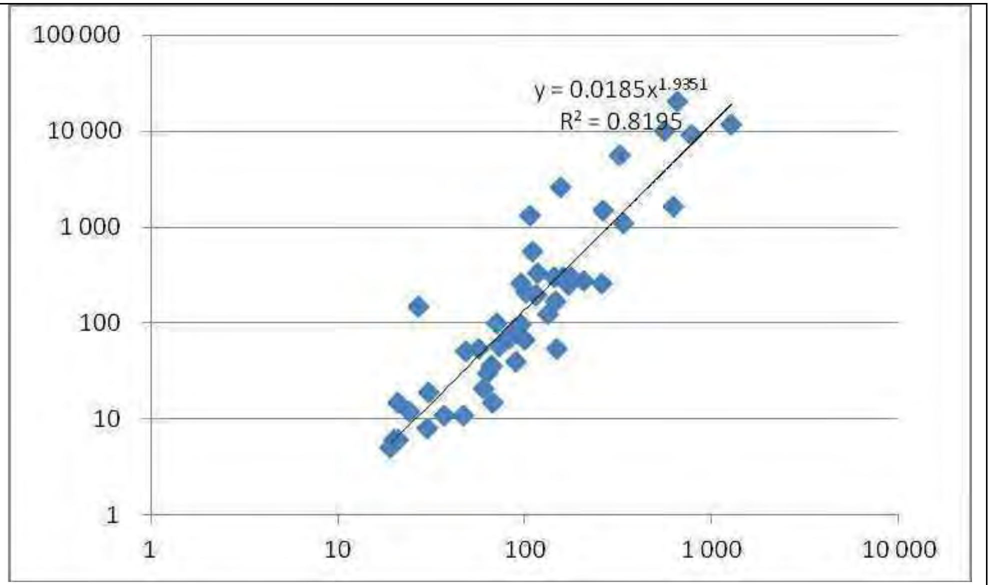
1970: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



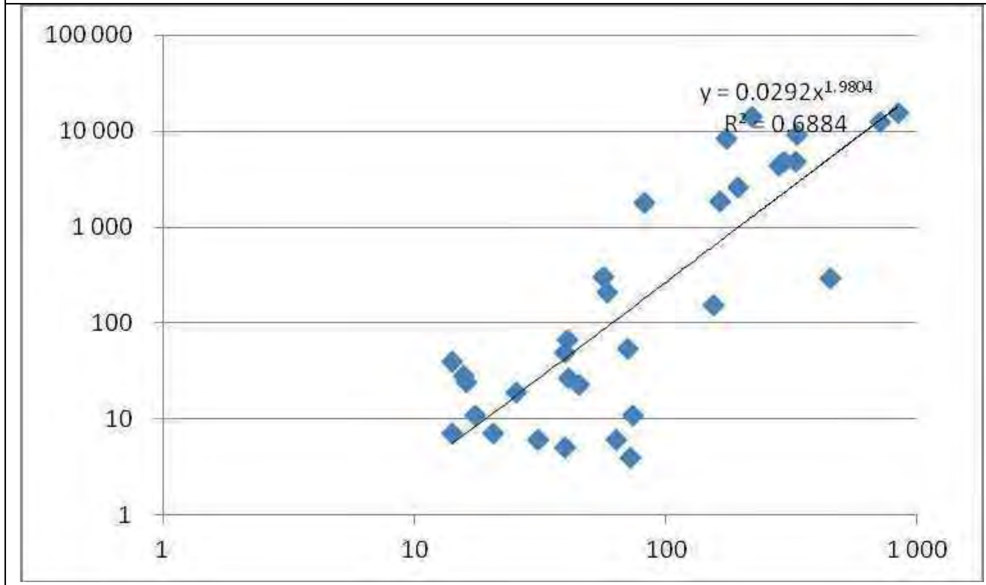
1971: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



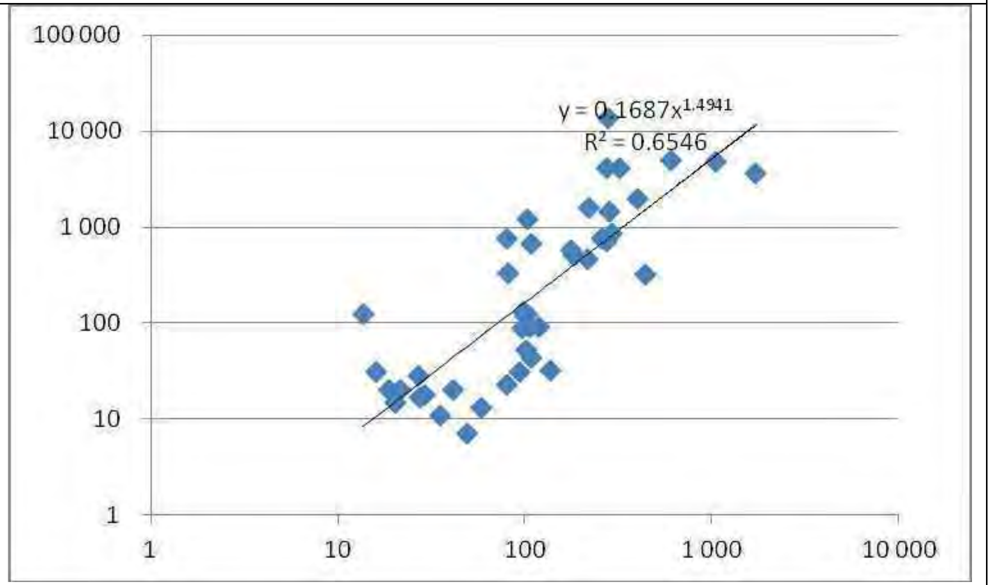
1972: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



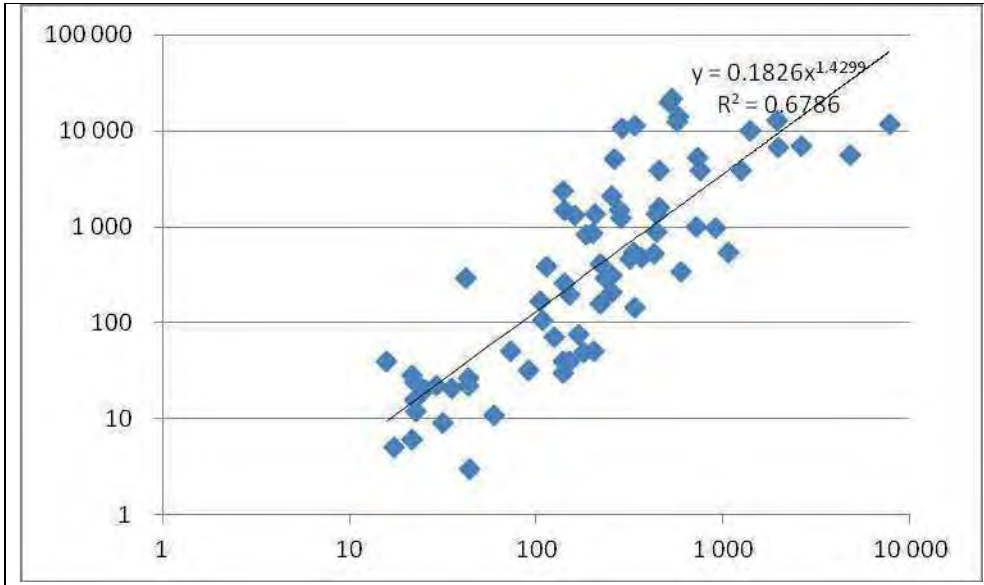
1973: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



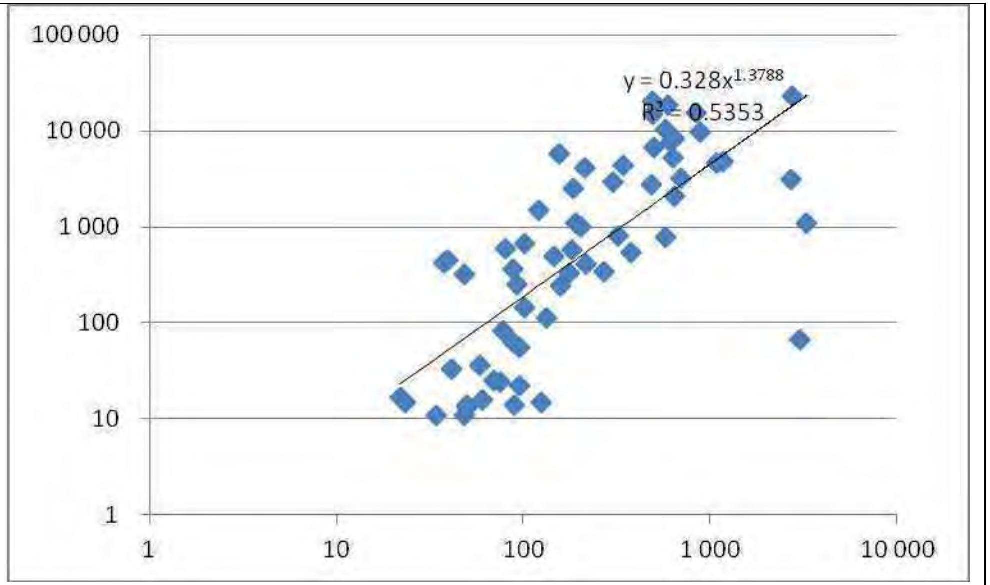
1974: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



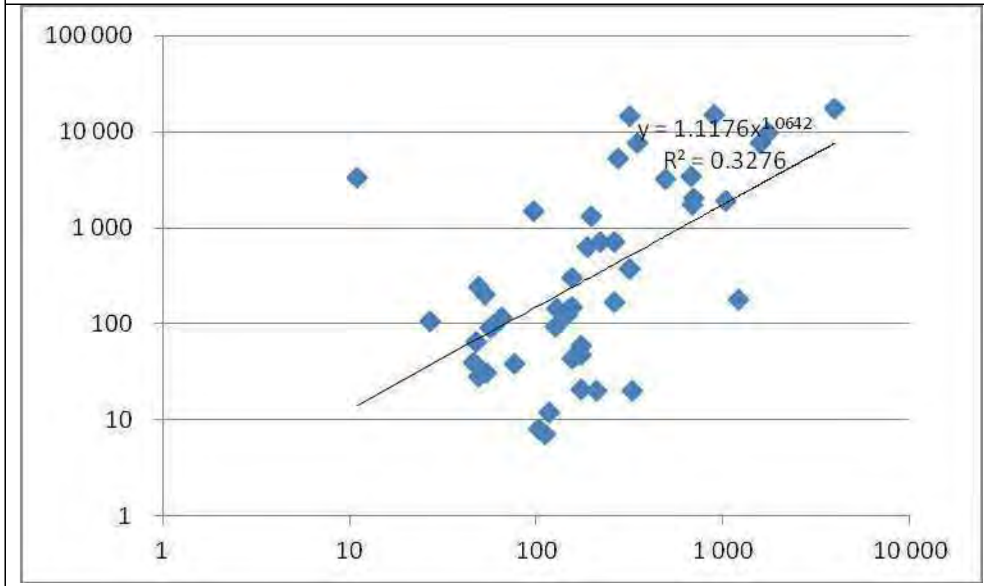
1975: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



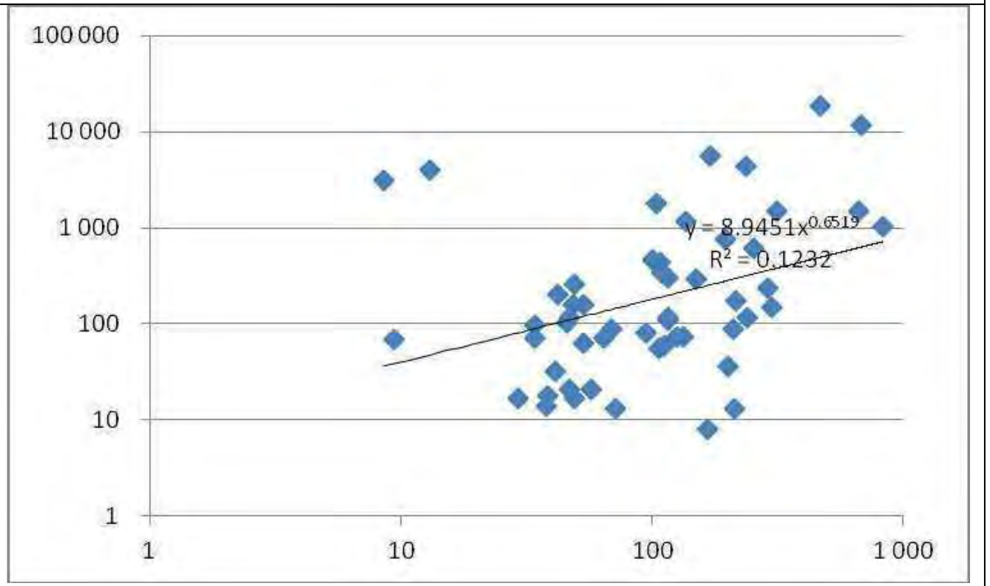
1976: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



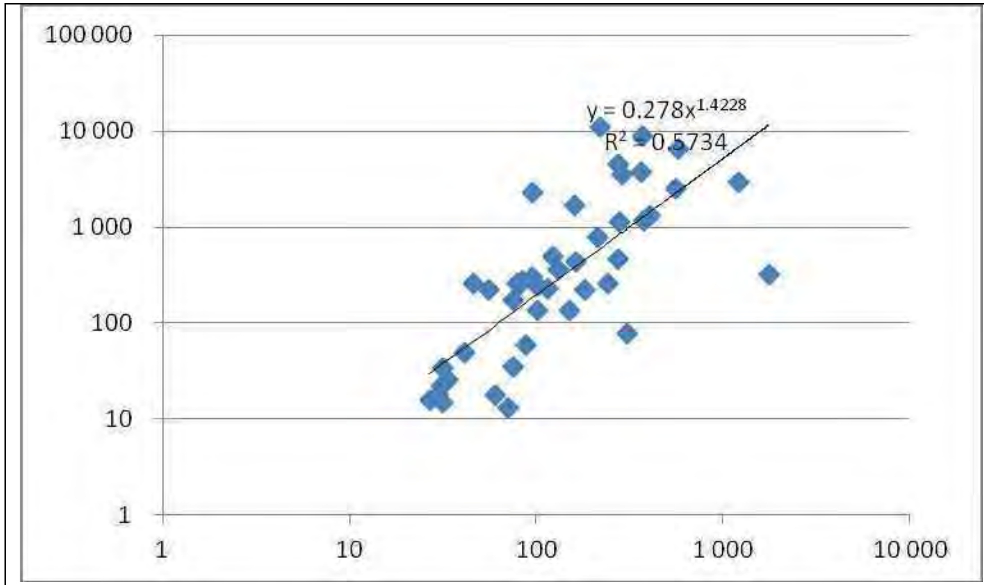
1977: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



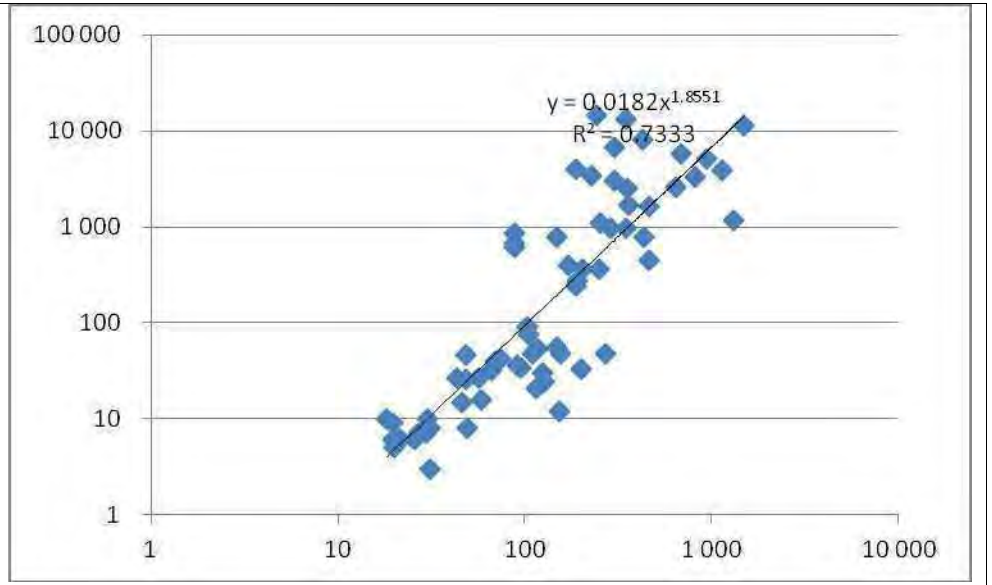
1978: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



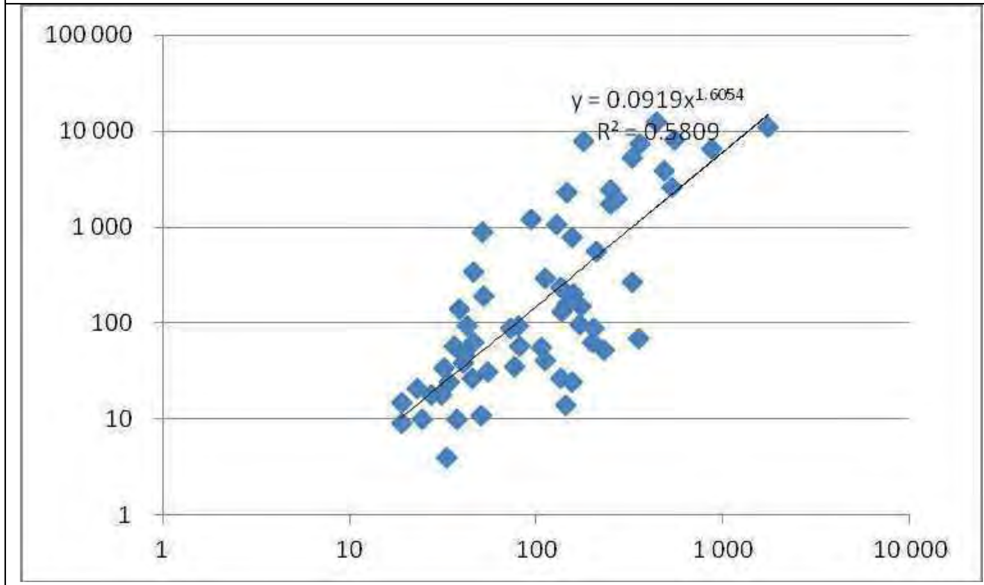
1979: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



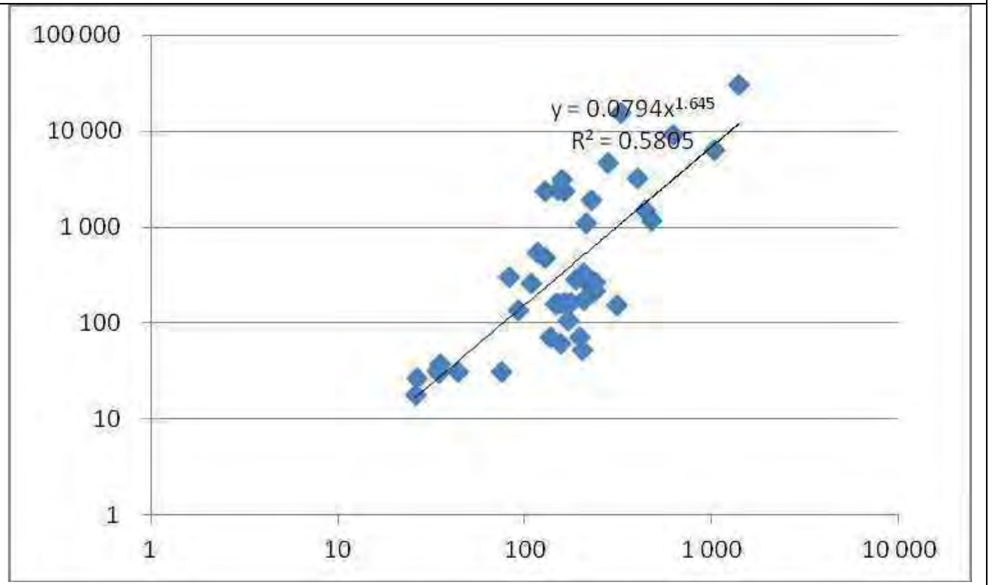
1980: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



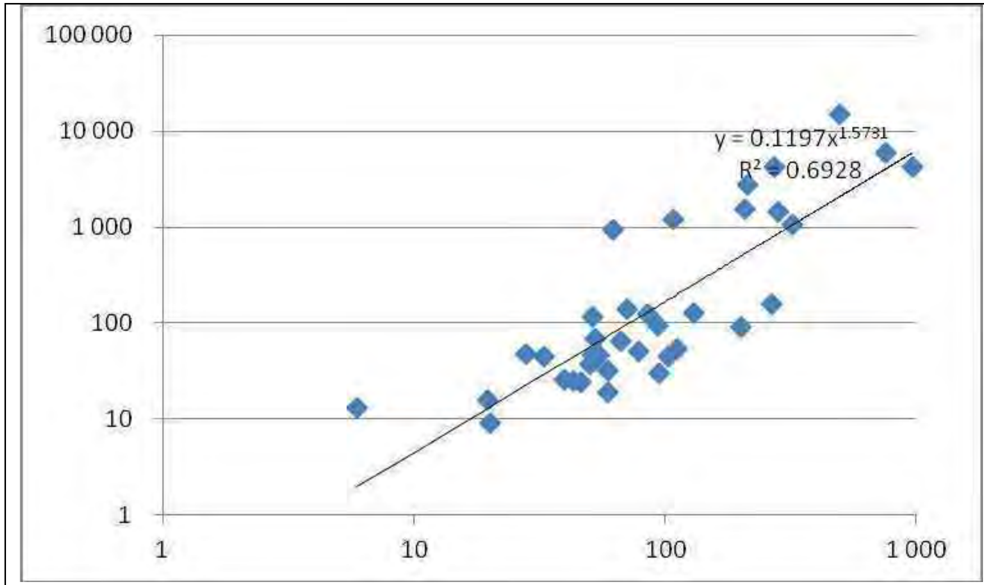
1981: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



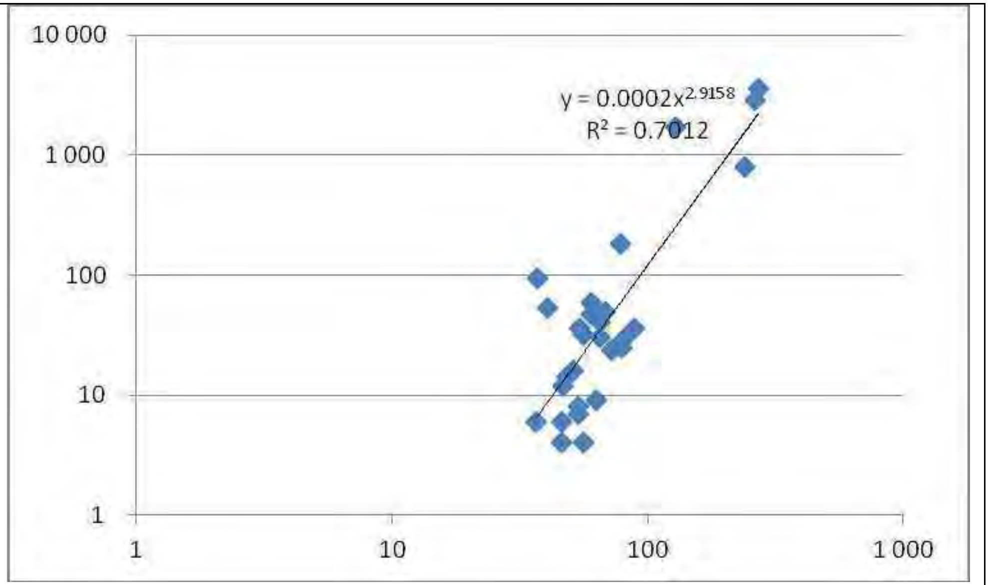
1982: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



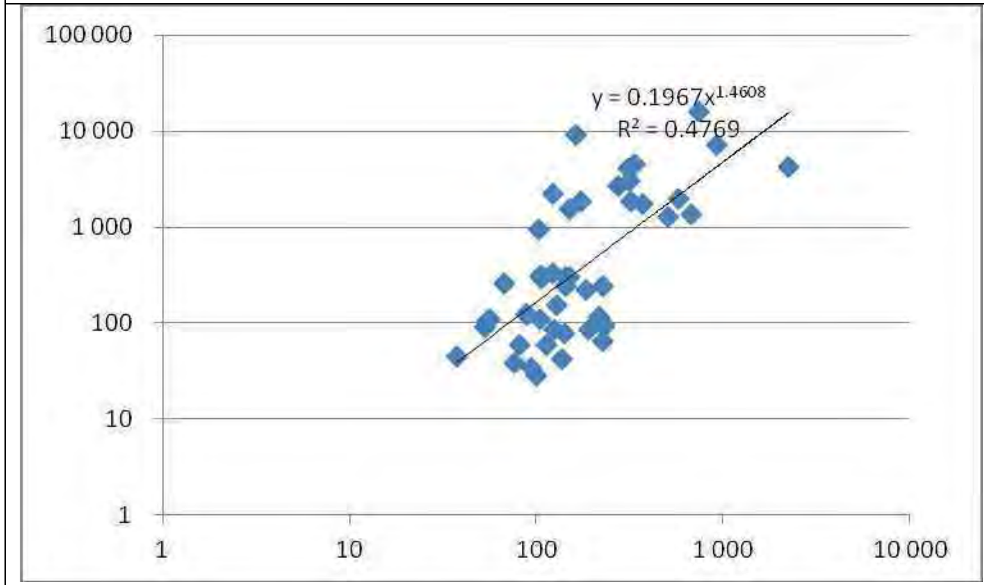
1983: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



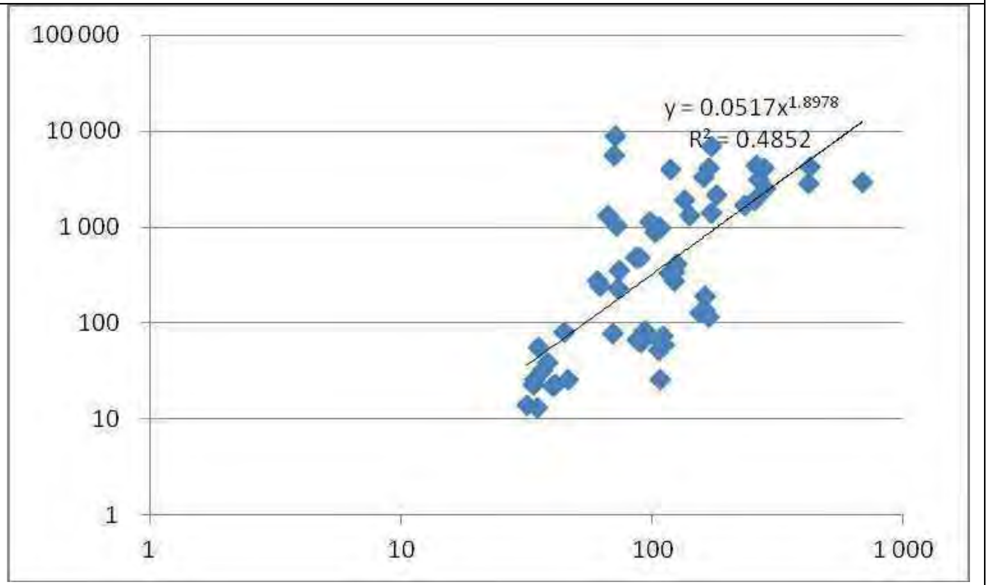
1984: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



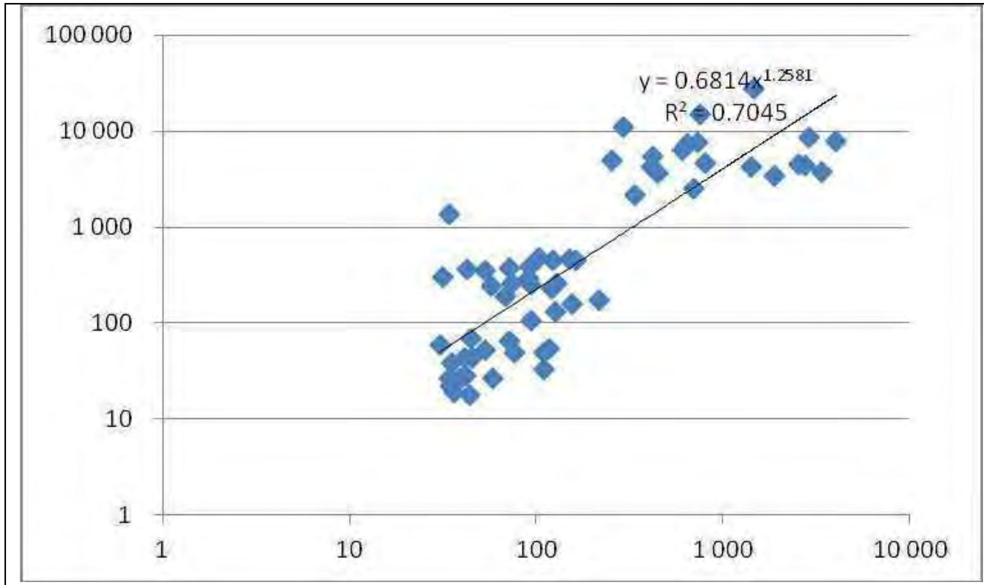
1985: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



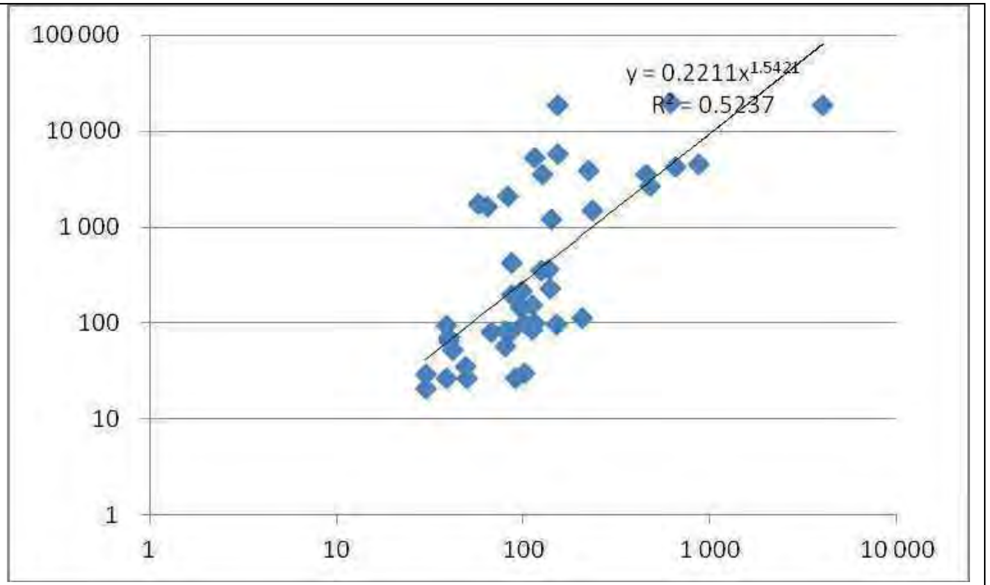
1986: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



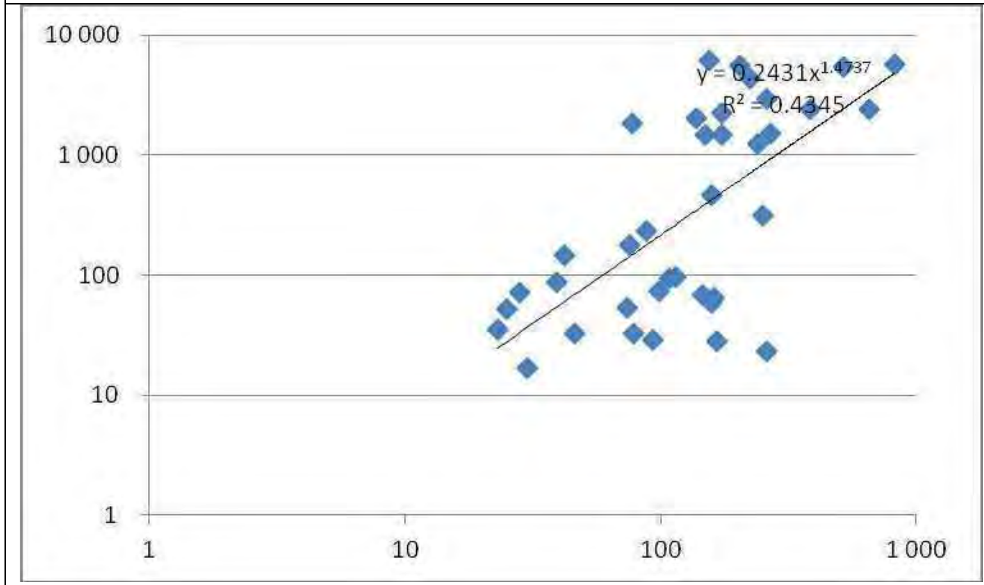
1987: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



1988: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



1989: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



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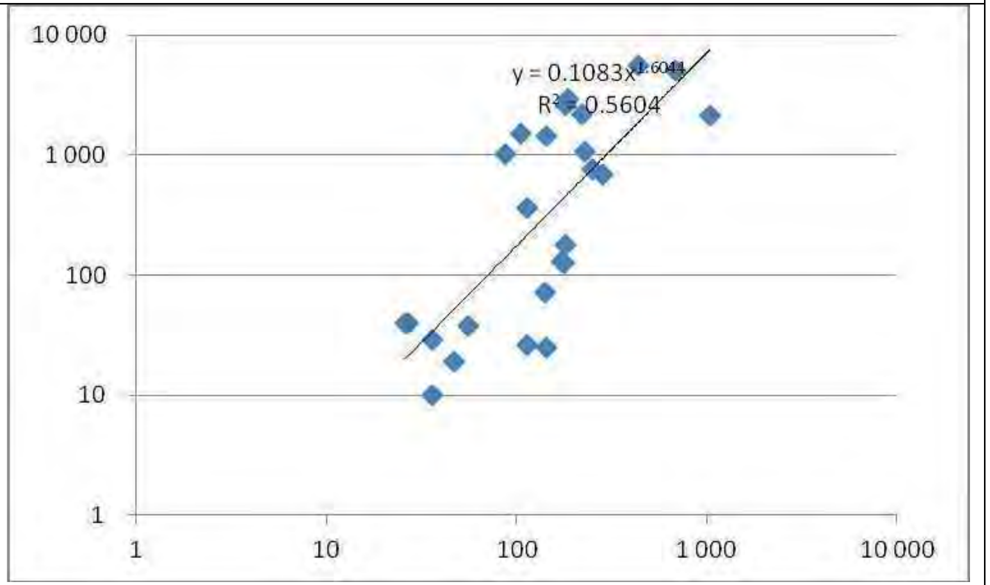
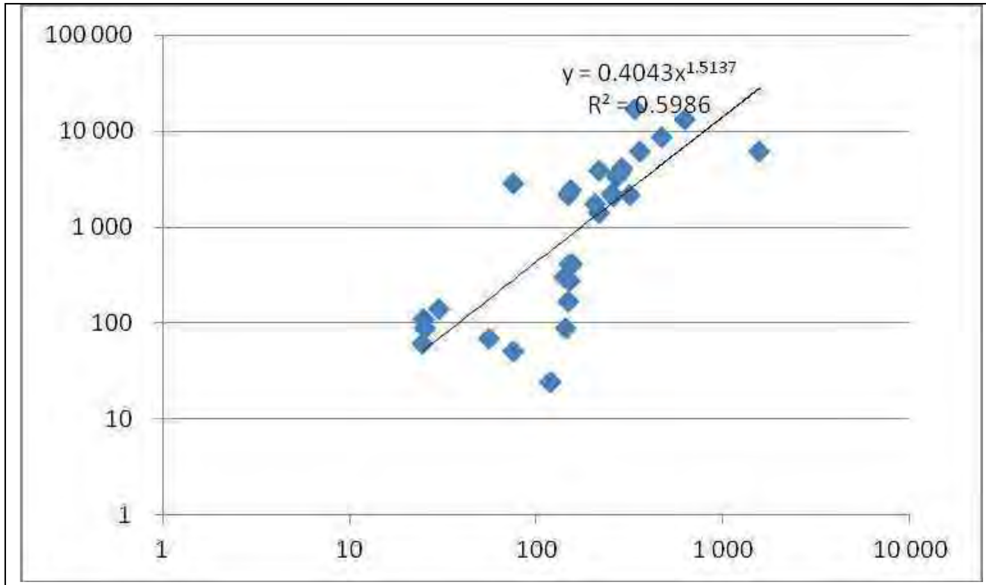
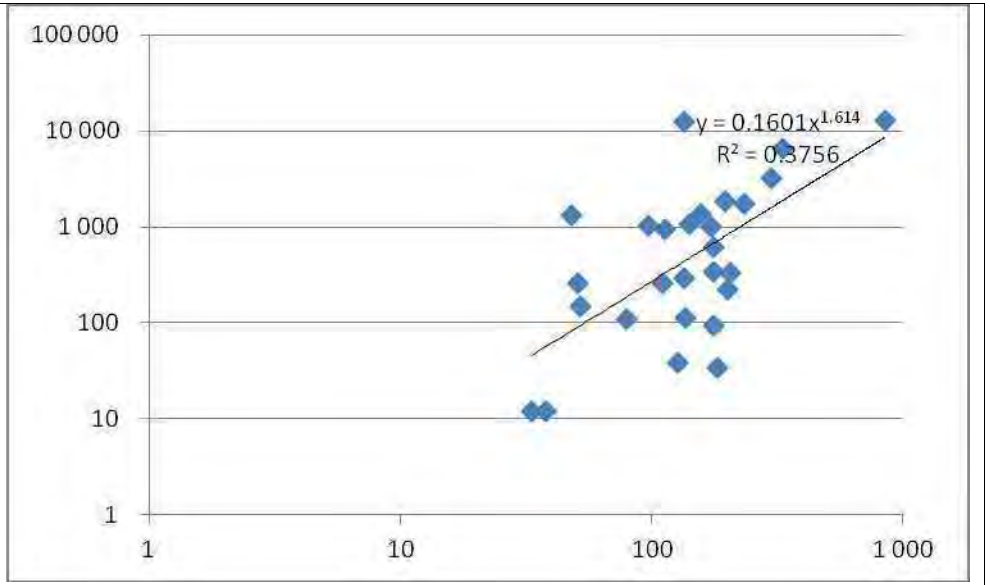


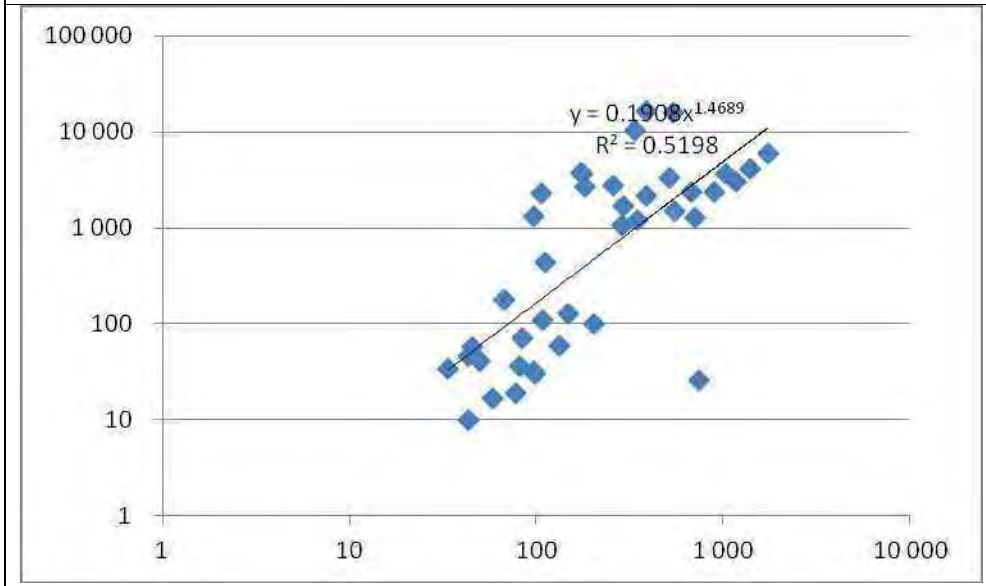
1991: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



1992: Suspended sediment (ppm, vertical axis) vs discharge (m³s⁻¹)



1993: Suspended sediment (ppm, vertical axis) vs discharge (m³s⁻¹)



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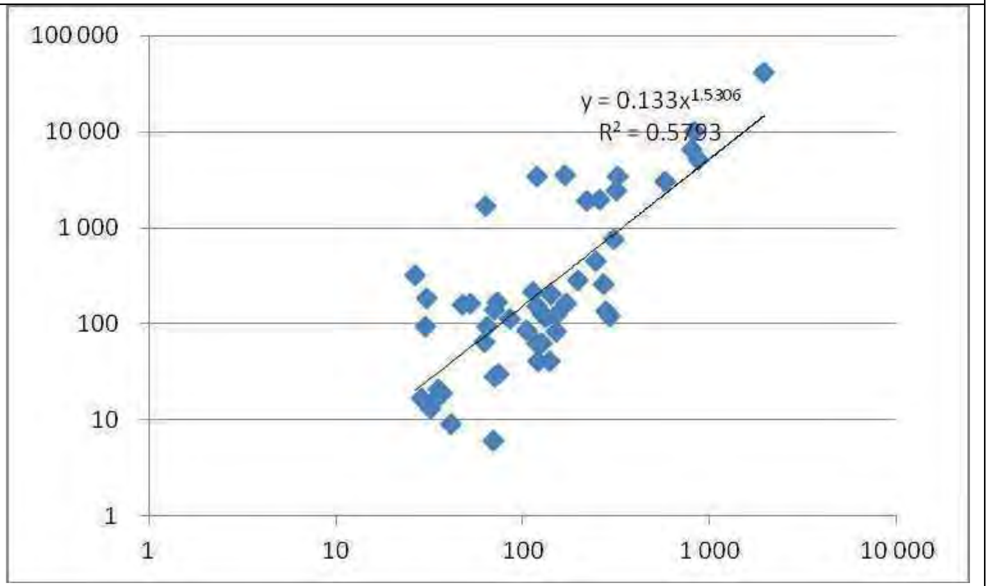

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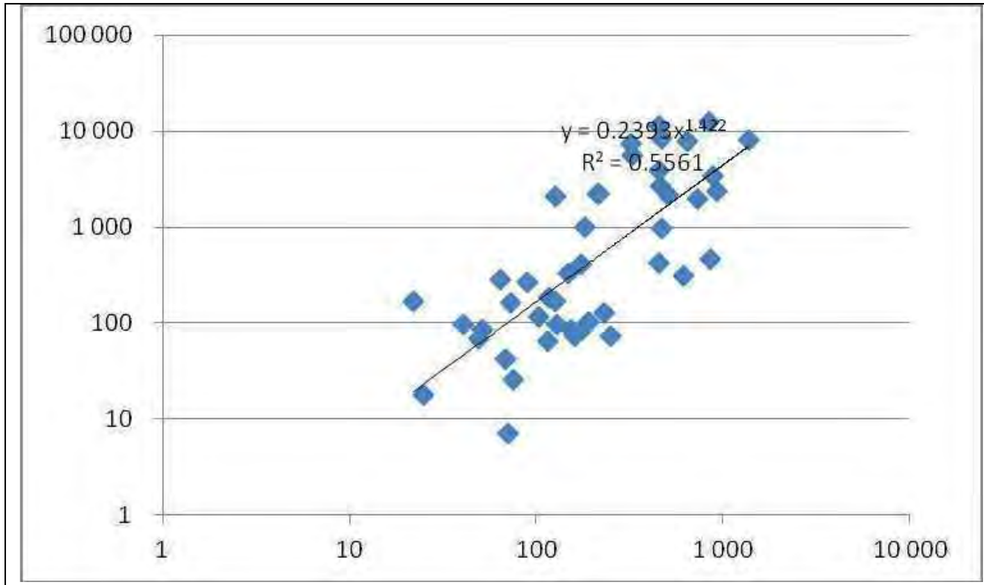
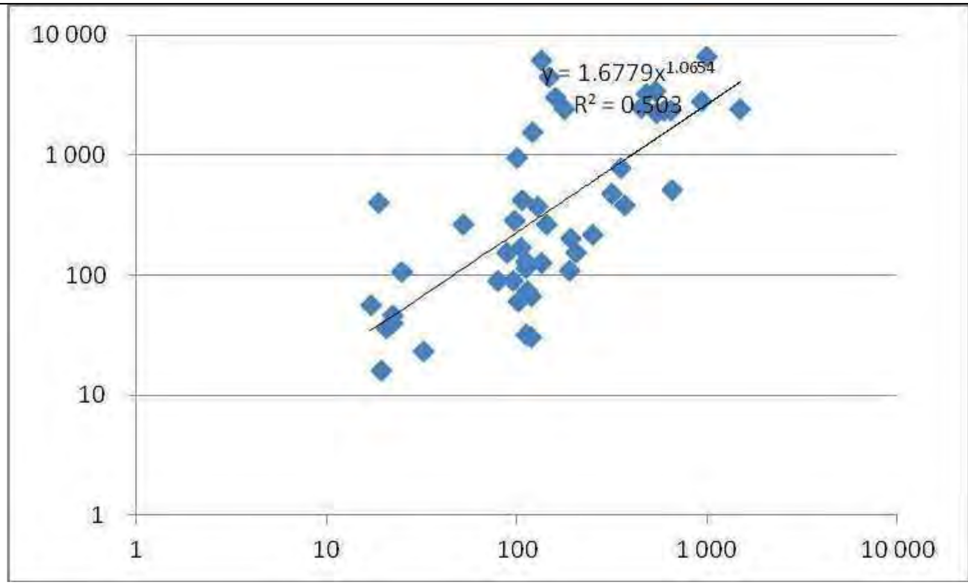
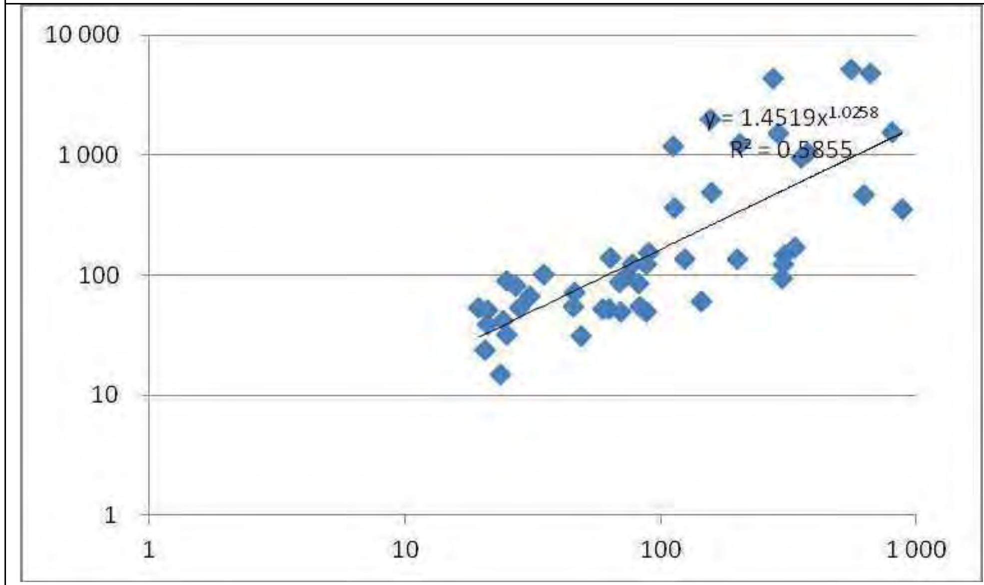


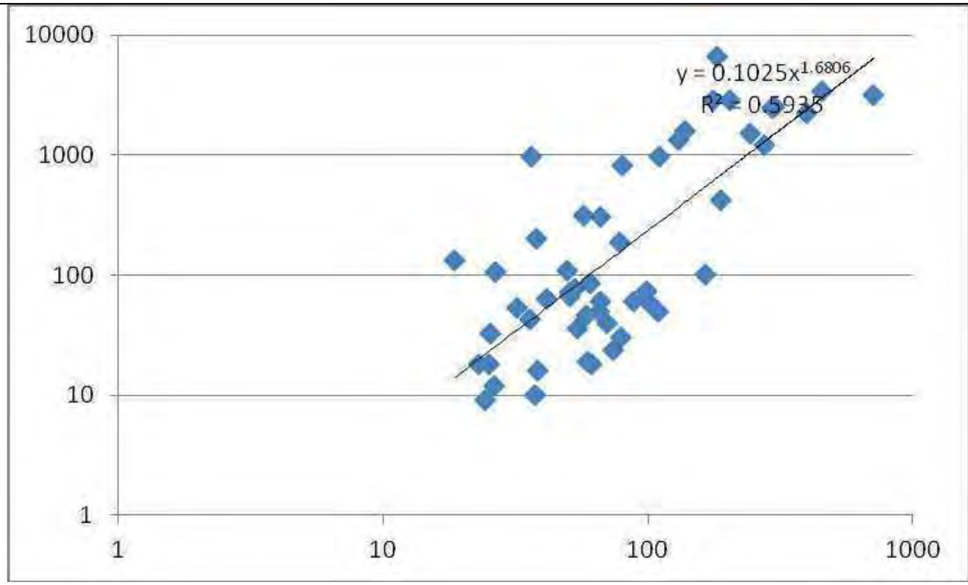
1996: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



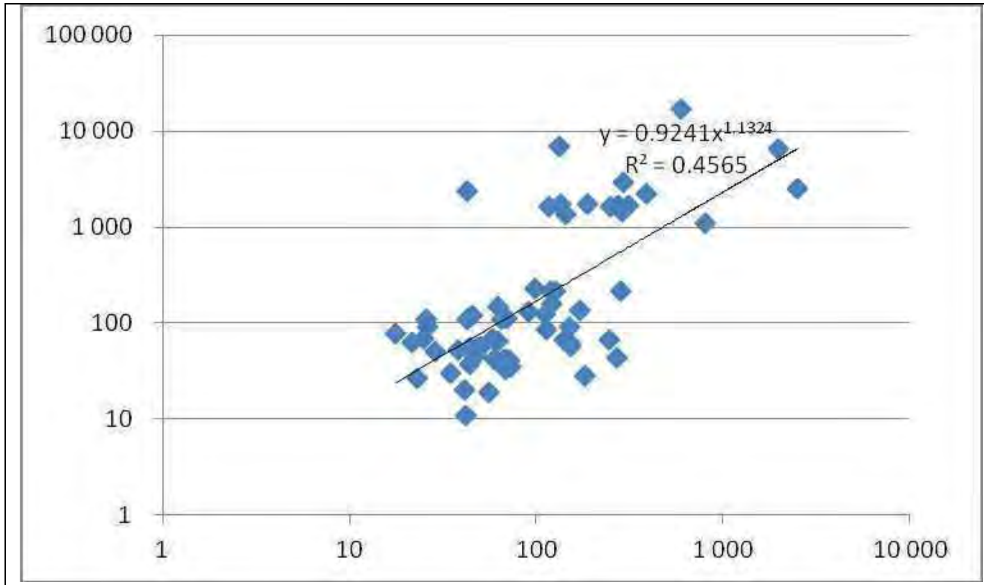
1997: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



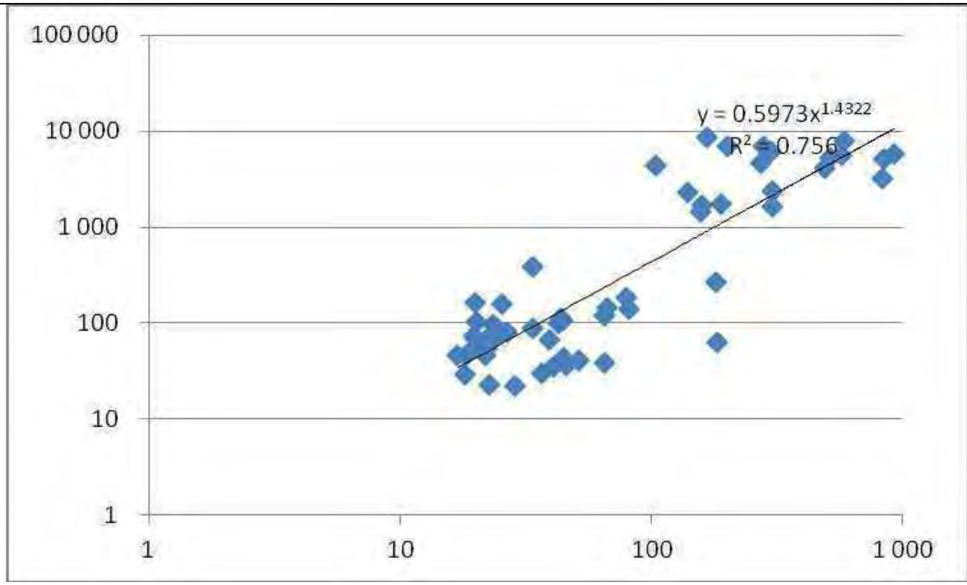
1998: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



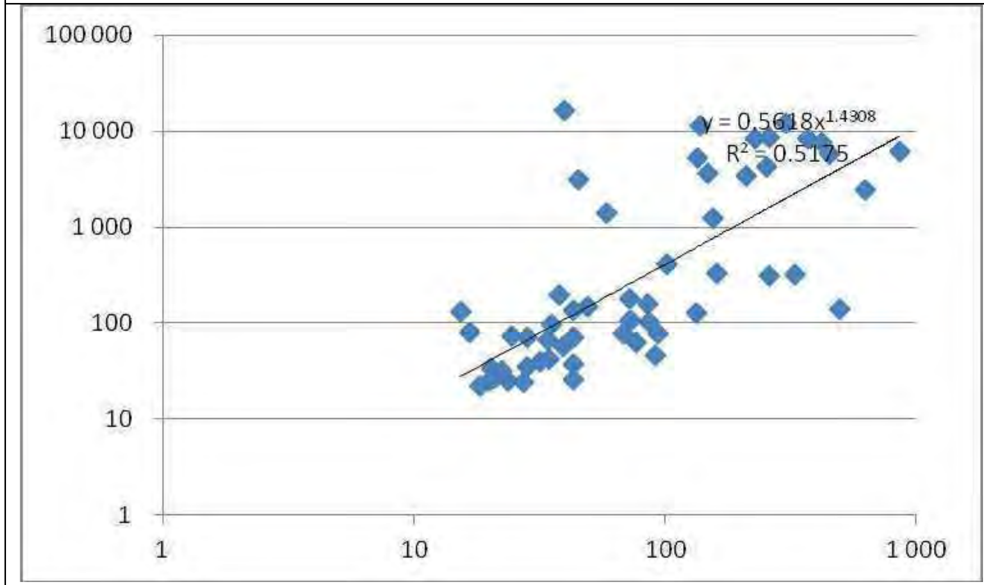
1999: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



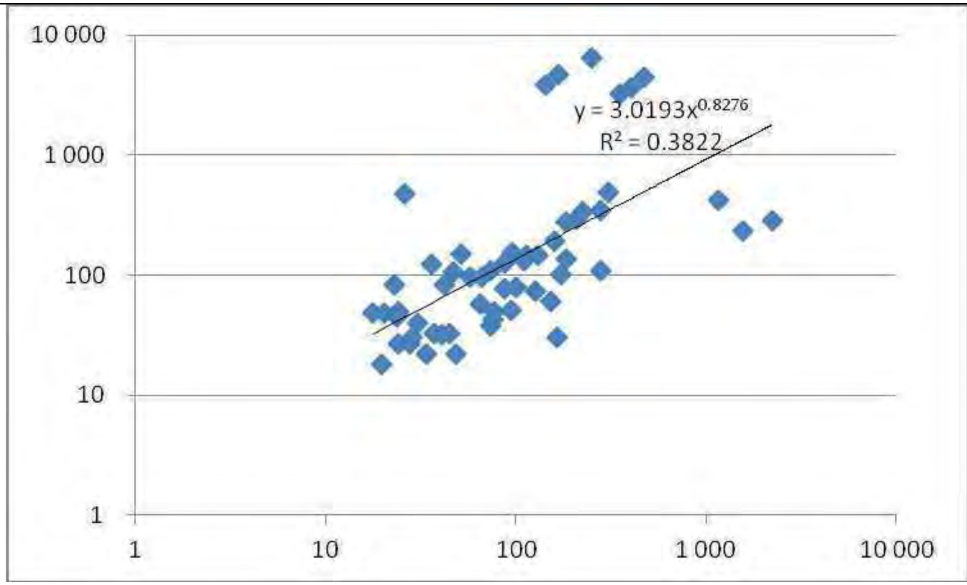
2000: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



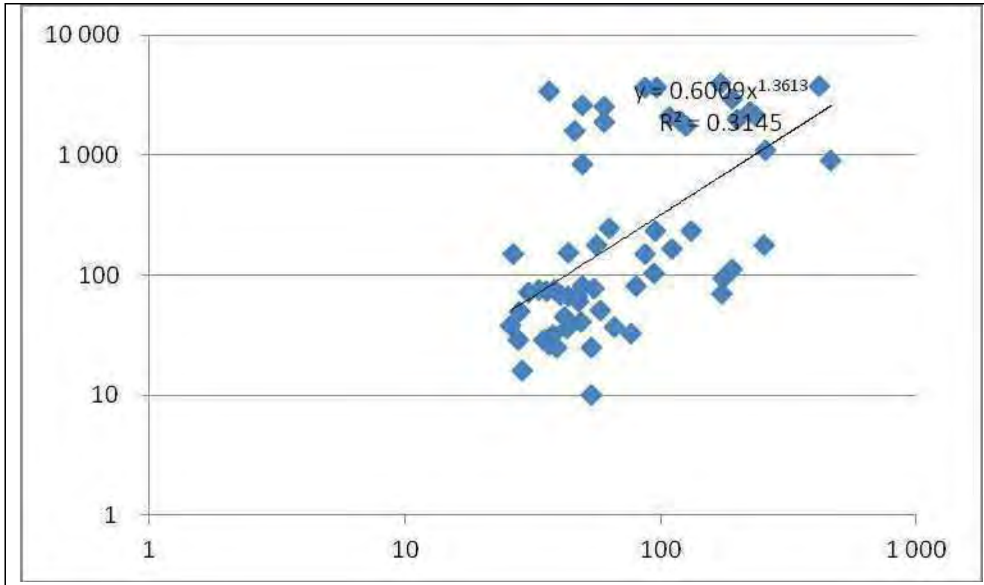
2001: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



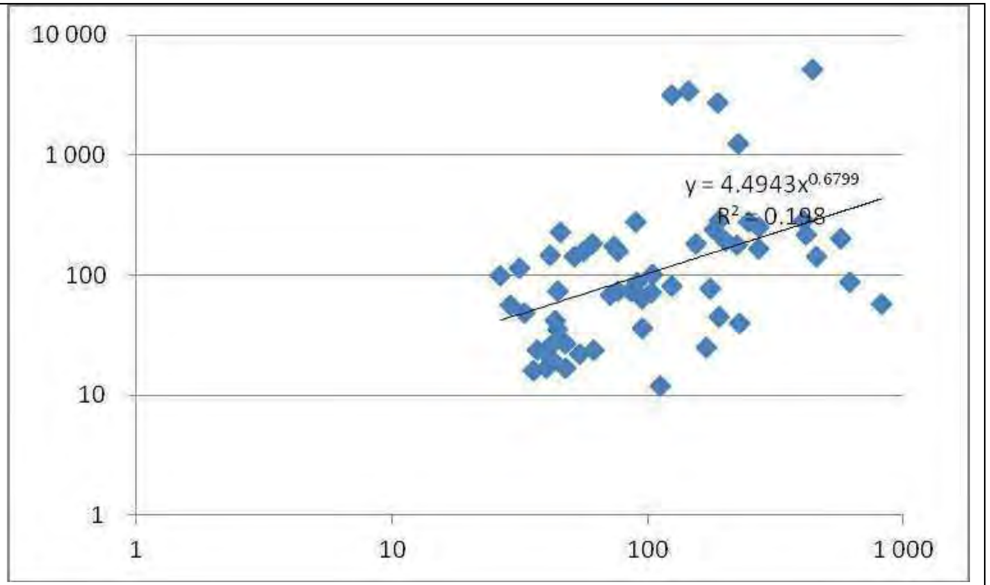
2002: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



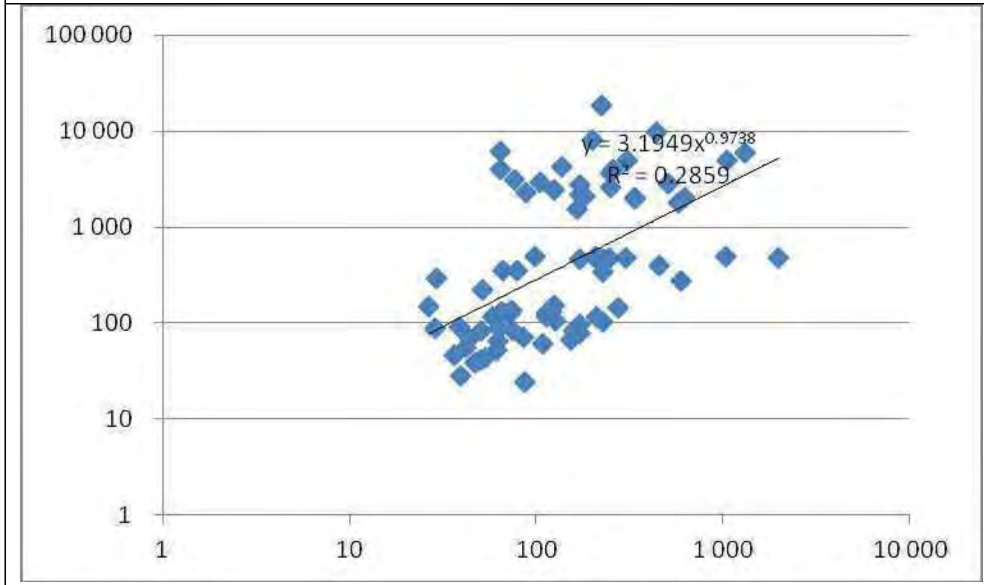
2003: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



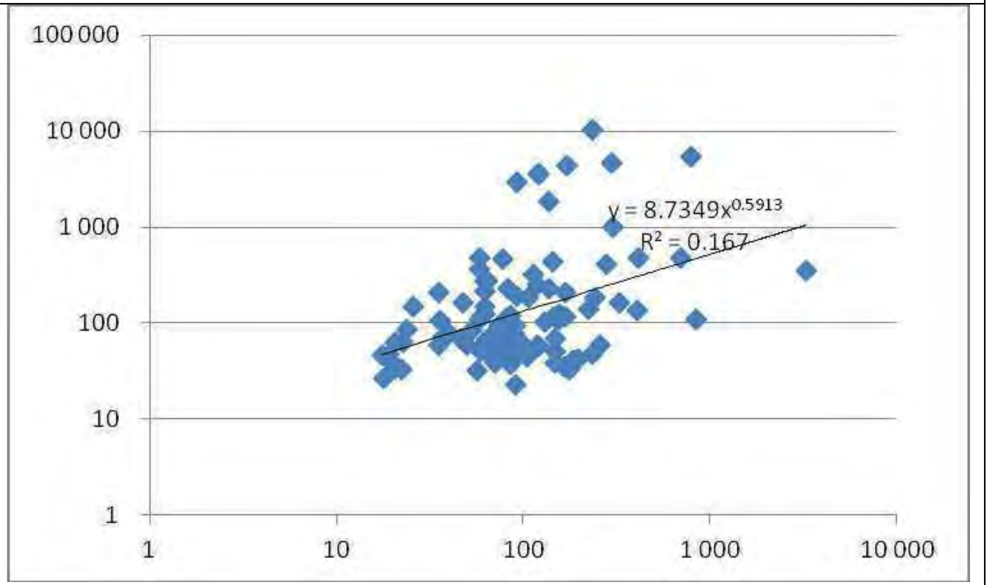
2004: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



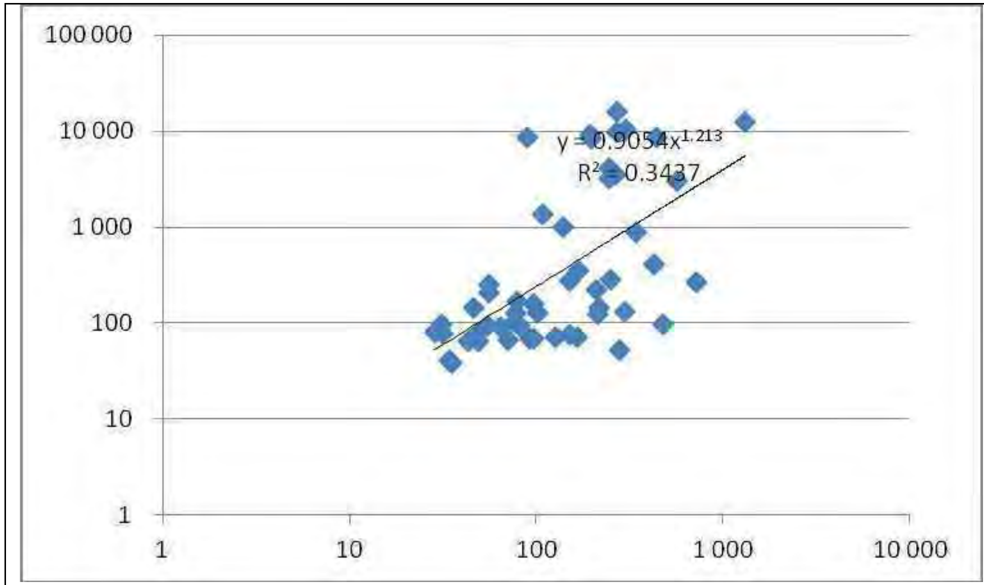
2005: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



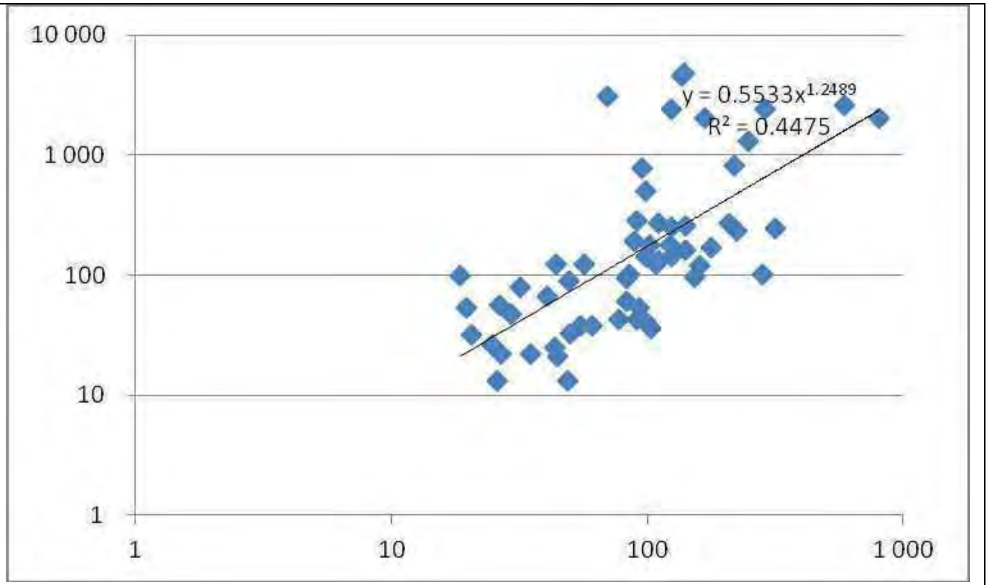
2006: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



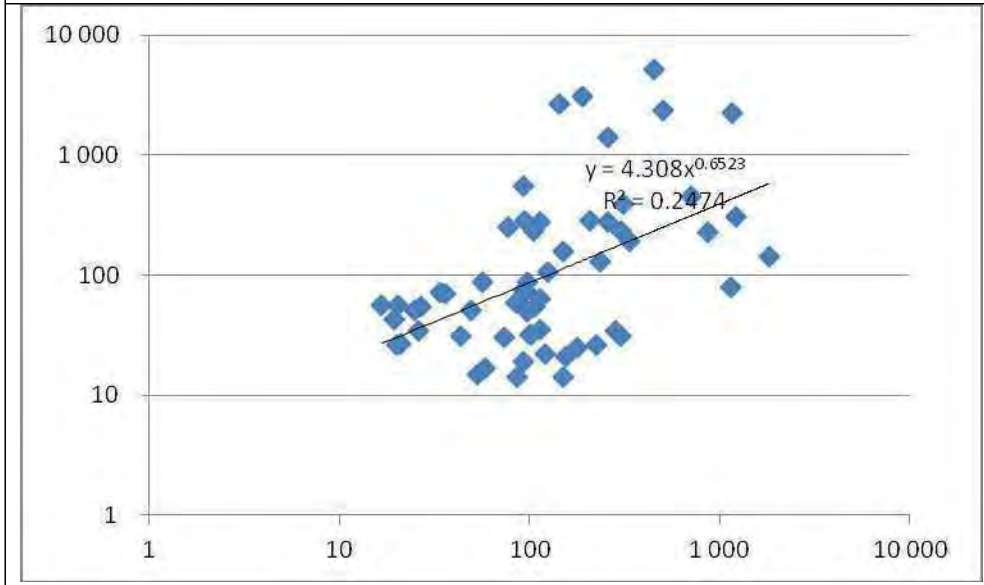
2007: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



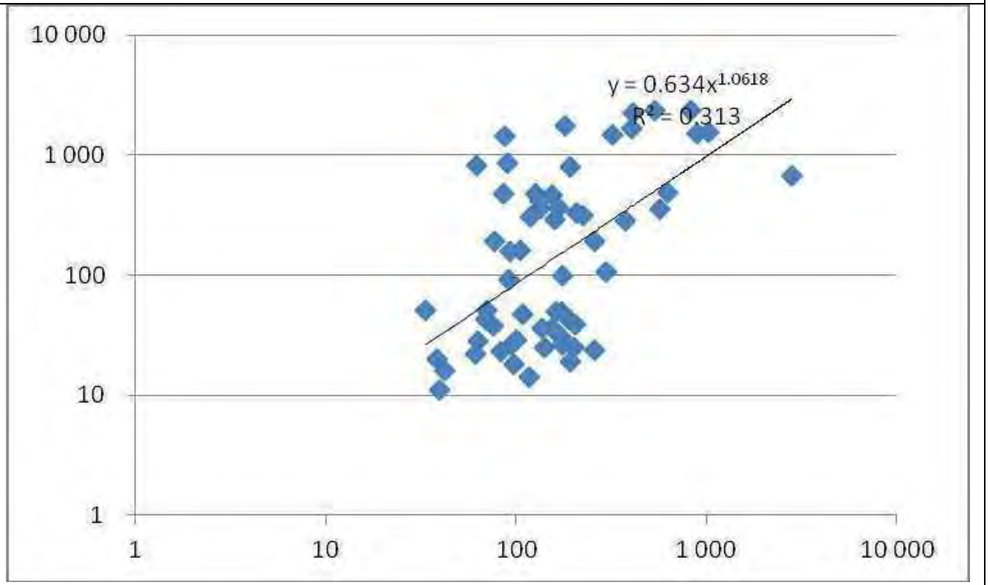
2008: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



2009: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



2010: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})



2011: Suspended sediment (ppm, vertical axis) vs discharge (m^3s^{-1})

Appendix F: Mitigation Strategies with Respect to the Impact of Sand and Gravel Mining in the Poonch Basin

See following pages.

GULPUR HYDROPOWER PLANT

POSSIBLE MITIGATION STRATEGIES WITH RESPECT TO THE IMPACT OF SAND AND GRAVEL MINING IN THE POONCH BASIN

DRAFT REPORT
March 2014

Fluvius Consultants
Southern Waters ER&C

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List of Acronyms

AJK:	Azad Jammu and Kashmir
DID:	Department of Irrigation and Drainage (Malaysia)
EF:	Environmental Flows
HBP:	Hagler Bailey Pakistan
HPP:	Hydroelectric Power Plant
I&Aps	Interested and Affected Parties
IUCN:	International Union for the Conservation of Nature
masl:	Metres above sea level
MCM:	Million cubic metres
MTonnes:	Million tonnes
ppm:	Parts per million
SWHP:	Surface Water Hydrology Project
ToR:	Terms of Reference
USA:	United States of America
VO:	Variation Order
WAPDA:	Water and Power Development Authority (Pakistan).

1 INTRODUCTION

1.1 TERMS OF REFERENCE

Hagler Bailey Pakistan (HBP) appointed Southern Waters to undertake work in accordance with a Variation Order (VO) on the Critical Habitat Assessment and Biodiversity Action Plan: Gulpur HPP. Fluvius Consultants were appointed by Southern Waters to outline the possible mitigation strategies with respect to the impact of sand and gravel mining in the Poonch Basin.

The Terms of Reference were to:

- Provide input on changes in availability of sand and gravel from the river (see Section 2 and the EF Assessment Report).
- Outline possible mitigation strategies with respect to the impact of sand and gravel mining on the river structure and function in the form of a framework for the control of these mining activities (Section 3).
- Provide an overview of potential mitigation management actions that could be employed to create more controlled, ecologically benign approaches for sand and cobble extractions from the river (Sections 3 and 4).
- Develop a Terms of Reference (ToR) for undertaking a feasibility study of more ecologically-friendly sediment (sand and cobble) mining in the Poonch River and its tributaries, with regard to the proposed development of the Gulphur HPP (Section 5).

1.2 IMPORTANT FISH HABITATS IN THE POONCH RIVER

Information on the ecologically important aspects of the physical habitat was gleaned from published information, discussions with regional experts[1], site observations and experience from previous studies.

More than 30 fish species are dependent on the river habitats in the Poonch River. At least 12 of these are of special concern as they are either endemic to Pakistan, are included in the IUCN Red List 2013[2], or are commercially-important food fishes. One species, Mahaseer (*Tor putitora*) is listed as Endangered in the IUCN Red List 2013 and another, the Kashmir Catfish (*Glyptothorax kashmirensis*), is listed as Critically Endangered. The Mahaseer is a prized sport and food fish.

The most important breeding areas for the fish are the tributary backwaters that are created by back flooding from the Poonch River up in to the tributary junctions during the high wet season baseflows (Dr Muhammad Rafique, Pakistan Museum of Natural History, Islamabad, pers. comm.), although backwaters in the mainstem also play an important role. In the

[1] Discussions with Mr Vaqar Zakaria (Hagler Bailly Pakistan) and Dr Muhammad Rafique (Pakistan Museum of Natural History, Islamabad).

[2] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 26 October 2013.

mainstem river is it largely the vegetated lateral (riparian) zones of the river that are important. The elevated water levels in the wet season inundate this marginal vegetation, creating low velocity refugia for fish that are used as both breeding and nursery areas.

The estimated relative importance of the Poonch mainstem and side tributaries (nullahs) as breeding areas for endangered fish is given in Table 1-1.

Table 1-1 Relative importance of the Poonch River mainstem and tributaries (nullahs) for breeding areas for endangered fish

River/river reach	Relative importance (%)
Poonch River (upper mainstem)	30
Rangar Nullah	18
Ban Nullah	15
Mehdar Nullah	15
Netil Nullah	11
Hajira Nullah	11

Although unsustainable over-fishing (sometimes using poisons, electrical devices and explosives) is considered to be the primary threat to the survival of the fish in the Poonch River, destruction of the spawning habitat by extraction of gravel and sand is also a major cause for concern, particularly given the recent increase in these activities linked with improvements to the road network (Section 1.3.3).

1.3 MINING IN THE POONCH BASIN

River sediments in the Poonch Basin are both a valuable environmental and economic resource. Apart from the provision of habitats for riverine biota, the sediment is mined from the river for use in building, road construction and other related activities. Sands and silts are used directly, and cobbles and boulders are crushed to create aggregate material. As such the sediments of the Poonch River and its tributaries are Valued Environmental Components.

1.3.1 Extraction methods used

The mining techniques used range from crude, labour intensive methods to larger scale mechanical methods. Smaller scale operations involve shovels and spades (Figure 1-1), but larger mechanised operations (Figure 1-2) are increasingly evident, particularly near urban areas.

Figure 1-1 Extraction of fine sands (left) and cobbles (right) on the Poonch River near EF Site 2

Figure 1-2 A mining operation in the bed of the Ban Nullah near its confluence with the Poonch River.

1.3.2 Ecological impacts associated with mining

River mining destroys aquatic habitats at the point of mining activities (Figure 1-3) but also reduces the size and amount of sediment that is distributed downstream, which can smother aquatic habitats in the downstream reaches. Changes to aquatic habitats as a result of mining have knock-on effects on the fish and other biota.

The ecological impacts associated with mining in the Poonch River include:

- complete destruction of instream and riparian habitat within the mined reach;

- lateral bank instability (Kondolf 1994) leading to erosion of the river banks and lateral bars, as well as any floodplain pockets;
- bed coarsening (Kondolf 1994) leading to a loss of gravel habitats, decreased bed mobility and overall poorer inchannel habitat conditions;
- elevated fines in the downstream areas, and smothering of downstream habitats and seeds, eggs, etc.;
- erosion of the bed and banks downstream of the site as the river "replaces" the sediment removed from the mined reach (Kondolf 1997); and
- bed and bank erosion upstream of the mined reach, if the nickpoint of the lowered bed erodes upslope. Such incision can migrate for kilometres upstream (Scott 1973; Stevens et al. 1990) and erode into tributaries (Harvey and Schumm 1987). The lowered river bed can also result in the abandonment of secondary channels.

Figure 1-3 Sediment mining degrades the in-channel and riparian (banks) environment through direct disturbance, vegetation removal and washing of fine sediment in to the channel and downstream (http://www.fdb.org.pk/documents/mnp.pdf, accessed February 2013).

1.3.3 Locations and timing

Mining of river sediment in the Poonch Basin is limited by access to the rivers. The locations where mining currently (2013) takes place are shown in Figure 1-4. Historically, mining was localized around major settlements, such as near the towns of Tatta Pani, Kotli, Barali, Gulpur and Radjhani, but this is no longer the case. The expansion of the road network and

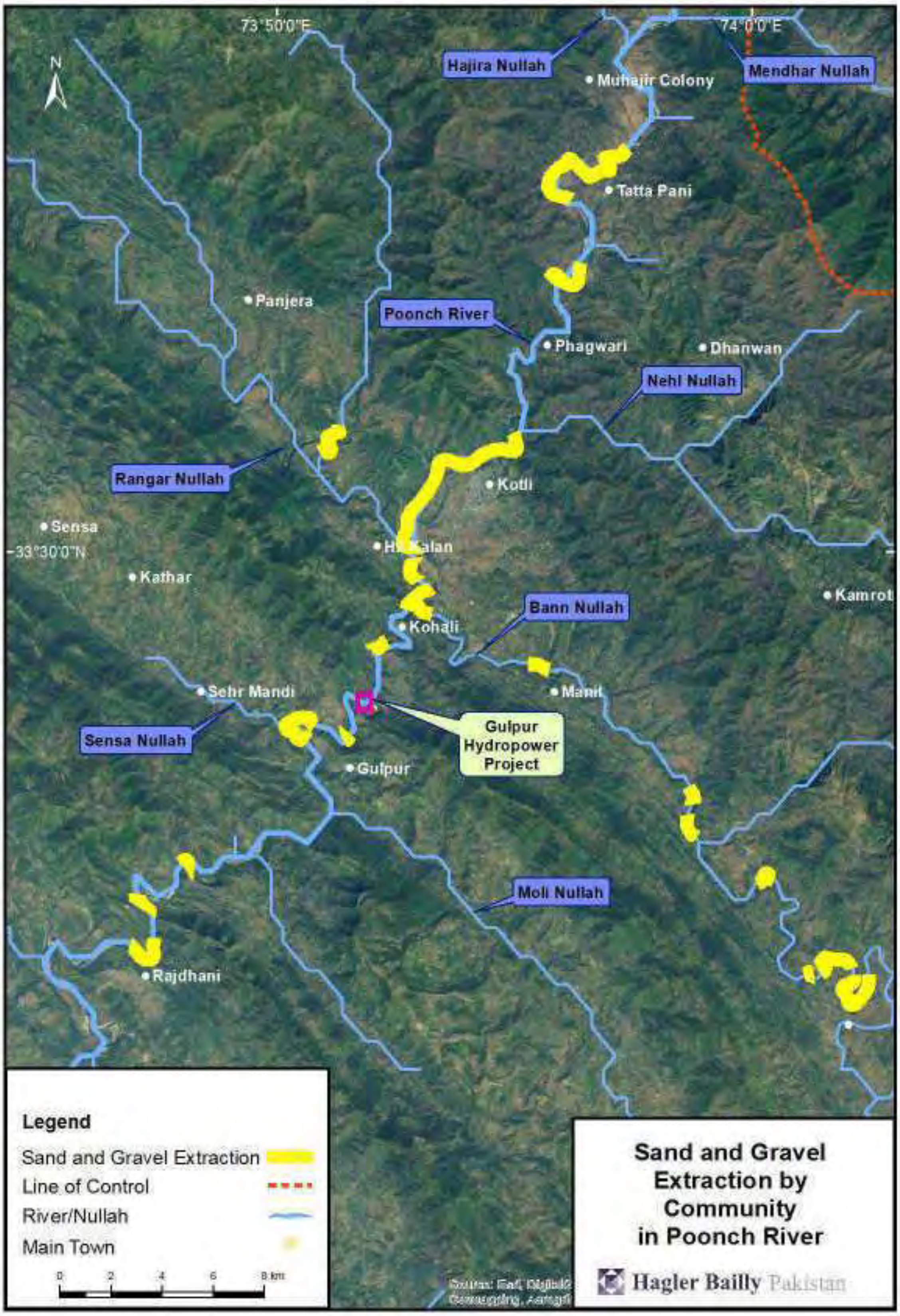

Figure 1-4 **The extent of sand and cobble mining operations in the Poonch Basin in the vicinity of the proposed Gulpur HPP.**

increased political stability and accessibility has led to an increase in construction activities in the region over the last 10-20 years. At the same time, the improved road network has opened up additional access to the river for mining, and thus both the quantities of sediment removed and spatial areas affected by mining have expanded. Of particular concern in this regard is the increase in mining in the Ban Nullah and Rangar Nullah (Figure 1-4), as both of these tributaries represent important breeding areas for the indigenous fish.

Sand mining and gravel extraction are usually undertaken in the winter (September to March), since during this low flow period more of the river bed and banks are exposed. During the high flow summer months, particularly in the monsoon period, the rivers tend to flow bank to bank, and access to exposed sediment is limited.

2 EXPECTED CHANGES IN AVAILABILITY/DISTRIBUTION OF SEDIMENT AS A RESULT OF GULPUR HPP

2.1 SEDIMENT LOADS IN THE POONCH RIVER

The 1960 to 2011 observed suspended sediment loads at the Rehman Bridge gauge station on the Poonch River near Kotli were provided by the Surface Water Hydrology Project (SWHP) of the Water and Power Development Authority (WAPDA) for use in this study. The mean suspended sediment load of the Poonch River is c. 10.87 MTa^{-1} (Mott MacDonald 2011; Figure 2-1). Although cobble and boulder beds are extensive morphological features on the river bed and banks, the sand fraction represents a large portion of the suspended load. Data from the neighbouring Jeelum River indicate that sands are also the dominant bed load (Qureshi et al. 2013), which suggests that the same may be true for the Poonch River.

The Poonch River flows into the large Mangla reservoir and a large volume of sediment has been deposited around this inflow (Figure 2-2). Observed measurements of sediment deposition indicated that 0.308 BCM of sediment was deposited in the Mangla Reservoir between 1967 and 2002 (Izhar-ul-Haq and Tanveer Abbas 2007).

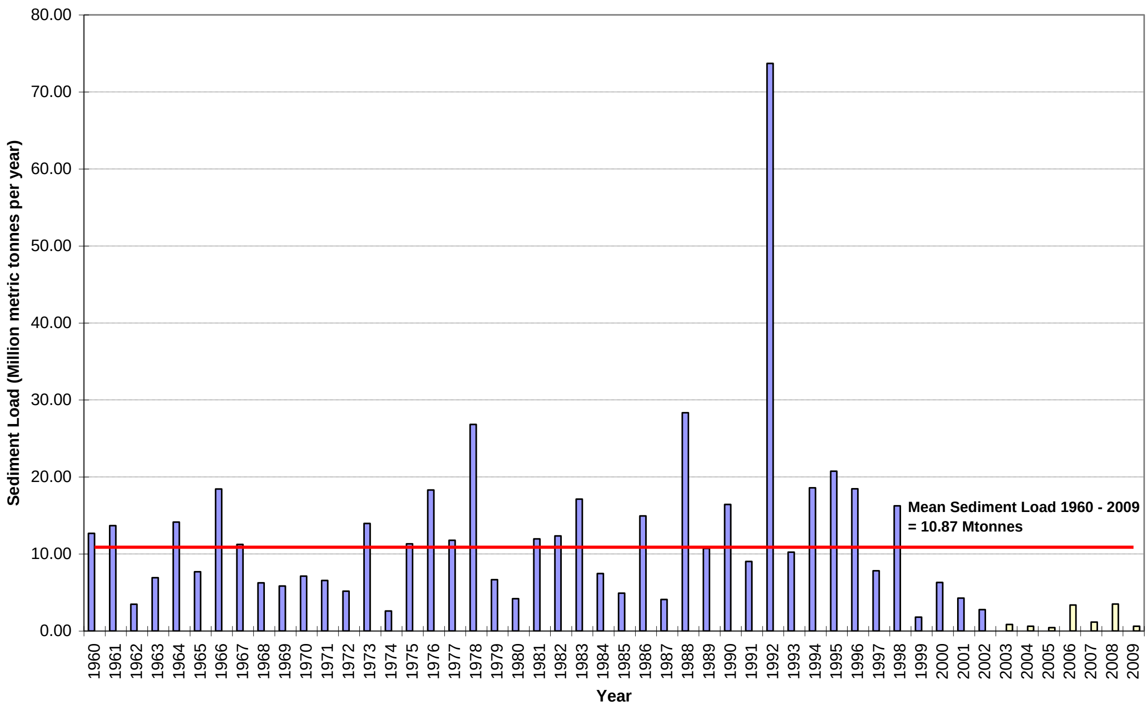

Figure 2-1 Annual suspended sediment loads in the Poonch River (1960 to 2009; Mott MacDonald 2011).

Figure 2-2 Large volumes of sandy sediments deposited where the Poonch River enters Mangla reservoir.

2.2 *EXPECTED CHANGES UPSTREAM OF GULPUR WEIR*

If the proposed Gulpur HPP reservoir is constructed, the sediment yield from more than 80% of the Poonch catchment area will be affected by the new weir. Mott MacDonald (2011) estimated that all of the cobble and boulders, almost all of the sand load and approximately 30% of the suspended silt load would be trapped in the proposed Gulpur HPP reservoir - in total about 40% (approximately 4.3 M tonnes) of the average total sediment inflow based on modelling results.

Observed sediment deposition data from the downstream Mangla Reservoir has shown that the annual average volume of sediment deposited from the Poonch River is 8.8 MCM[3] (Izhar-ul-Haq and Tanveer Abbas 2007). If 80% of this load (approximately 7 MCM) is trapped behind Gulpur, and we estimate conservatively that only 10% of the affected sediment yield is captured in accessible portions of the backup zone of the reservoir, this would translate to more than 700 000 m^3 of sediment per annum, which is sufficient to provide for nearly 60,000 loads of large 25 ton dump trucks per year. This seems well in excess of the current levels of sediment extraction from the region. These figures are supported by Gulrez and Malik (2007) who reported that the volumes of sediment deposited in and just upstream of Mangla reservoir are well in excess of what could be commercially utilised in the region.

The availability of the deposited sediment for extraction will depend on the location and pattern of sediment deposition, which is influenced by the size of the sediment and the

[3] The modelled data of Mott MacDonald (2011) provide lower estimates of sediment load than the observed data of Izhar-ul-Haq and Tanveer Abbas (2007), but MacDonald (2011) estimated that bedload was only 10% of the suspended load. The morphology of the rivers, and observed data from Mangla reservoir, suggest that this was an underestimate. The observed data provide a much more reliable measure of the true sediment load.

operation of the weir. Cobbles would be trapped close to the upstream end of the reservoir or slightly upstream in the wet season backup zone (Table 2-1) because the lowered flow velocities in this backup area would be too slow to transport very large bed elements. Progressively smaller sediment classes, including sands, which travel as suspended load in high velocities, would be deposited where the river enters the reservoir and flow velocities drop.

Table 2-1 Summary of expected percentage trapping of different sediment particle sizes in the proposed Gulpur HPP for flows up to 830 m^3s^{-1} (Mott MacDonald 2011).

Sediment Type	Particle size (mm)	Volume of sediment in inflow (M tonnes/annum)	% trapping assumed	Estimate of trapped sediment (M tonnes/annum)
Clay	<0.0055	1.3	0%	0
Silt	0.0055 – 0.0625	6.5	30%	1.9
Sand	>0.0625	3.0	100%	3.0
TOTAL		10.8	-	5.9

The normal operating level of the weir for Option 3 for Gulpur HPP is 535 masl, which means that the backup will extend to near Kolti town. Given that there is good access to both banks along much of this reach, and that sediment mining operations are already in existence here, it is likely that exploitation of the sediments which become deposited in this reach would be a viable proposition. Further detailed studies would be needed to confirm the exact location and volumes of sediment expected to be deposited.

2.3 *EXPECTED CHANGES DOWNSTREAM OF GULPUR WEIR*

Sediment concentration generally increases with volume, although the actual concentrations linked to a particular discharge vary widely. For example, for a mean annual discharge of 125 m^3s^{-1}, the sediment concentration ranges between 10 ppm and 15 000 ppm. Within the context of this natural variability, downstream of the reservoir, the changes in discharge and the sediment trapping effects of the reservoir can be expected to result in altered sediment delivery to the downstream reaches.

The expected changes in sediment downstream of Gulpur weir can be divided into those in the reach between the weir and the tailrace, and those downstream of the tail race. In general, both reaches are expected to experience a reduction in sediment supply, but differences in the volume of water between the two reaches will result in very different outcomes.

In the dewatered reach between the weir and the tailrace there will be very low total sediment loads because for most of the year the discharges will be very low (Figure 2-3), and the availability of cobbles and boulders in particular will be considerably reduced. However, during flushing or sluicing of the reservoir very large peak suspended sediments are likely to occur during high flows, and may be deposited in this reach when the flows are cut-off again.

Downstream of the tailrace, the suspended loads will be reduced relative to 2013 because of the sediment trapping effect of the reservoir (Table 2-1). As in the upstream dewatered zone, annual flushing of the reservoir may however yield peak suspended sediment discharges higher than normal. The availability of cobbles and boulders is expected to be low immediately downstream of the tailrace but should improve with distance as a result of the replenishment by supply of these sediments from lateral bars, the channel bed and from tributary inputs.

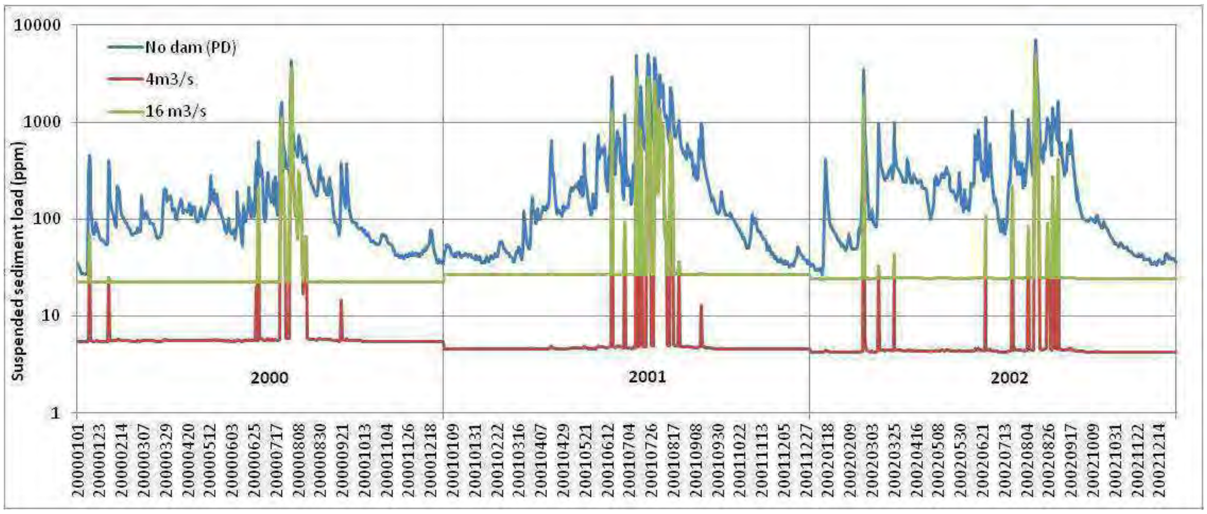

Figure 2-3 **Suspended sediment loads generated for the present day (no dam), 4m3/s and 16 m3/s baseflow release flow scenarios that could be expected in the dewatered zone. The critical reductions in suspended sediment are linked to the large declines in baseflows, whereas the large peaks in the 4m3/s and 16m3/s scenarios are associated with proposed periodic flushing of the reservoir (HBP 2014).**

3 OPTIONS FOR REDUCING THE IMPACTS OF SEDIMENT MINING IN THE POONCH BASIN

The Environmental Flow scenarios for Gulpur HPP (HBP 2014) included evaluation of three protection levels affecting the non-flow related human induced impacts on the riverine ecosystem. These were (HBP 2014):

- Protection Level 1 (Pro 1) = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over the next 50 years.
- Protection Level 2 (Pro 2) = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over the next 50 years.
- Protection Level BAU = Business as usual - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next 50 years.

Thus, in terms of sediment mining in the Poonch Basin, the 50-year targets were:

- Protection Level 1 (Pro 1) = no increase in mining impacts;
- Protection Level 2 (Pro 2) = 50% reduction in mining impacts;
- Protection Level BAU = doubling of mining impacts.

Given that it is entirely plausible that the demand for sediment will continue to increase over the next fifty years, achieving the Protection Level 1 or 2 will necessitate management and control that will limit the impact of mining on the river in the face of increased demand/volumes being abstracted. This could be achieved using one or more of the following strategies:

1. Focus mining activities in non-sensitive areas;
2. Ban mining in sensitive areas;
3. Implement on-site control and management of mining activities;
4. Rehabilitate/restore habitats already destroyed by mining;
5. Alternatives sources of aggregate:
    a. reuse spoil;
    b. quarries for aggregate.

3.1 FOCUS MINING ACTIVITIES IN NON-SENSITIVE AREAS

Arguably the best way to achieve the proposed reductions in mining impacts is to focus mining activities in fewer areas where they can be better managed as this will reduce the area of sediment mining, reduce mining in sensitive areas and potential reduce the direct site-specific impacts. The construction of Gulpur weir would present an opportunity for doing just this. As discussed in Section 2.2, it is expected that large quantities of sediment will become trapped at or slightly upstream of the upper end of the reservoir in an area that is both close to Kotli and easy to access.

Although the feasibility of implementing a large-scale mining operation in the head waters of the Gulpur reservoir is subject to confirmation (see Section 5), initial indications suggest that:

- the quantities likely to be deposited annually will exceed the (very) preliminary estimates of 2013 demand for sediment and probably exceed demand for quite some time to come[4] (Section 2.2)[5];
- roads could be constructed/existing roads improved to allow for easy and safe access to the area;
- since sediment loads are highest in the wet season, much of the sediment would probably be deposited above the normal operating level as reservoir levels and backup effects tend to extend upstream in the wet season;
- if necessary, access to the sediments, particularly the smaller size fractions, could be enhanced by lowering the operating level of the weir in the dry winter months;
- current mining operations within a 10-15 km radius of the backup zone could be relocated to the backup zone without subjecting the miners to undue additional travel or transport costs (Figure 3-1);
- it possible that some (or all) of the activities further afield than the 10-15 km radius, such as those of the upper Ban Nullah (Figure 3-1), can also be relocated to the back-up of Gulpur weir, depending on the location of the target market for sediments mined in these areas;
- similar initiatives have been successfully implemented elsewhere, for instance:
    i. at Inanda Dam on the Mgeni River (South Africa), sediment mining in the backup zone upstream of the dam is promoted to reduce sedimentation of the reservoir (Figure 3-2);
    ii. in Yorkshire (UK) sediment from reservoirs is used for potting soil, which is sold commercially (Halcrow 2001).

Outside of the 10-15 km radius, mining operations can also be focused on fewer, better controlled areas that avoid the sensitive habitats. The selection of appropriate sites for sediment mining should be based on local knowledge or information regarding aggradation (sediment deposition) rates; where the proposed operation can minimize disturbance and maximise stability of channel; and where instream sites are located where the channel loses gradient or increases in width, and deposition occurs unrelated to regular bar-pool spacing in channel (such as upstream of a bedrock constriction or backwater, or at deltas created near confluences; PWA 1996).

[4] The assumptions regarding sediment deposition locations and volume estimates require validation in the form of detailed backflooding and sedimentation studies of the proposed reservoir. These verification studies would be undertaken as part of a detailed feasibility study of the identified mitigation options.
[5] The quantity of sediment extracted in the stretch of the river downstream of the LoC to the Mangla reservoir is estimated at 224,500 m^3 (HBP 2014).

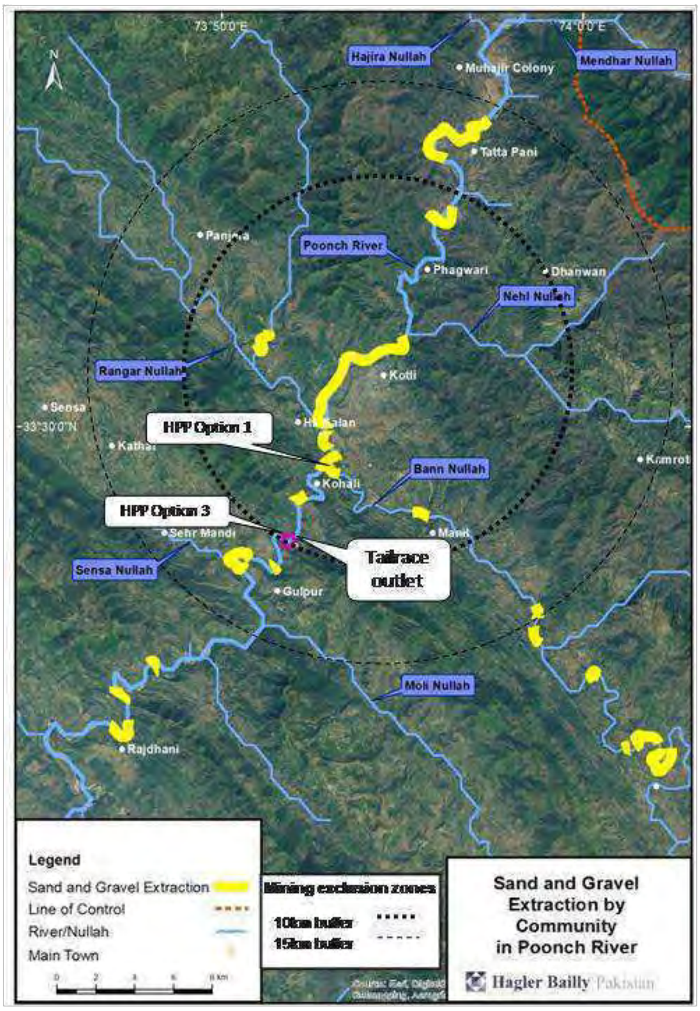

Figure 3-1 **The 10 and 15-km radii around the backwater areas of the Gulpur reservoir.**

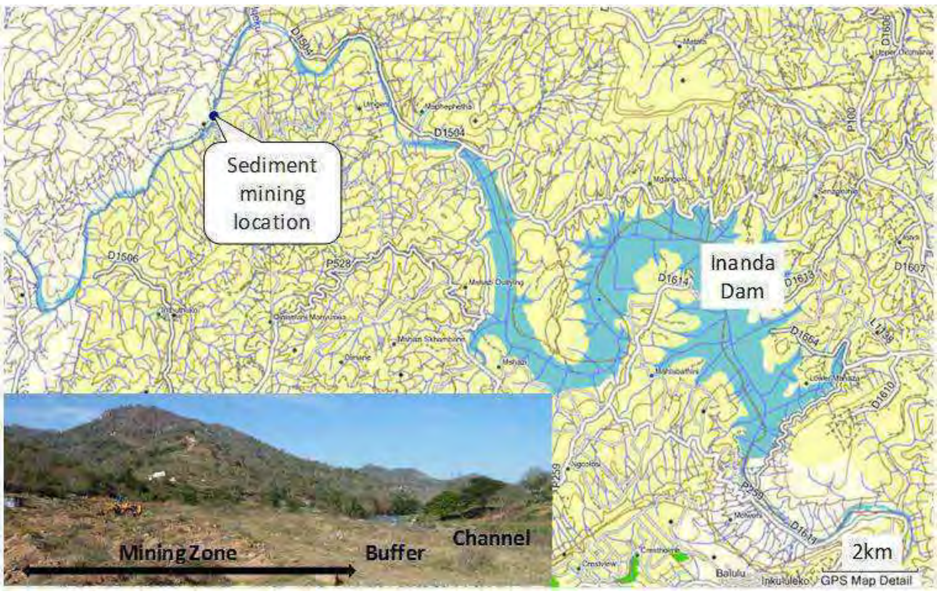

Figure 3-2 **Inanda Dam on the Mgeni River (South Africa), sediment mining in the backup zone upstream of the dam is promoted to reduce sedimentation of the reservoir.**

As mentioned above (Inanda Dam), mining sediments from the back-up zone may also reduce sedimentation in Gulpur reservoir, prolonging the life of the weir and/or reducing the need for sediment flushing (Basson and Rooseboom 1999).

3.2 *BAN MINING IN SENSITIVE AREAS*

It is unlikely that provision of a focussed mining area (or areas) alone will reduce sediment mining in the sensitive areas. This will need to be accompanied by a prohibition on mining in sensitive areas, particularly in the tributaries and at the confluences between tributaries and the main river. Such a ban could include:

- Limiting access (or implementing road closures using barriers or decommissioning roads) to sensitive zones of the river.
- Policing of the restricted, sensitive breeding areas of the rivers and tributaries.

This could be achieved through development of a sediment mining plan in conjunction with authorities and miners to scale down operations in sensitive areas and relocate those operations to less sensitive reaches (cf. Figure 3-2). Collaboration with the Fisheries Development Board, Pakistan, and AJK Fisheries and Wildlife Department should be sought, as they have proposed similar measures (http://www.fdb.org.pk/documents/mnp.pdf, accessed February 2014). Note: A two year ban on sediment mining in the Poonch, and total ban on extraction of sand and gravel at the confluence of the nullahs, with the offer of alternative sites to miners, was requested in 2012 by the Fisheries Development Board[6].

3.3 *IMPLEMENT ON-SITE CONTROL AND MANAGEMENT OF MINING ACTIVITIES*

Where sediment mining is allowed, the localised and downstream impacts of operations could be reduced through on-site control and management measures. These could include:

1. License mining activities according to volume based on measured annual replenishment, and with conditions regarding method of mining (following best practice guidelines), location, timing and volumes of extraction permissible (after PWA 1996);
2. Implementation of setbacks and buffer zones (which could include placement of berms) between the sediment extraction areas and the low flow channels in order to reduce lowflow season impacts. These should ensure
    a. that excavations are set back at least 5 m from the main low flow channel bank;
    b. that the maximum depth of mining is > 1 m above natural channel thalweg elevation, as determined by pre-mining surveys, to prevent channel shift.
3. Employing more environmentally-friendly extraction methods (Box 3-1);
4. Minimise activities that release fine sediment to the river;
5. Avoid the removal of any vegetation;

[6] (http://www.fdb.org.pk/documents/mnp.pdf).

6. Retain a buffer (at least 5-10 m) between the low flow channel and the mining operations;
7. Limit in-stream operations to the dry season (DID 2009); and
8. Implement a programme of compliance monitoring and control.

Box 3-1 Less-damaging methods for sediment removal

Kondolf et al. (2001) identified several methods of sand and gravel mining operations that are less damaging than the more commonly employed methods.

Bar scalping or skimming
Bar scalping or skimming is the extraction of sand and gravel from the surface of bars. Historical scalping commonly removed most of the bar above the low flow water levels, leaving an irregular topography. Present methods generally requires that surface irregularities be smoothed out and that the extracted material be limited to what could be taken above an imaginary line sloping upwards and away from the water from a specified level above the river's water surface at the time of extraction (typically 0.3 - 0.6 m).

Bar scalping is commonly repeated year after year to maintain the upstream hydraulic control provided by the riffle head. The preferred method of bar scalping is generally to leave the top one-third (approximately) of the bar undisturbed, mining only from the downstream two-thirds.

Bar Excavation
In this sediment extraction method, a pit is excavated at the downstream end of the bar as a source of aggregate and as a site to trap sand and gravel. Upon completion, the pit may be connected to the channel at its downstream end to provide side channel habitat. This method reduces the area of disturbance.

A combination of these measures would assist to regularise the sediment mining activities in the Poonch Basin, and to reduce the localised and downstream impacts associated with such.

Cooperation could be enhanced through the development of guidelines or best practice principles for sediment mining operations to which an association of sediment miners could subscribe. This should take in to account buffer zones between the mining operation and active (low flow) channels; ecologically sensitive methods of sediment removal, as well as the overarching focus of only removing sediment at appropriate (less sensitive) extraction sites.

3.4 REHABILITATE HABITATS ALREADY DESTROYED BY MINING

3.4.1 Reactivate secondary channels near Kotli

The reach of the Poonch River adjacent to Kotli shows signs of changes in course. In particular, comparison between 1970 maps and 2011 Google images (Figure 3-3) suggest that at least two secondary channels in this reach have been abandoned during the last few decades. Although it is not possible to identify the reasons for these abandonments without more extensive investigation, the river reach around Kotli has been extensively mined and there are signs of bank stabilisation that indicate an incising reach. It is thus possible that the secondary channels have been abandoned due to the incision (down-cutting) of the active channel in response to sediment extraction. Incision of the active channel and abandonment of secondary channels is a common response to the reduced sediment availability associated with sediment mining (Kondolf 1997).

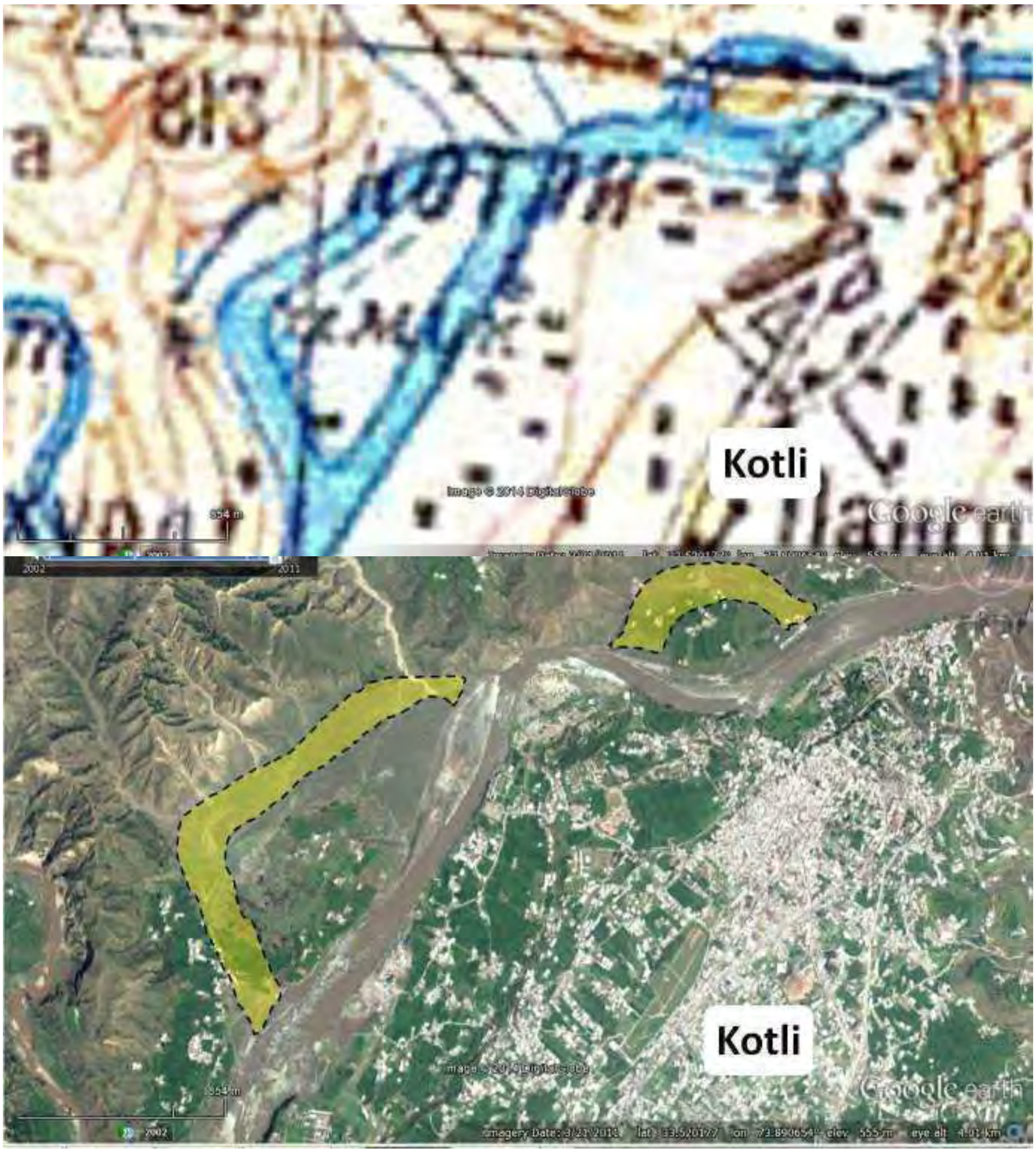

Figure 3-3 **Two secondary channels opposite the town of Kotli appear to have been abandoned in recent decades. The top map (derived from a 1970's USSR Topographic map) indicates two secondary channels which have been abandoned. Their alignment is indicted in the lower 2011 Google image. Secondary channel abandonment is a common response to sediment mining, and there has been extensive sediment extraction from the river in the vicinity of Kotli.**

Experience in similar mountainous rivers and discussions with local experts indicate that these types of secondary channels represent areas of slower velocity in the flood season and are important fish refugia in fast, steep rivers. The reconnection and rehabilitation of these secondary channels, to allow for annual flooding and the creation of additional instream habitat area for fish species, could be assessed:

- as a potential off-site mitigation option to reduce (offset) the effects of inundating kilometres of the weir,
- to potentially reverse some of the impacts of sediment mining on river habitat, and
- to improve the physical habitat upstream of the weir.

Similar restoration initiatives are showcased at http://wildfish.montana.edu/Cases. For instance:

- the Green River, Utah, USA, where the river was reconnected with it floodplain to provide spawning and nursery areas for the endangered Colorado razorback sucker (*Xyrauchen texanus*; Figure 3-4),), and ;
- Clear Creek, California, USA, where the creek was redirected into the cobble-bedded channel that provided better spawning habitat for fish Figure 4-1.

Figure 3-4 Restoration of floodplain connectivity on the Green River, Utah. Levee breaches were done by excavating a "notch" in the levee or by lowering the existing levee height. Some breaches were narrow channels which backfill slowly, while others had large portions of the levee removed to allow the river current to push water into the site. http://wildfish.montana.edu/Cases. Accessed 27.03.2104

Figure 3-5 **Channel changes to increase fish spawning habitat in Clear Creek California. Above = before; Below = after. http://wildfish.montana.edu/Cases. Accessed 27.03.2104**

3.4.2 Rehabilitate tributary habitats

Once mining operations have been moved from sensitive tributary areas, the river will gradually reset. However, this natural restoration could be accelerated through judicious site specific manipulations of the channel.

3.5 *ALTERNATIVES SOURCES OF AGGREGATE*

A reduction in the sediment mining pressures in the river could be achieved if alternative sources of building aggregate could be found, such as:

- Reusing surplus spoils: surplus spoils from the construction of the Gulpur HPP could be stockpiled for use;
- Using open rock quarries on hillsides rather than using river sediment as source of gravels.

Neither of these has been considered in any detail here, but should form part of the considerations in developing a sediment mining plan for the basin.

4 OUTLINE OF KEY COMPONENTS FOR ACHIEVING PROTECTION LEVEL 2 FOR SEDIMENT MINING

The main challenges in implementing protection measures for sediment mining in the Poonch Basin are:

- the level of integration required between technical, legal, administrative and political processes, and the private and government sectors;
- the need for extensive public participation, and broad governmental and societal support, both during the technical work and for legislating the outcomes;
- the need for interventions that depend on people changing their perceptions and behaviour.

To achieve the mining targets for Protection Level 2 (50% reduction in impacts), these challenges should be focused on creating and implementing a Sediment Mining Management Plan that is supported by technical data, considers trade-off between ecological protection and the requirements of the miners and the community at large, and enjoys broad-based support from both the community and the authorities that will be responsible for its implementation.

The key activities required to develop Sediment Mining Management Plan are summarised in Figure 4-1.

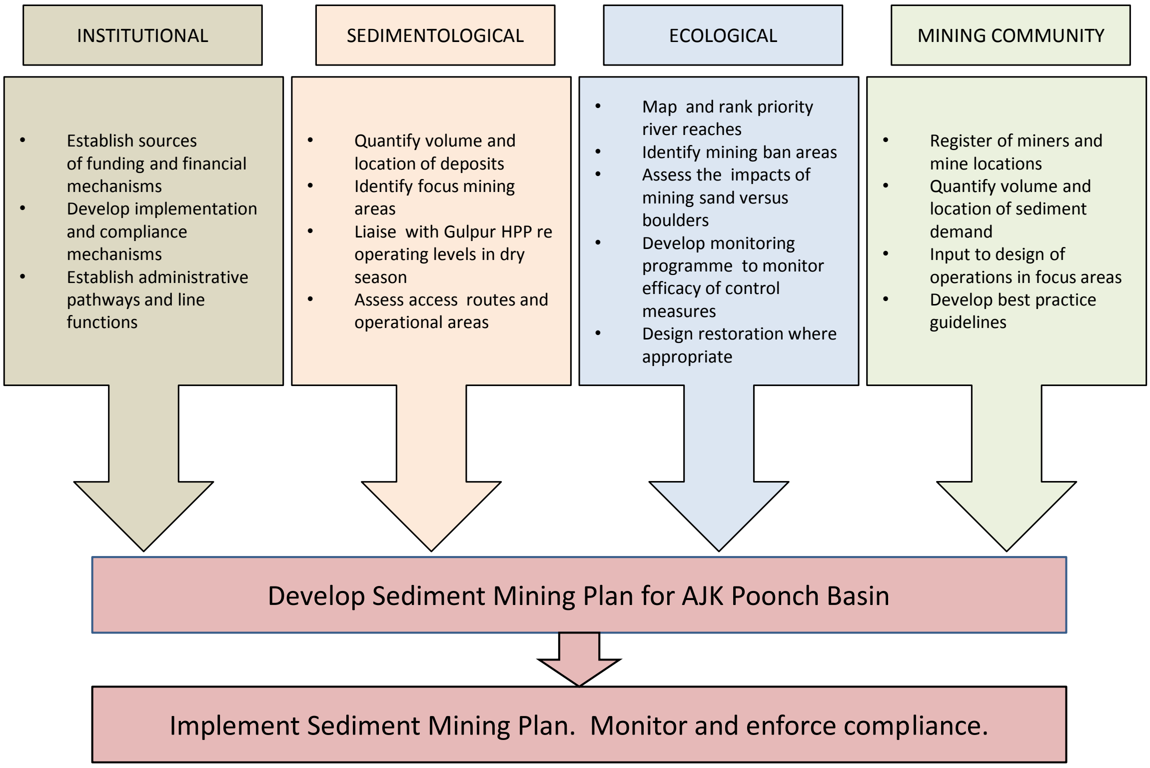

Figure 4-1 Key activities required for a Sediment Mining Management Plan to achieve Protection Level 2.

These have been arranged according to four categories:

1. The institutional (legal and administrative) provisions that need to implement protection measures.
2. The modelling and other technical studies required to determine the location, quality and quantity of sediment deposits linked with Gulpur HPP, and to assist with identification of other focus areas.
3. The confirmation of the key ecological sites or reaches within the system needed to identify no-go or restricted use reaches to inform the trade-offs between ecosystem protection and mining locations.
4. The necessary engagement with the affected mining operators in order to ensure that their needs are considered in, and where possible integrated into, the process.

In reality, however, there will need to be considerable co-operation across these areas to produce the technical information, management mechanisms and buy-in required to ensure successful implementation of the protection measures.

4.1 INSTITUTIONAL

The key legal and administrative activities required include:

1. Establish/implement sources of funding and financial mechanisms: The Biodiversity Action Plan (HBP 2014) for Gulpur HPP identified avenues for generating funds for the implementation of Protection Level 2 measures for fishing, sediment mining and use of riparian vegetation. However, appropriate mechanisms will still need to be designed and implemented to finance the acquisition of technical information; the formation of stakeholder associations (see Section 4.4); construction of access roads, and; the ongoing costs of management, administration, monitoring and reporting.
2. Develop implementation and compliance mechanisms:
3. Establish administrative pathways and line functions.

4.2 SEDIMENTOLOGICAL

The key technical activities required include:

1. Quantify volume and location of deposits: A two-dimensional hydraulic model will need to be developed based on existing hydrological and sediment records and used to predict the areas and volume of sediment deposition in the backup zone of the Gulpur reservoir. This critical aspect of work should determine the volumes and accessibility of the sediment deposits associated with the proposed reservoir. This information will contribute to an assessment of the feasibility of focusing mining activities in this area, and be used to inform the need for additional focus areas, whether the operation of Gulpur weir should consider mining and the design of access road and operational areas.

2. Identify other focus mining areas: It may not be possible to relocate mining activities downstream of Gulpur weir to the back-up zone of the weir, but this does not necessarily mean that the impact of these activities could not be reduced by focusing mining in less sensitive reaches. Any decisions with respect to this would need to include:
   a. economic in terms of transportation cost.
   b. ecological considerations as the fish in that section of the river will be cut off from their favoured breeding areas in the upper catchment.
3. Liaise with Gulpur HPP operators: If necessary, the possibilities of manipulating the operating levels of Gulpur weir to increase dry-season access to smaller sediments should be explored.
4. Undertake an assessment of the access routes and the operational areas: Whether existing routes will do or upgrading or new access roads will be required. Also, are there sufficient spaces to organize operations where the different sediment sizes are deposited, e.g., for boulders, is there an area where stone crushers for producing aggregate can be placed.

4.3 ECOLOGICAL

The key technical activities required include:

1. Map and rank priority river reaches: Sensitive and important river reaches in the tributaries and mainstem will need to be identified and ranked to provide input to decisions about where sediment mining should be restricted to protect instream habitat. This information will be needed to evaluate the potential of tradeoffs between mining activities and biodiversity protection.
2. Assess the relative ecological impacts associated with sand and gravel mining versus cobble and boulders mining.
3. Identify mining ban areas. In liaison with miners, authorities and based 1 and 2 above and on data provided by the sedimentological technical studies (Section 4.2).
4. Develop monitoring programme to monitor efficacy of control measures.
5. Design restoration where appropriate: The cost and benefits of undertaking restoration in areas previously destroyed by sediment mining will been to be evaluated based on the extent to which mining activities can be relocated, the importance of the areas (see 1 above), damage caused by previous activities and whether this damage will reset naturally once mining has stopped. Such an assessment may be particularly important downstream of Gulpur weir as the fish in that section of the river will be cut off from their favoured breeding areas in the upper catchment. Additionally, if deemed necessary to achieve 50% reduction in activities, the secondary channels around Kotli could be examined to determine the potential of reconnecting and rehabilitation of these as summer breeding and nursery habitats.

4.4 *MINING COMMUNITY*

The buy-in of the mining community is possibly the most important aspect of successful implementation of the protection measures directed at sediment mining. How this could be achieved is outside of the ToR for this report, but there is little doubt that this will require extensive consultation. It is suggested that buy-in could be enhanced through the formation of a Miners Association, if this does not already exist. Such an association could elect representatives to provide input to the sediment management plan, and negotiate with authorities on their behalf. It could also be instrumental in:

1. Developing a register of miners and mine locations.
2. Quantifying volume and location of sediment demand.
3. Providing input to design of operations in focus areas.
4. Developing best practice guidelines: Best Practice Guidelines for sediment mining in the Poonch Basin could be developed by the mining community in liaison with environmental authorities and conservation bodies. These guidelines could then be translated into on-site management and control measures.

5 PROVISION OF TECHNICAL INFORMATION AND DEVELOPMENT OF A SEDIMENT MINING PLAN FOR THE POONCH BASIN: TERMS OF REFERENCE

5.1 BACKGROUND

The construction of a 100-MW HPP, Gulpur HPP, has been proposed on the Poonch River in Pakistan-administered Azad Jammu and Kashmir (AJK). The Poonch River, a tributary of the Jeelum River in the Indus Basin, arises in India-controlled Kashmir and flows through AJK and thereafter into Pakistan where it discharges into the Mangla Reservoir.

Details on the ecological and social characteristics (and importance) of the Poonch River, the expected impacts associated with the Gulpur HPP, and agreed mitigation strategies to reduce those impacts are provided in HBP (2014), Mira Power (2013) and see also Sections 3, 4 and 6.

5.2 MOTIVATION

The Poonch River and its tributaries are heavily utilised by the local communities, and over-fishing, sediment mining, harvesting of riparian vegetation and effluent disposal have taken their toll on the health of the riverine ecosystem. Among the agreed mitigations was the development and implementation of protection measures[7] that would result in a 50% reduction in the 2013 level of impacts from these activities (Sections 3; HBP 2014).

With respect to sediment mining, the protection measures involve the creation and implementation of a Sediment-Mining Management Plan, which is supported by technical studies, considers trade-off between ecological protection and the requirements of the miners (and the community at large), and enjoys broad-based support from both the community and the authorities that will be responsible for its implementation.

The ToR address the generation of technical information required to support Sediment Mining Management Plan.

5.3 LIST OF TASKS

The proposed studies encompass the following technical tasks:

- Task 1: Document river–based sediment mining activities in the study area.
- Task 2: Evaluate the practicability of consolidating mining locations in the Poonch Basin.
- Task 3: Evaluate ecological importance and restoration potential of river reaches in the Poonch Basin.
- Task 4: Draft Sediment Mining Management Plan for the Poonch Basin.

[7] Protection Level 2 (See Section 3).

These will be done in close cooperation with the Gulpur HPP management, basin authorities and the mining community and will contribute towards discussions between these parties aimed at delivering a final agreed Sediment-Mining Management Plan.

5.4 *STUDY AREA*

The study area for the technical studies addressed in the ToR encompasses (Figure 5-1):

- the mainstem of the Poonch River from the Line of Control to Mangla Reservoir;
- the main tributaries of the Poonch River, in particular Rangar Nullah, Bann Nullah, Mehdar Nullah, Netil Nullah, Hajira Nullah, Moli Nullah and Palak Nullah, and;
- the contributing catchments for these systems.

Figure 5-1 Study area for the technical studies addressed in the ToR

5.5 *TASK 1: DOCUMENT RIVER–BASED SEDIMENT MINING ACTIVITIES IN THE STUDY AREA*

5.5.1 Objectives

The main objectives for Task 1 are to:

- Provide a baseline for river–based sediment mining activities in the study area that can be used to inform the other tasks.
- Evaluate options for alternative (non-river) sources of sand and aggregate.

5.5.2 Expected Outcomes

The outcomes expected for Task 1 include:

1. A map of the location of any and all river-based sediment mining activities in the study area.
2. A report detailing:
    a. For each of the locations identified in 1 above: access routes; spatial extent of operations; intensity of the impact; target sediment size; volumes extracted annually per sediment size; methods of extraction; target market, number of jobs created (direct).
    b. The volume and location of sediment demand.
    c. Options, if any, for alternative (non-river) sources of sand and aggregate.
3. A pamphlet presenting key information and conclusions for dissemination among stakeholders and Interested and Affected Parties (I&Aps).

5.6 *TASK 2: ASSESS THE FEASIBILITY OF FOCUSING MINING ACTIVITIES IN THE BACKUP OF GULPUR WEIR*

5.6.1 Objectives

The main objectives for Task 2 are to:

- quantify of the volume location and nature of the sediments that are expected to be trapped in the reservoir and backup zone (including upstream of the normal operating level) of Gulpur weir;
- identify suitable locations for focused mining areas on the Poonch River downstream of Gulpur weir;
- evaluate the practicality of relocating mining activities in sensitive areas (as identified by Task 1) to less sensitive and more-sustainable locations;
- design access and staging areas for the focus areas.

5.6.2 Expected Outcomes

The outcomes expected for Task 2 include:

1. A calibrated two-dimensional sediment transport and back-flooding model for the Poonch River up to Gulper weir.

2. A map of the location of the sediment deposits in the back-up zone of Gulpur weir giving:
    a. estimated volumes
    b. size range
    c. mean size
    d. suitability for mining.
3. A map of possible focus locales for sediment mining in the Poonch River downstream of Gulpur weir giving:
    a. estimated volumes
    b. size range
    c. mean size
    d. suitability for mining.
4. A report evaluating the practicality of relocating mining activities in sensitive to less sensitive and more-sustainable locations in terms of:
    a. quality, availability and location of deposited sediments
    b. volume and location of sediment demand
    c. the potential of enhancing access through changes in the operation of Gulpur weir
    d. other implications, if any, for the operation of Gulpur HPP
    e. viability of access routes
    f. whether there is sufficient space for the required mining operations.
5. A pamphlet presenting key information and conclusions for dissemination among stakeholders and I&Aps.

5.7 TASK 3: EVALUATE ECOLOGICAL IMPORTANCE AND RESTORATION POTENTIAL OF RIVER REACHES IN THE POONCH BASIN

5.7.1 Objectives

The main objectives for Task 3 are to:

- map and rank ecologically important river reaches within the study area, with particular attention to their importance for the indigenous fish of the region;
- assess the relative ecological impacts associated with sand and gravel mining versus cobble and boulders mining;
- identify no-go areas for mining;
- assess the cost and benefits of restoring habitats destroyed by mining activities.

5.7.2 Expected Outcomes

The outcomes expected for Task 3 include:

1. A map of ecologically important river reaches within the study area.
2. A report that:

    a. ranks reaches in terms of their ecological importance, with reasons;
    b. quantifies the threats from sediment mining that distinguishes between target sediment size, if applicable;
    c. identifies reaches where mining should be banned based on ecological criteria, with motivations;
    d. identifies reaches already affected by mining where restoration of habitats would materially benefit the riverine biota.
3. A comprehensive rehabilitation plan and costing for each reach identified in d.
4. A comprehensive a monitoring programme to monitor efficacy of control measures.
5. A pamphlet presenting key information and conclusions for dissemination among stakeholders and I&Aps.

5.8 TASK 4: SEDIMENT MINING MANAGEMENT PLAN FOR THE POONCH BASIN

5.8.1 Objectives

The main objectives for Task 4 are to compile a Sediment Mining Management Plan for the Poonch Basin that is based on the outcomes of the various Gulpur HPP-related studies, including Tasks 1-3 of this ToR, and finalised through discussion and agreement with the relevant authorities, the sediment miner and other I&Aps.

5.8.2 Expected Outcomes

The outcomes expected for Task 4 include:

1. Draft Sediment Mining Management Plan for the Poonch Basin that includes:
    a. Focus mining locations, including for each location:
        i. volumes available based on practical and sustainable extraction in the context of the sediment balance for the basin
        ii. size range
        iii. arrangement of access and staging areas
        iv. on-site controls
    b. Banned locations
    c. Schedule and methods for closure and rehabilitation of mines within sensitive river reaches
    d. Best Practice Guidelines to promote sustainable mining
2. Final Sediment Mining Management Plan for the Poonch Basin.
3. A Report detailing the nature, extent, frequency and outcomes of stakeholder liaison.
4. A pamphlet outlining the Sediment Mining Management Plan for the Poonch Basin for dissemination among stakeholders and I&Aps.

5.9 *IMPLEMENTATION ARRANGEMENTS*

5.9.1 Project team and organization

Key project team members include:

1. Team Leader with ≥15 years of experience in Natural Resource Management, a postgraduate qualification in engineering, freshwater ecology, geomorphology, sedimentology or related fields, and a proven ability in compiling management plans for resource utilisation.
2. Fluvial sedimentologist/fluvial geomorphologist with a relevant postgraduate degree, ≥10 years of experience internationally and a proven ability in modelling sediment movement and deposition in rivers.
3. Fish biologist with a relevant postgraduate degree, ≥10 years of experience in freshwater fish ecology, and some experience in the region and the study area.
4. River restoration expert with a relevant postgraduate degree and ≥10 years of practical experience in rehabilitating rivers to restore fish habitat.
5. Policy and Public Participation Specialist with ≥5 years of experience in the region and fluency in Urdu and English.

While some of the sub-tasks clearly fall within a single discipline, and can be undertaken by a single experienced individual, others will require considerable inter-disciplinary cooperation and/or stakeholder liaison. Of particular relevance here are the practicality of relocating mining activities away from sensitive areas; the cost and benefits of restoration, restoration planning and costing, the generation of information pamphlets and drafting the Sediment Mining Management Plan.

5.9.2 Estimated level of effort

The level of effort anticipated for each of the key project team members identified in Section 5.9.1 is shown in

Table 5-1 Estimated level of effort anticipated for key project team members

Project team members	Time in days
Team Leader	20
Fluvial sedimentologist/fluvial geomorphologist	26
Fish biologist	12
River restoration expert	12
Policy and Public Participation Specialist	40

5.9.3 Field visits

It is essential that the technical work be supported by an appropriate level of field work, and that detailed site-specific considerations form part of any recommendations.

5.9.4 Stakeholder consultations

Engagement with authorities, representative of the sediment mining industry, conservation agencies and other I&Aps is considered essential to the success of this assignment. Provision should be made for meaningful consultation, co-operation and understanding between the project team and stakeholders.

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Appendix G: Ecohydraulics Specialist Report

See following pages.

GULPUR HYDROPOWER PLANT

ENVIRONMENTAL FLOW ASSESSMENT

ECOHYDRAULICS SPECIALIST REPORT

A. Birkhead, Streamflow Solutions

March 2013

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Abbreviations and Acronyms

amsl	above mean sea level
dec. deg.	decimal degrees
Baseline	Historical hydrology: 1960 to 2011
DRIFT	Downstream Response to Imposed Flow Transformation
DSL	Dead Storage Level
DSS	Decision Support System
EF	Environmental Flow
ft	feet
GE	Google Earth
GIS	Geographic Information System
$GWha^{-1}$	Giga Watt-hours per annum
HBP	Hagler Bailly Pakistan
HECRAS	Hydrological Engineering Centre River Analysis System
HPP	Hydropower Plant
LOC	Line of Control
mamsl	meters above mean sea level
MAR	Mean Annual Runoff
MOL	Minimum Operating Level
MWL	Maximum Water Level
MS	Microsoft
$m^3\ s^{-1}$	cubic meters per second
NESPAK	National Engineering Services Pakistan (Pvt.) Limited
NOL	Normal Operating Level
SKAT	Swiss Centre for Appropriate Technology
SPD	Survey of Pakistan Datum
WGS 84	World Geodetic System 1984
WWF	World Wildlife Fund

Acknowledgements

The topographic survey and manual flow gauging data used in this study were collected by STECO and the World Wildlife Fund (WWF). River surveys in this environment, characterised by fast flows over steep rapids, are challenging, even in the low flow season, and the teams responsible for the data collection are gratefully acknowledged. Hagler Bailey Pakistan (HBP) was responsible for overseeing the river site surveys, and the efforts of Mr Vaqar Zakaria and Mr Hussain Ali in this regard are much appreciated.

1 *INTRODUCTION*

This report describes the topographic and hydraulic data (Section 2); analysis and modelling (Section 3); and hydraulic results (Section 4) for the proposed Gulpur Hydropower Plant (HPP) EF Sites 1 (Kallar Bridge), 2 (Borali Bridge), 3 (Gulpur Bridge) and 4 (Billiporian Bridge) on the Poonch River in Kashmir, Pakistan. The locations of the EF Sites 1 to 4 are shown in the locality map in Figure 2.1, together with the diversion tunnel for Layout Option 1.[1] The proposed weir site is located *c*. 200 to 500 m downstream of the Ban Nullah confluence. Hydrological information and HPP scenario modelling are discussed in Sections 5 and 0.

Additional details on the river, the EF assessment and the Gulpur HPP project are available in HBP (2014).

[1] Changes to the Gulpur HPP layout occurred after the EF site selection (10.10.2013), and was not finalised prior to the hydraulic/hydrological analysis and modelling being completed (03.12.2013). An updated layout for the HPP (Option 3) and baseload operational rules (12.03.2014) are presented in Section 0.

2 *TOPOGRAPHIC AND HYDRAULIC DATA*

2.1 TOPOGRAPHIC DATA

Requirements for the topographic river surveys (and hydraulic data collection - refer to Section 2.2, following) were communicated to Hagler Bailey Pakistan (HBP) on 10 October 2013. These included a written explanation of the data collection requirements and location of cross-sections at the EF sites.

The following were provided:

1. Google Earth (GE) file with EF site and cross-section locations;
2. GE images of 1. above (per site), using the historical image with the lowest flow;
3. Geographic Information System (GIS) shape files;
4. Microsoft (MS) Excel file providing the end positions per cross-section as extracted from the GE file (1. above), geomorphological units through which the cross-sections are located and descriptions thereof;
5. MS Powerpoint file providing identifiers showing the (approximate) cross-section locations on selected photographs (supplied by HBP) that could be reconciled with the GE views and preferred cross-section positioning.

Surveys were done by World Wildlife Fund (WWF) and STECO, under the auspices of HBP. At EF Site 1, 11 linked cross-sections were surveyed over a reach distance of 764 m; at EF Site 2, six linked cross-sections were surveyed over a reach distance of 998 m; at EF Site 3, seven linked cross-sections were surveyed over a reach distance of 705 m; at EF Site 4, five linked cross-sections were surveyed over a reach distance of 387 m. The geographic site positions and survey dates are provided in Table 2.1 for these four sites.

Table 2.1 Geographic site positions and dates of river topographic surveys

EF site		Location (dec. deg., WGS 84)		Topographic survey dates
Number	Name	Latitude (E)	Longitude (N)	
1	Kallar Bridge	73.934733	33.578836	21 - 22.10.2013
2	Borali Bridge	73.869342	33.472497	22 - 23.10.2013
3	Gulpur Bridge	73.837169	33.449514	23.10.2013
4	Billiporian Bridge	73.790117	33.383314	24.10.2013

Figure 2.1 Locality map showing the main rivers draining the Poonch River catchment. Also indicated are the Gulpur HPP inlet, diversion tunnel and outlet (tailrace outfall) for Layout Option 1, the location of EF sites, main towns and cities (source: HBP)

Aerial photographs showing the locations of cross-sections surveyed at the EF sites, and ground photographs (that show selected cross-sections) are provided in Figure 2.2 to Figure

2.9. Survey data were provided (by STECO) in the form of Eastings and Northings [2], with elevations relative to the Survey of Pakistan Datum (SPD).

Figure 2.2 **The positioning of surveyed cross-sections at EF Site 1 (Kallar Bridge) using a 15 March 2010 aerial view.**

Figure 2.3 **Composite photographs of the Poonch River at EF Site 1, taken from the position indicated in Figure 2.2 (10 November 2013), showing cross-sections (10 and 11) used for hydraulic characterisation in the DRIFT DSS.**

[2] As far as could be established, the projection used was Kalianpur 1962/India zone I.

Figure 2.4 **The positioning of surveyed cross-sections at EF Site 2 (Borali Bridge) using a 1 November 2005 aerial view.**

Figure 2.5 **Composite photographs of the Poonch River at EF Site 2, taken from the position indicated in Figure 2.4 (10 November 2013), showing cross-sections (1 and 3) used for hydraulic characterisation in the DRIFT DSS.**

Figure 2.6 **The positioning of surveyed cross-sections at EF Site 3 (Gulpur Bridge) using a 1 November 2005 aerial view.**

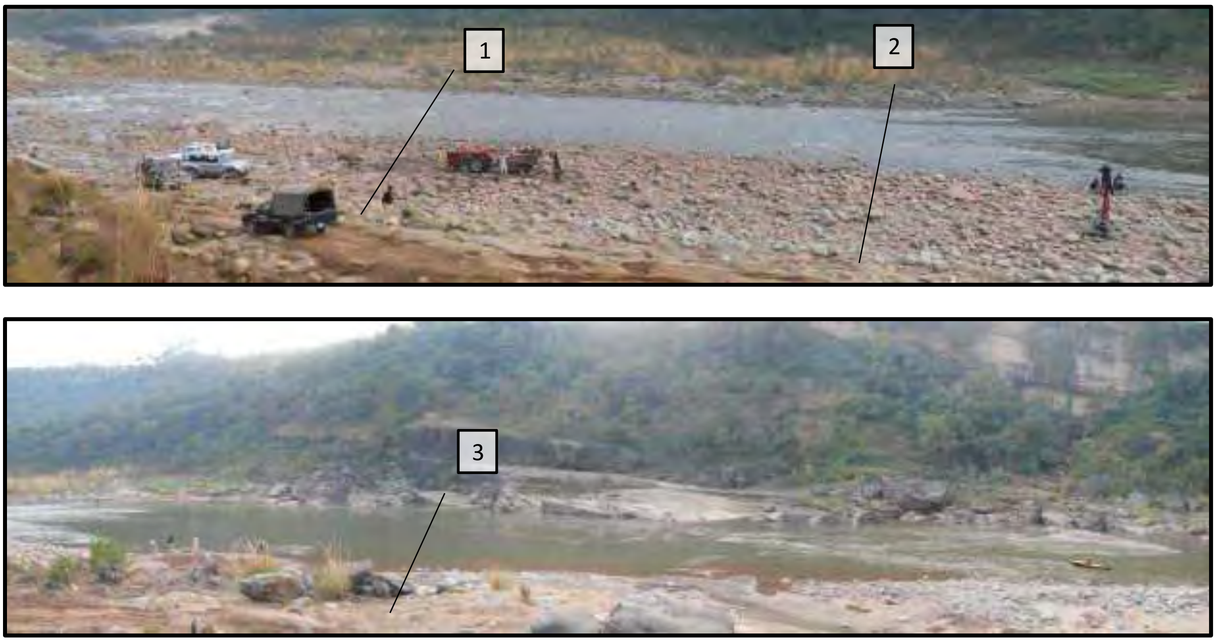

Figure 2.7 **Composite photographs of the Poonch River at EF Site 3, taken from the positions indicated in Figure 2.6 (10 November 2013), showing cross-sections (1 and 3) used for hydraulic characterisation in the DRIFT DSS.**

Figure 2.8 **The positioning of surveyed cross-sections at EF Site 4 (Billiporian Bridge) using a 9 February 2013 aerial view.**

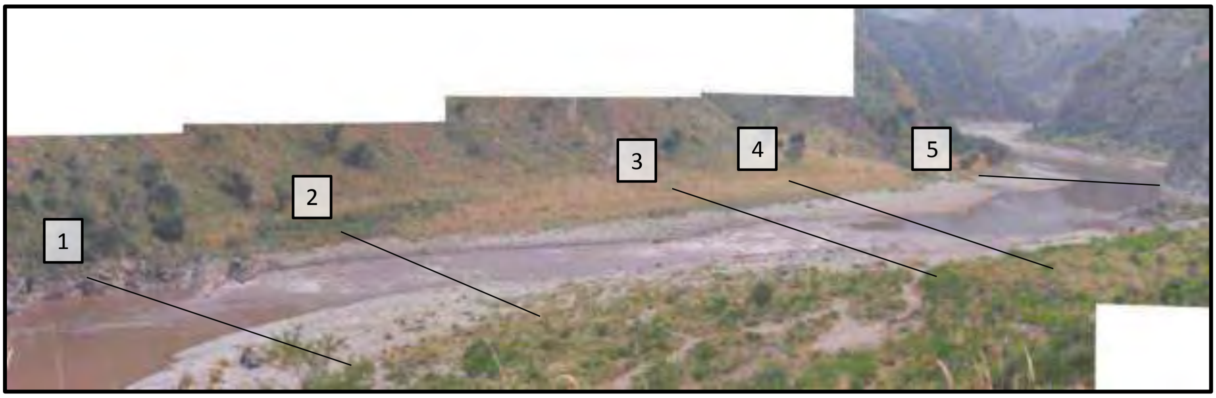

Figure 2.9 **Composite photographs of the Poonch River at EF Site 4, taken from the position indicated in Figure 2.8 (9 November 2013), showing cross-sections (3 and 5) used for hydraulic characterisation in the DRIFT DSS.**

The above water channel topography (at the time of data collection) was surveyed by standard land surveying methods. For non-wadeable conditions, the channel bed was surveyed using sonar. Depth sounding took place by mounting the sonar equipment on a float and attaching to a tag line. The cross-sections used to derive hydraulic information for use in the DRIFT DSS are plotted in Figure 2.10.

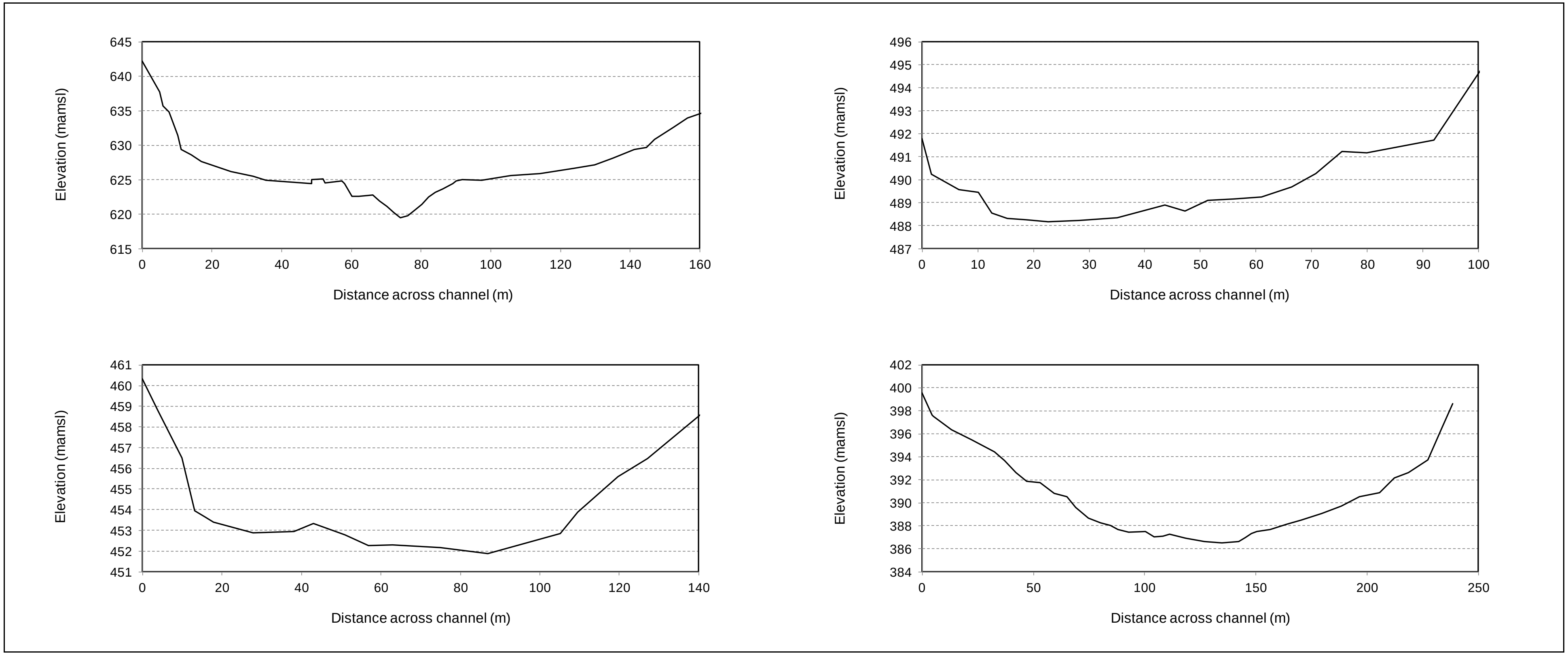

Figure 2.10 **Plots of selected cross-section profiles: top-left: EF Site 1 (cross-section 10), top-right: EF Site 2 (cross-section 1), bottom-left: EF Site 3 (cross-section 1), bottom-right: EF Site 4 (cross-section 3)**

2.2 *HYDRAULIC DATA*

2.2.1 Stage measurements

Stage measurements were made on the right and left banks of the surveyed cross-sections at the time of topographic surveys (Table 2.1), and these data are included in **Error! Not a valid bookmark self-reference.** to Table 2.5. Also included are the approximate (surveyed) stages corresponding to historic high flows and floods, including: high flows during the previous wet season, and the 2010 (EF Site 1) and 1992 (all EF sites) floods. These stage measurements are valuable for calibrating the hydraulic models for high flows, particularly for this study where only a single set of directly measured low flow rating (stage-discharge) data are available.

2.2.2 Discharge measurements

Discharge measurements were provided by manual gauging and also by making use of measurements from the Rehman Bridge Gauge on the Poonch River at Kotli (refer to Section 2.2.2.2).

2.2.2.1 *Manual gauging*

Manual gauging was performed using an acoustic doppler profiler, held in position along the transect using a tag line. The velocity-area method (BS 3680) was used for discharge computation.

The discharges measured at the four EF sites were 17.2, 37.9, 40.0 and 49.2 $m^3 s^{-1}$, respectively.

Table 2.2 Stage and discharge data for EF Site 1

EF Site 1				
Date	**21.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge ($m^3 s^{-1}$)	**17.2**	**476**	**995**	**3060**
Cross-section	**Stage (mamsl)**			
1	618.71	622.20		623.36
2	618.90	620.56	621.78	622.70
3	619.02	620.53	621.85	623.32
4	619.54	627.48		630.22
5	620.26	625.73		
6	620.75	623.26	625.93	
7	620.99	624.94		628.70
8	621.13	624.93		
9	621.38	624.42		626.01
10	624.38	626.53	627.32	629.07
11[3]	624.45	627.68		629.33

[3] Note: cross-section 11 was used directly in the DRIFT DSS (refer to Section 3.2)

Table 2.3 Stage and discharge data for EF Site 2

EF Site 2				
Date	**23.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge ($m^3 s^{-1}$)	**37.9**	**700**		**4500**
Cross-section	**Stage (mamsl)**			
1[4]	489.56	491.17		
2	489.65			
3	490.07	493.92		495.78
4	490.75	495.68		498.31
5	491.65	495.70		498.81
6	492.52	496.21		499.56

Table 2.4 Stage and discharge data for EF Site 3

EF Site 3				
Date	**24.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge ($m^3 s^{-1}$)	**40.0**	**700**		**4500**
Cross-section	**Stage (mamsl)**			
1[5]	452.82	455.59		458.72
2	453.61	455.26		460.29
3	453.60	456.65		458.81
4	453.48	456.03		458.34
5	453.69	455.02		458.97
6	455.46	459.17		464.59
7	455.97			

Table 2.5 Stage and discharge data for EF Site 4

EF Site 4				
Date	**25.10.2013**	**14.08.2013**	**28.07.2010**	**10.09.1992**
Discharge ($m^3 s^{-1}$)	**49.2**	**770**		**4950**
Cross-section	**Stage (mamsl)**			
1	385.09	388.53		395.79
2	385.91	388.73		393.62
3[6]	387.59	390.51		396.52
4	387.85	391.44		394.64
5	387.96	391.83		396.06

2.2.2.2 *Rehman Bridge Gauge*

Records from the Rehman Bridge Gauge on the Poonch River at Kotli, located *c*. 130 m downstream of its confluence with the Ban Nullah, were used to provide the maximum discharge for the wet season prior to the survey in October 2013, and historic floods[7] in 2010

[4] Note: cross-section 1 was used directly in the DRIFT DSS (refer to Section 3.2)
[5] Note: cross-section 1 was used directly in the DRIFT DSS (refer to Section 3.2)
[6] Note: cross-section 3 was used directly in the DRIFT DSS (refer to Section 3.2)
[7] Historic maximum flood discharges and their corresponding surveyed stage levels (Hydraulic data

and 1992 (refer to Figure 2.11).

These stage and discharge data have been used to develop hydraulic models for each of the sites, which are described in Section 3, following.

1.1.1 Stage measurements

Stage measurements were made on the right and left banks of the surveyed cross-sections at the time of topographic surveys (Table 2.1), and these data are included in **Error! Not a valid bookmark self-reference.** to Table 2.5. Also included are the approximate (surveyed) stages corresponding to historic high flows and floods, including: high flows during the previous wet season, and the 2010 (EF Site 1) and 1992 (all EF sites) floods. These stage measurements are valuable for calibrating the hydraulic models for high flows, particularly for this study where only a single set of directly measured low flow rating (stage-discharge) data are available.

1.1.2 Discharge measurements

Discharge measurements were provided by manual gauging and also by making use of measurements from the Rehman Bridge Gauge on the Poonch River at Kotli (refer to Section 2.2.2.2).

1.1.2.1 Manual gauging

Manual gauging was performed using an acoustic doppler profiler, held in position along the transect using a tag line. The velocity-area method (BS 3680) was used for discharge computation.

The discharges measured at the four EF sites were 17.2, 37.9, 40.0 and 49.2 m3 s-1, respectively.

Table 2.2 to Table 2.5) were used circumspectly, since it is not unreasonable to expect that subsequent physical channel changes have occurred, and furthermore the stage levels are estimates (21 years ago for the 1992 flood)

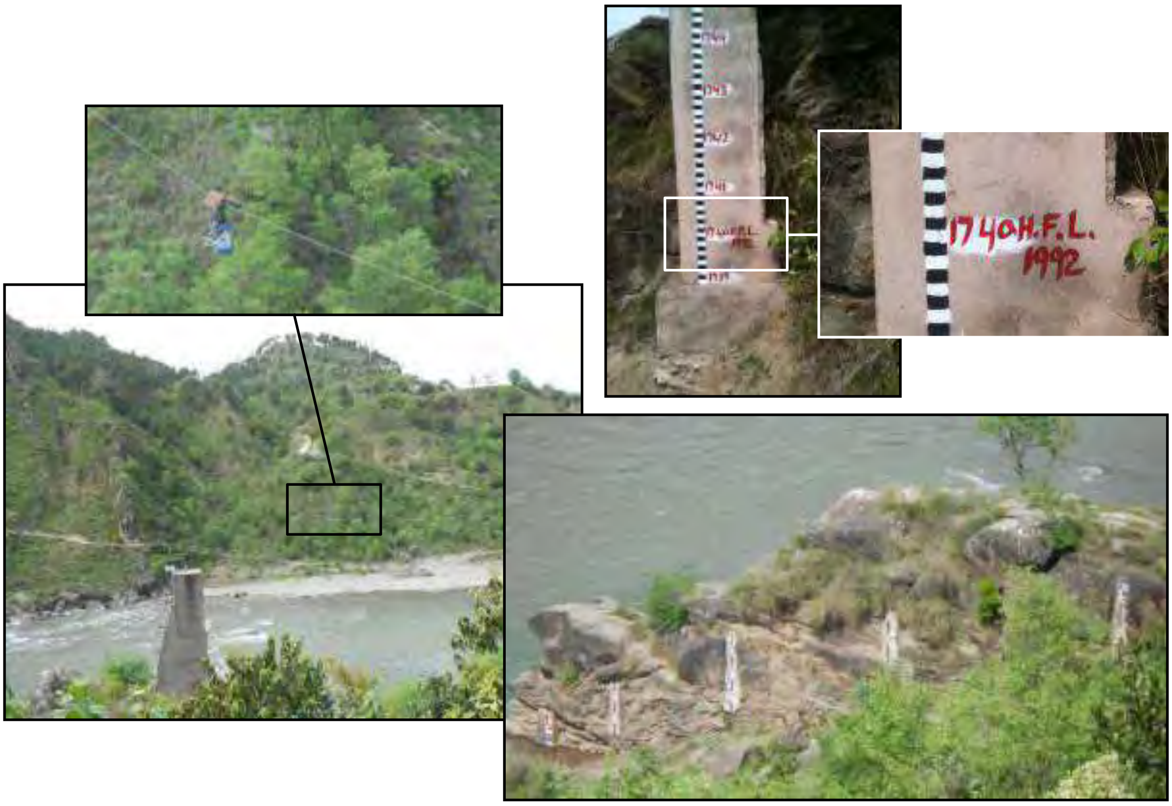

Figure 2.11 **Photographs of the Rehman Bridge Gauging Station, located *c.* 130 m below the confluence of the Poonch River and Ban Nullah. Note the 1992 High Flood Level (HFL) of 1740 ft amsl (source: Mr Yasir Abbas, NESPAK)**

3 HYDRAULIC ANALYSIS AND MODELLING

3.1 HECRAS MODELLING

The well-known hydraulic modelling software, HECRAS (v4.1, available at http://www.hec.usace.army.mil/) was used for steady-state non-uniform computations at the EF sites.

The procedure used for setting-up and applying the hydraulic models was as follows:

- calibration of flow resistance values (Manning's n is used in HECRAS) using the stage-discharge (rating) data presented in Section 2.2, and
- application of the models to interpolate and extrapolate the measurement-based rating data.

3.1.1 Model set-up and calibration

For each of the sites, the georeferenced (refer to Figure 2.2 to Figure 2.9) topographic channel cross-section data were imported into HECRAS. Reach lengths were measured using river distances between cross-sections, and surveyed cross-sections were interpolated. Flow resistances at high flows (floods) were determined using the surveyed flood stages, with discharges estimated by the combination of recorded flows at the local gauging station[8], the

[8] approximately factored for upstream and downstream EF sites using catchment areas

need for flow continuity between sequential sites, and realistically calibrated resistance values.

The Poonch River in the study area is characterised by pool-rapid channel type morphology, with (less common) riffle features composed of cobbles. A typical hydraulic characteristic of reaches with large-scale alluvial sediments (occurring in rapids) is increasing flow resistance with reducing discharge. This is evident from the calibrated values given in Table 3.1. For the four EF sites, high-flow resistances (reach-averaged) are in the range 0.040 to 0.090, and are between 0.063 and 0.16 for the lowest gauged discharges. These discharge-related variations emphasize the importance of increasing flow resistance when modelling the hydraulic behaviour of flows substantially less than historic (*ie*. Baseline) values (refer to Section 3.1.2: 'Model application'). In the HECRAS models, downstream boundary conditions are provided by rating relationships.

Table 3.1 Calibrated reach-averaged flow resistance coefficients

Discharge ($m^3 s^{-1}$)	Flow resistance[9] (Manning's *n*)
EF Site 1	
17.2	0.16
476	0.092
995	0.074
3060	0.045
EF Site 2	
37.9	0.063
700	0.054
4500	0.040
EF Site 3	
40.0	0.077
700	0.045
4500	0.040
EF Site 4	
49.2	0.10
770	0.090
4950	0.041

Figure 3.1 shows plots of the modelled longitudinal water surface profiles and measured stages at the EF sites for the lowest gauged discharges.

[9] expressed using two significant figures

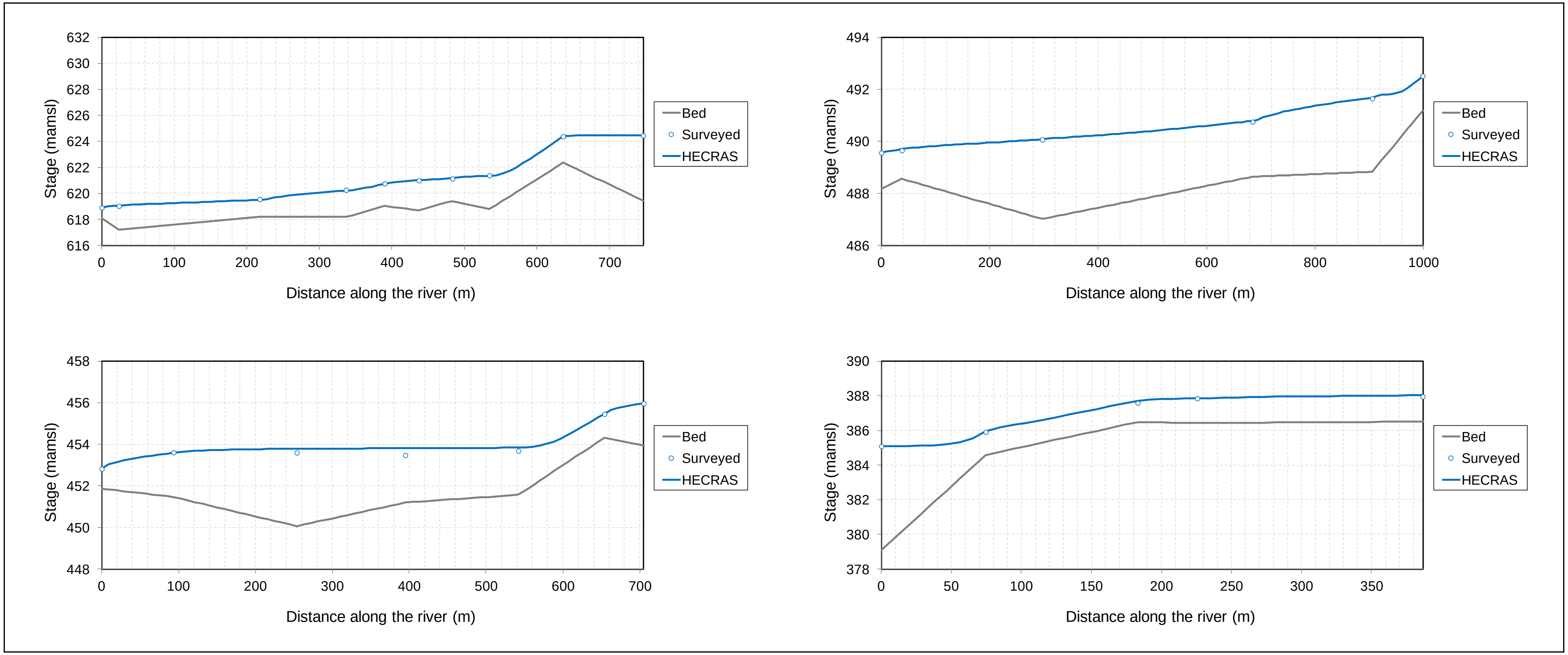

Figure 3.1 **Plots of the longitudinal bed slope, surveyed stages (21 to 24 October 2013) and modelled water surface profiles for the four EF sites (top-left: EF Site 1, 17.2 $m^3 s^{-1}$; top-right: EF Site 2, 37.9 $m^3 s^{-1}$; bottom-left: EF Site 3, 40.0 $m^3 s^{-1}$; bottom-right: EF Site 4 , 49.2 $m^3 s^{-1}$).**

3.1.2 Model application

In the application of the HECRAS models, hydraulic characteristics are computed for a range of discharges. In the case of the Poonch River with Gulpur HPP operational, discharges in the dry season will fall well below historic Baseline values[10] along the dewatered reach between the dam and tailrace outfall (represented by EF Site 2), and thus the flows used for model calibrations in Section 3.1.1. Model applications are necessary to predict hydraulic behaviour at these reduced flows, and it is consequently necessary to estimate concomitant flow resistances. Low flow resistance values were extrapolated from the calibration values (*ie*. as given in Table 3.1).

3.2 HYDRAULIC CHARACTERISATION FOR USE IN THE DRIFT DSS

3.2.1 Hydraulic habitat-flow simulation modelling

The (hydraulic) Habitat-Flow simulation model, HABFLO, was used to produce text files relating discharge to ecologically relevant parameters, for use in the DRIFT DSS. The hydraulic parameters included for (potential) use were maximum and average depth, inundated width, wetted perimeter, average velocity, and a velocity-depth class relevant to fish. The model is described in detail by Birkhead (2010).

Biota in the aquatic environment are associated with a combination of hydraulic variables (*eg*. depth and velocity), as well as physical features such as substrate, vegetation and cover for fish. Hydraulic habitat classes are a means of grouping these combinations into units which have ecological meaning, in that they represent broad, known (or 'judged') preferences of biota for hydraulic and biophysical variables. A class represents a range of values pertaining to at least two environmental variables, of which at least one is flow-dependent (depth, velocity, area of inundation, *etc*). Kleynhans (1999) suggested that the hydraulic variables of depth-averaged velocity and depth, together with substrate and cover, may be used to broadly characterise fish habitat. The environmental variables used (hydraulic and biophysical) and their numerical ranges may be defined using available information on conditions utilised by indicator biota that is available and relevant to the EF assessment.[11]

The abundance of hydraulic habitat defined by the combination of velocity and depth (*ie*. a velocity-depth class) can be predicted by combining the result of a rating relationship (*eg*. Equation 3.1) and the frequency-distribution of depth-averaged velocity (*eg*. Lamouroux *et al*., 1995). For the Gulpur HPP EF assessment, response curves describing the abundance of Mahaseer and Kashmir Catfish were directly linked to indicators of hydraulic habitat in the DRIFT DSS. The flow preference is defined by a velocity-depth class with velocities in the

[10] when flow is being diverted for power generation

[11] For example, Lamouroux *et al*. (1999) developed regional habitat preferences for 24 fish species using five velocity classes. For rock catfish of the Senquyane River (southern Africa), Niehaus *et al*. (1997) found a velocity of 0.1 m s^{-1} to be the threshold separating recruits (lower values) from juveniles and adults (higher values). Cambray *et al*. (1989) noted that the fish species *Barbus afer* and *Kneria auriculata* spawn at depths of 0.1 - 0.2 m. Such data are ostensibly built into the preference ratings for fish species. Where detailed preference information exists (*eg*. Paxton, 2009) classes may be appropriately defined using suitable variables and resolutions.

range 0.1 - 0.7 m s^{-1}, and depths in the range 0.25 - 0.50 m. The HABFLO model was used to predict changes in the abundance of this class as a function of discharge, and the results are expressed as available width on the cross-sectional profile (refer to Table 4.1).

3.2.1.1 Model assumptions

HABFLO is based on the assumptions that:

- cross-sectional profiles and one-dimensional hydraulic parameters may be used to characterise the bed topography and hydraulic conditions, respectively, in morphological features,
- frequency-distributions of depth-averaged velocity may be estimated with reasonable accuracy using statistical methods, and
- depth-averaged velocity and flow depth are mutually exclusive (*ie*. independent) variables.

The use of cross-sections to represent characteristics (topographic and hydraulic) of morphological features relates to their appropriate selection for EF assessment. Generally, biotic considerations tend to dominate this selection, since hydraulic indicators of biotic response to flow variation is of concern. However, while hydraulic considerations cannot benefit from pre-eminence in the site selection process, they are important to the extent that sites and sections chosen are not of such hydraulic complexity that reliable analysis and prediction is impractical.

The reach-scale frequency-distribution velocity model of Lamouroux *et al*. (1995) provides good predictions at the site scale, and fair predictions at the morphological feature scale (Hirschowitz *et al*., 2007). Measurement of point depths and depth-averaged velocities in rapids and riffles has indicated independence at low flows, where parameter estimation is particularly relevant for EF assessment.

3.2.1.2 Data requirements

HABFLO model application requires the following data:

- cross-sectional profile (*ie*. as plotted in Figure 2.10),
- rating relationship (*ie*. as plotted in Figure 3.2),
- numerical ranges defining velocity-depth classes, and
- dominant roughness.

Rating relationships of the form given by Equation 3.1 were fitted (by regression) to the modelled HECRAS rating data. The regression coefficients are provided in Table 3.2, and the relationships are plotted in Figure 3.2 together with the HECRAS and measured data. The '*c*' coefficient in Equation 3.1 is the stage of zero discharge, and is the (maximum) stage remaining (along the cross-section) when flow ceases.

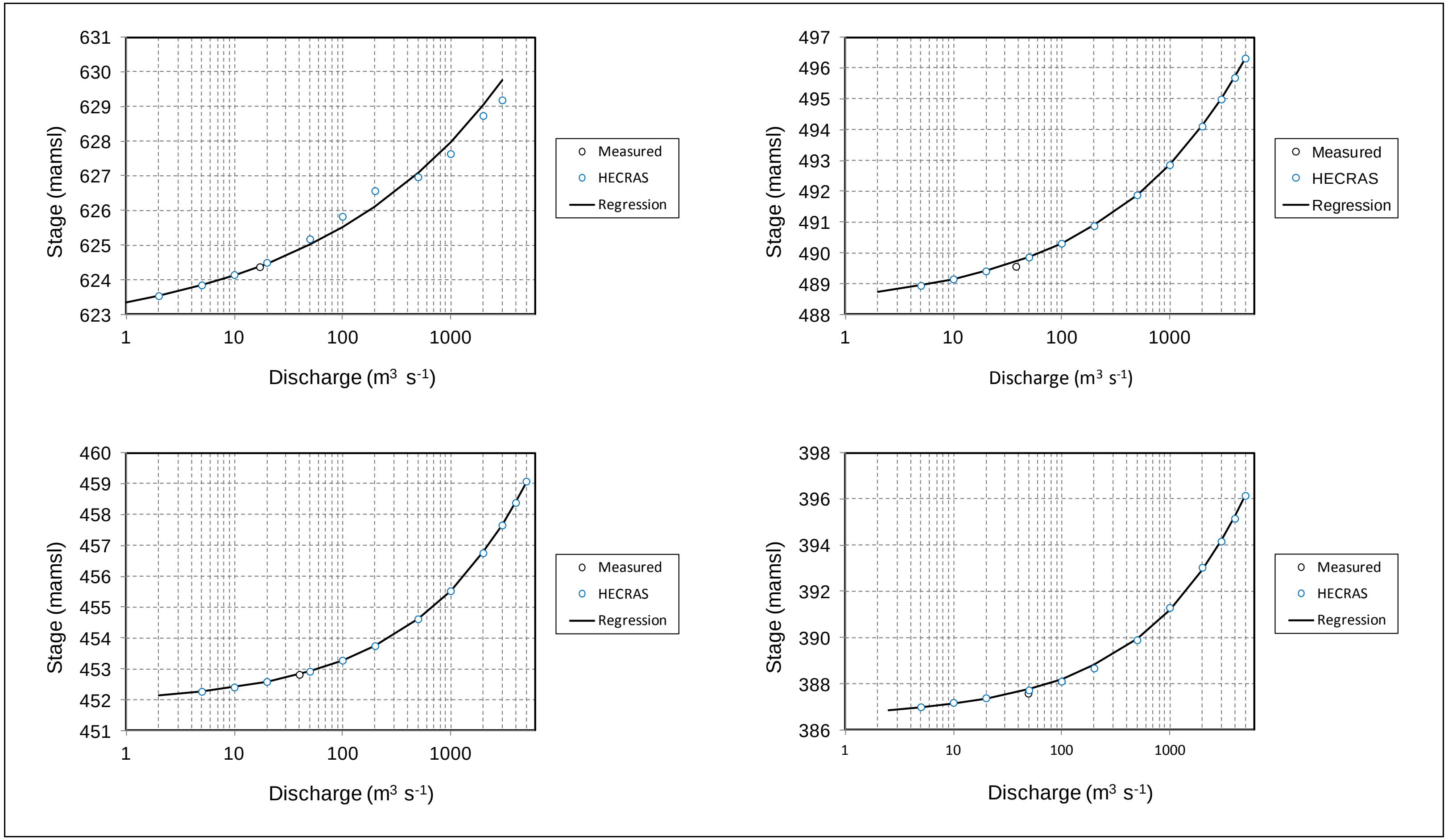

Figure 3.2 **Modelled rating (stage *vs*. discharge) relationships for EF site.cross-sections 1.10 (top-left), 2.1(top-right), 3.1 (bottom-left) and 4.3 (bottom-right)**

$z = aQ^b + c$

Equation 3.1

where z is stage (mamsl), Q is discharge (m^3/s), and a, b and c are regression coefficients.

Table 3.2 Regression coefficients in the rating relationship given by Equation 3.1

Regression coefficients	EF Site Cross-section			
	1.10	2.1	3.1	4.3
a	1.000	0.439	0.206	0.205
b	0.250	0.343	0.417	0.452
c	622.35	488.18	451.87	386.55

The dominant roughness is a parameter used in the frequency-distribution velocity modelling, with values of 0.4 m for cross-sections through rapids used directly in the DRIFT DSS.

4 *HYDRAULIC RESULTS*

The products of the analyses and modelling (Section 3) used to characterise hydraulic conditions at the four EF sites are:

- non-uniform hydraulic models in the form of HECRAS project files, and
- text file outputs from HABFLO for use in the DRIFT DSS, an example of which is provided in Table 4.1 for EF Site 2 (Borali Bridge).

Table 4.1 Example (EF Site 2.1) of the text file output from HABFLO used in the DRIFT DSS

Discharge ($m^3 s^{-1}$)	Depth (m)		Inundated width (m)	Wetted perimeter (m)	Average velocity ($m^3 s^{-1}$)	Velocity-depth class (m width)
	Maximum	Average				
0.0	0.15	0.09	18.8	18.8	0.00	0.0
0.1	0.20	0.13	20.9	20.9	0.03	0.0
0.2	0.25	0.17	22.3	22.3	0.05	0.1
0.3	0.30	0.21	23.6	23.6	0.06	2.1
0.5	0.35	0.24	25.0	25.0	0.08	4.3
0.7	0.40	0.28	26.2	26.2	0.10	7.0
1.0	0.45	0.32	27.1	27.2	0.12	9.2
1.4	0.50	0.35	28.9	29.0	0.14	10.6
1.8	0.55	0.37	31.0	31.0	0.16	8.1
2.4	0.60	0.40	33.0	33.1	0.18	6.3
3.0	0.65	0.42	35.1	35.2	0.20	4.7
3.7	0.70	0.45	37.1	37.2	0.22	4.0
4.6	0.75	0.49	38.3	38.4	0.25	4.1
5.5	0.80	0.53	38.8	39.0	0.27	5.0
6.6	0.85	0.57	39.4	39.5	0.30	5.5
7.8	0.90	0.61	40.0	40.1	0.32	6.0
9.2	0.95	0.64	41.6	41.7	0.35	6.8
10.7	1.00	0.62	46.2	46.4	0.37	6.2
12.4	1.05	0.63	49.2	49.4	0.40	5.2

Discharge	Depth (m)		Inundated	Wetted	Average	Velocity-depth
14.2	1.10	0.66	50.8	51.0	0.42	4.3
16.2	1.15	0.70	51.6	51.8	0.45	3.4
18.3	1.20	0.74	52.3	52.5	0.47	3.4
20.6	1.25	0.78	53.1	53.3	0.50	5.1
23.2	1.30	0.81	54.6	54.8	0.53	6.5
25.9	1.35	0.83	56.7	56.9	0.55	6.8
28.8	1.40	0.85	58.5	58.8	0.58	6.7
31.9	1.45	0.89	59.5	59.7	0.61	5.2
35.3	1.50	0.92	60.5	60.7	0.63	3.7
38.8	1.55	0.96	61.3	61.5	0.66	3.3
42.6	1.60	1.00	62.0	62.3	0.69	2.8
46.6	1.65	1.04	62.7	63.0	0.72	2.8
50.9	1.70	1.07	63.5	63.7	0.75	3.2
55.4	1.75	1.11	64.2	64.5	0.78	3.2
60.2	1.80	1.15	64.9	65.2	0.81	2.6
65.2	1.85	1.18	65.7	66.0	0.84	2.0
70.5	1.90	1.22	66.4	66.7	0.87	1.6
76.1	1.95	1.26	67.1	67.4	0.90	1.5
82.0	2.00	1.29	67.8	68.2	0.93	1.4
88.1	2.05	1.33	68.6	68.9	0.97	1.1
94.6	2.10	1.37	69.1	69.5	1.00	1.1
101.3	2.15	1.41	69.4	69.8	1.03	1.1
108.4	2.20	1.46	69.7	70.1	1.07	1.0
115.7	2.25	1.50	70.0	70.4	1.10	1.0
123.4	2.30	1.54	70.3	70.8	1.14	0.7
131.5	2.35	1.59	70.6	71.1	1.17	0.8
139.8	2.40	1.63	70.9	71.4	1.21	0.6
148.5	2.45	1.67	71.2	71.7	1.25	0.4

5 *HYDROLOGY*

5.1 INFORMATION SUPPLIED

5.1.1 Historical flows

Historically gauged flows from the Rehman Bridge Station on the Poonch River at Kotli (refer to Section 2.2.2.2) were supplied by Mira Power through HBP. These comprise the Baseline hydrological data used in this study, and are for the period 1960 to 2011. The Baseline discharge time series for the four EF sites were provided by the National Engineering Services Pakistan Limited (NESPAK), and were estimated using proportional catchment areas (Table 5.1).

Table 5.1 Catchment-area factors for the EF sites

EF site	Catchment area factor
1	0.68
2	1.00
3	1.02
4	1.10

5.1.2 Dam and HPP layout: Option 1

Selected design features for the dam and HPP, relevant for modelling baseload and peaking power generation scenarios, are listed in Table 5.2, with other pertinent information including (Mira Power 2013):

- dam level-storage volume-surface area (Table 5.3),
- a power function for the tailwater rating relationship, which was determined by regression using rating data provided (Equation 5.1),
- monthly and annual average evaporation (Table 5.4), and
- the head loss equation (Equation 5.2).

Table 5.2 Selected design features for the dam and HPP: Layout Option 1

Normal Operating Level (NOL)	540.0m
Number and type of turbines	3 x Francis
Total installed capacity	100 MW
Turbine efficiency	92.6%
River discharge at which generation ceases[12]	830 $m^3 s^{-1}$

[12] To prevent damage to the turbines due to high suspended sediment loads.

Table 5.3 Option 1: dam level - storage volume - surface area

Level (mamsl)	Storage (10^6 m^3)	Surface area (km^2)
543.6^{MWL}	32.13[1]	3.12[1]
540.0^{NOL}	21.89	2.28
538.0^{MOL}	17.72	1.89
535.0	12.78	1.40
530.0	7.17	0.87
525.0	3.72	0.52
520.0	1.62	0.32
517.0^{DSL}	0.92[1]	0.22[1]

MWL: Maximum Water Level (= dam crest level)[13]
NOL: Normal Operating Level
MOL: Minimum Operating Level
DSL: Dead Storage Level (= gate invert level)
[1]interpolated

$$z = 0.099Q^{0.600} + 476.00$$

Equation 5.1

where z is stage at the tailrace outfall (mamsl) and Q is the (river) discharge (m^3 s^{-1}).

$$l = aQ^2$$

Equation 5.2

where l is the head loss (m), Q is the (turbine) discharge (m^3 s^{-1}), and a is a function of the number of generating turbines: 0.000442, 0.000194 or 0.000140 for 1, 2 and 3 turbines, respectively.

Table 5.4 Monthly average evaporation

Month	Evaporation (mm)
Jan	48
Feb	68
Mar	108
Apr	158
May	226
Jun	229
Jul	157
Aug	123
Sep	111
Oct	89
Nov	66
Dec	46
Annual	*1429*

[13] No overtopping - 'spillage' is through radial gates (invert level of 517.0 m)

5.1.3 Baseload scenarios

Four baseload scenarios were calculated and provided by NESPAK for constant EF releases of 4, 8, 12 and 16 $m^3 s^{-1}$. For all these the discharge time series at EF Sites 1, 3 and 4 remained unchanged[14] from Baseline conditions.

For EF Site 2, the baseload scenario discharge was calculated as follows:

- if the discharge at the dam site is less than the EF, then use the dam site (Baseline) discharge;
- else, use the minimum EF release, plus:
  - if (dam site discharge - EF) ≥ 194 $m^3 s^{-1}$, then add (dam site discharge - (194 $m^3 s^{-1}$ + EF));
- for both of the above, add the incremental Baseline discharge between the dam site and EF Site 2.

Concerns regarding practical implementation of above baseload scenarios (for different EF releases) were conveyed to the client group (*viz*. HBP and Mira Power). These included:

- Francis turbines have a relatively narrow range of discharge ratios[15] with high generation efficiency (certainly over 90%), as illustrated in Figure 5.1;
- There exist minimum discharge ratios (or discharges for given generation heads) below which:
  - turbine efficiencies are extremely low - resulting in sub-optimal power generation; and
  - turbines are susceptible to vibration.

Notwithstanding these concerns, the impacts of these baseload scenarios (as provided) were modelled using the DRIFT DSS. Modified baseload scenarios were later considered (12 March 2014) as part of an updated layout (Option 3) for the HPP, and are presented in Section 0.

5.2 *MODELLING OF A PEAKING OPERATIONAL SCENARIO*

In addition to the above baseload scenarios provided by NESPAK (Section 5.1.3), a discharge time series for <u>one</u> peaking scenario, corresponding to a minimum constant EF release of 8 $m^3 s^{-1}$ (G8Peak[16]) was modelled and provided for assessment in the DRIFT DSS.

[14] This is because EF Site 1 is located upstream of the HPP; EF Sites 3 and 4 are downstream of the tailrace outfall but these are baseload scenarios with a constant NOL in the diversion dam.

[15] actual to maximum turbine discharge

[16] An 8 $m^3 s^{-1}$ minimum release from the Gulpur Dam with peaking power generation

5.2.1 Operating rules

The following operating rules were used for modelling the peaking scenario:

- NOLs between 539.0 and 540.0 m[17];
- Variable turbine efficiency (Francis turbine), as plotted in Figure 5.1;
- Minimum discharge ratio (all turbines) of 0.5 (*ie.* minimum efficiency of 72.5%);
- Turbines operated successively to maximum capacity[18];
- Hourly power-demand times as follows[19]:
    - Peak: 18:00 to 21:00,
    - Standard: 06:00 to 18:00 and 21:00 to 23:00, and
    - Off-peak: 23:00 to 06:00;

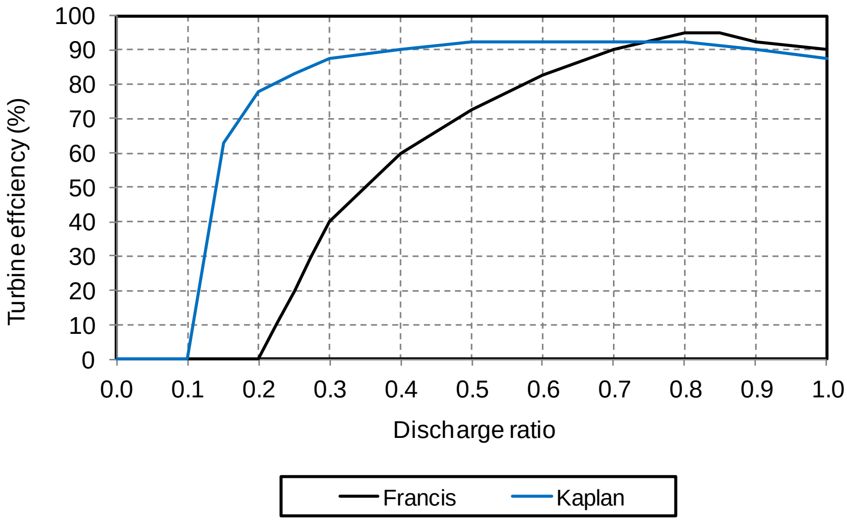

Figure 5.1 Francis and Kaplan (adjustable guide vanes) turbine efficiency curves used to compute power generation. The efficiency for the Francis turbine is limited to a discharge ratio of 0.5 to provide at least 72.5% efficiency; for the Kaplan turbine the minimum ratio is 0.20 (78.0%) (source: SKAT, 1985)

- Priority given to generation firstly during Peak, followed by Standard, and lastly during Off-peak times;
- When there is insufficient average daily discharge ([inflow + storage] - [environmental release + evaporation]) to generate at maximum capacity, then the

[17] Peaking operation requires changes in storage to accommodate an unsteady sub-daily release pattern. This is achieved by allowing a nominal range in the daily NOLs (ie. values at 24:00). During the course of a day, however, the level may (for a few hours) be higher or lower than the 24:00 daily value. For G8Peak, the actual (01:00 to 23:00) levels range from 538.8 to 540.8 m - well below the maximum of 543.6 m (dam crest level). Levels are kept as high as possible to increase the available generation head, thereby reducing the required discharge for a given power output.

[18] *ie*. the second turbine is operated only when the first turbine is generating at maximum capacity, and similarly for the third turbine. This results in discharge ranges of *c.* (since they are head-dependent) 33 - 66, 99 - 132, and 165 - 198 $m^3 s^{-1}$. It is possible, however, to generate at all (available) discharges above *c.* 33 $m^3 s^{-1}$ by reducing the discharge through the first and second turbines (to the minimum discharge ratios) when generation commences for the second and third turbines, respectively. This would result in lower power output and more complex (hourly) operation. Since no operational design or rules were provided for peaking operation, this was not modelled.

[19] Determined in consultation with HBP and NESPAK

discharge through the turbines is reduced over the course of a day according to the priority peaking rules above[20].

5.2.2 Results

An illustration of the discharge time series at EF Site 3 for the peaking scenario with a minimum constant EF of 8 $m^3 s^{-1}$, is plotted in Figure 5.2. The unsteady flows discharged into the Poonch River at the tailrace outfall (*c.* 5.2 km upstream of EF Site 3) are not routed downstream. This is reasonable given the steep downstream gradient (0.0042)[21], and the time series at the downstream EF sites therefore represent worst case situations. For this scenario, a summary of the annual water balance volumes and power generation are given in Table 5.5.

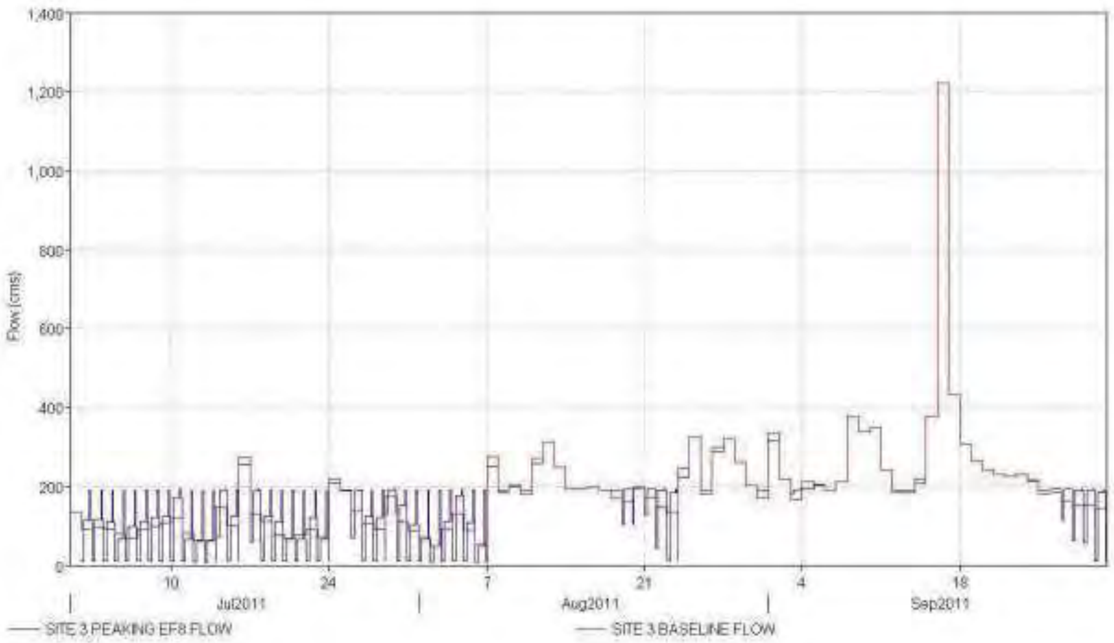

Figure 5.2 **Discharge time series for the period 1 July to 30 September 2011, showing the Baseline (historical) average daily flows at EF Site 3 (red) and that resulting from peaking Scenario G8Peak (blue) (cms = $m^3 s^{-1}$)**

Table 5.5 **Annual water balance for Scenario G8Peak**

Year	Volume (10^6 m^3)					Load factor (%)	HPP (GWh)
	Inflow	EF	Spill	HPP	Evaporation		
1960	3160.0	253.0	874.1	2030.1	2.8	36.3	287.0
1961	4327.2	249.5	1277.7	2795.8	2.8	50.0	393.5
1962	2618.0	252.3	245.7	2118.1	2.8	38.2	300.5
1963	3220.2	252.3	587.5	2377.9	2.8	42.5	335.1
1964	4144.7	253.0	1217.8	2671.1	2.8	47.7	376.4

[20] With the Peak, Standard and Off-peak generation times remaining the same

[21] *ie*. minimal attenuation expected

1965	3851.4	252.3	660.4	2935.9	2.8	52.3	411.6
1966	4586.6	252.3	1315.5	3016.0	2.8	53.8	423.1
1967	4002.0	252.3	997.4	2749.5	2.8	49.1	386.0
1968	3666.1	253.0	520.3	2889.9	2.8	51.7	407.9
1969	3365.7	252.3	609.8	2500.6	2.8	44.8	352.7
1970	2899.3	252.3	727.0	1917.5	2.8	34.4	270.9
1971	2817.9	252.3	699.2	1863.6	2.8	33.4	262.8
1972	3065.4	253.0	485.9	2323.7	2.8	41.8	329.8
1973	4727.7	252.3	1520.6	2952.0	2.8	52.6	414.3
1974	2179.9	252.3	218.0	1706.7	2.8	30.9	243.2
1975	4253.8	252.3	1368.8	2630.0	2.8	47.0	370.3
1976	5995.3	253.0	2398.6	3340.8	2.8	59.0	466.3
1977	4119.3	252.3	1135.4	2728.2	2.8	48.9	384.7
1978	6077.2	252.3	2172.0	3650.7	2.8	64.7	509.2
1979	3555.0	252.3	558.4	2741.4	2.8	49.1	386.9
1980	3054.0	253.0	344.5	2452.9	2.8	44.1	347.2
1981	4274.8	252.3	1097.1	2923.5	2.8	52.0	409.2
1982	4321.1	252.3	1283.8	2781.1	2.8	49.5	389.6
1983	5356.5	252.3	1700.0	3402.5	2.8	60.2	474.6
1984	3310.0	253.0	762.9	2291.3	2.8	40.9	322.9
1985	2922.0	252.3	558.1	2107.9	2.8	38.1	300.3
1986	5300.5	252.3	1383.8	3661.8	2.8	65.1	512.9
1987	3444.9	252.3	306.6	2882.7	2.8	51.7	407.1
1988	4909.4	253.0	2129.6	2523.9	2.8	45.0	355.2
1989	3506.4	252.3	706.7	2545.6	2.8	45.8	360.6
1990	4536.9	252.3	1276.0	3003.7	2.8	53.6	421.7
1991	4370.3	252.3	922.4	3194.6	2.8	57.0	448.6
1992	8216.9	253.0	3505.0	4456.3	2.8	78.5	620.1
1993	4407.3	252.3	752.1	3400.1	2.8	60.5	475.9
1994	5191.3	252.3	1942.5	2992.3	2.8	53.3	419.6
1995	5050.6	252.3	1573.3	3222.6	2.8	57.4	451.6
1996	5467.3	253.0	1697.3	3515.1	2.8	62.1	490.3
1997	4582.8	252.3	1249.4	3078.2	2.8	55.1	433.4
1998	4621.6	252.3	1489.8	2876.6	2.8	51.3	403.4
1999	2427.6	252.3	129.6	2042.7	2.8	37.0	290.7
2000	2900.9	253.0	488.8	2156.6	2.8	38.8	305.6
2001	2523.8	252.3	381.6	1887.1	2.8	33.8	266.1
2002	2487.9	252.3	224.6	2008.2	2.8	36.2	284.9
2003	3428.4	252.3	805.7	2367.6	2.8	42.4	333.3
2004	2086.4	253.0	40.7	1789.9	2.8	32.4	255.4
2005	3969.3	252.3	615.5	3098.0	2.8	55.3	434.8
2006	4187.4	252.3	907.7	3025.3	2.8	54.1	426.5
2007	4018.1	252.3	852.8	2910.2	2.8	51.9	408.2
2008	3794.3	253.0	528.8	3008.5	2.8	53.6	423.1
2009	2782.9	252.3	100.4	2428.7	2.8	43.8	344.4
2010	3867.5	252.3	911.6	2699.8	2.8	48.3	380.6
2011	4239.5	252.3	575.9	3409.5	2.8	60.9	479.8
Average	*3965.2*	*252.4*	*977.6*	*4456.3*	*2.8*	*48.8*	*384.4*

5.3 *RESULTS SUMMARY: PEAKING AND BASELOAD*

A summary of the results for Layout Option 1 is provided in Table 5.6 for EF releases in the range 4 to 16 $m^3 s^{-1}$. The impact on power generation is calculated relative to no EF release. For comparison, the baseload scenarios are also included, with both constant (90%) and

Table 5.6 **Summary showing the influence of EF release on average annual power generation and reduction relative to no EF for baseload and peaking operation (Layout Option 1: MAR= 3965.2 10^6 m^3, Layout Option 3: MAR = 3989.0 10^6 m^3)**

EF (m^3 s^{-1})	EF (10^6 m^3 a^{-1})	Spill (10^6 m^3 a^{-1})	EF/MAR (%)	(EF+spill) /MAR (%)	90% constant turbine efficiency: Ave. annual power generation (GWha^{-1})	90% constant turbine efficiency: Ave. annual reduction in power generation (%)	Variable turbine efficiency (refer to Figure 5.1): Ave. annual power generation (GWha^{-1})	Variable turbine efficiency (refer to Figure 5.1): Ave. annual reduction in power generation (%)
HPP Layout Option 1 with three Francis turbines								
Baseload scenarios								
0.0	0.0	1047.0	0.0	26.4	422.8	0.0	408.7	0.0
4.0	126.2	1024.0	3.2	29.0	407.8	3.5	392.1	4.1
8.0	252.4	1001.9	6.4	31.6	392.5	7.2	375.6	8.1
16.0	503.4	960.4	12.7	36.9	361.8	14.4	344.7	15.7
Peaking scenarios[1]								
0.0	0.0	1022.4	0.0	25.8			414.0	0.0
4.0	126.2	999.4	3.2	28.4			399.3	3.6
8.0	252.4	977.6	6.4	31.0			384.4	7.1
16.0	503.4	956.5	12.7	36.8			354.6	14.3
HPP Layout Option 3 with two Kaplan turbines								
Baseload scenarios								
0.0	0.0	1028.3	0.0	25.8			395.1	0.0
4.0	126.2	1025.5	3.2	28.9			378.3	4.3
6.0	189.3	1020.8	4.7	30.3			370.4	6.3
8.0	252.4	1017.1	6.3	31.8			362.4	8.3
12.0	378.4	1001.7	9.5	34.6			347.6	12.0
16.0	503.4	981.5	12.6	37.2			333.2	15.7

GWha^{-1}: Giga (10^9) Watt-hours per annum
MAR: Mean Annual Runoff
[1]time series for DRIFT DSS provided for EF = 8 m^3 s^{-1}

variable turbine efficiencies, but no minimum discharge ratio. For baseload operation and an EF release of 4 $m^3 s^{-1}$, 90% efficiency gives an average annual power generation of 407.8 $GWha^{-1}$, close to 408.6 $GWha^{-1}$ given in the design report. The latter quotes a value of 464.3 $GWha^{-1}$ when using average monthly discharges. By comparison, application of the (sub-daily) HPP model[22], parameterised with information used for monthly modelling[23], gives the same average annual power generation for the 50-year period 1960 to 2009 (*viz*. 464.3 $GWha^{-1}$). It therefore appears that for the Poonch River's highly variable flow regime, the use of monthly modelling substantially overestimates power generation for baseload operation[24]. Table 5.6 indicates that reductions in average annual power generation are very similar for the same EF releases, being largely independent of the other operational parameters.

[22] used in this study
[23] constant tailwater level of 478.72 mamsl; 92.6% efficiency; no evaporation
[24] with the dam level held at the NOL

6 *UPDATED LAYOUT FOR DAM AND HPP: OPTION 3*

An updated and different layout for the HPP (Option 3) has also been considered. The dam is located *c.* 5.9km further downstream[25]; the dewatered river reach has been reduced to *c.* 900 m; and EF Site 2 is located in the reservoir basin.

Selected design features for this layout are given in Table 6.1, with the dam level-storage volume-surface area data provided in Table 6.2[26]. The tailrace outfall is located *c.* 600 m downstream of that for Option 1 (Figure 6.1), and in the absence of updated information, the Option 1 tailwater rating equation (*viz.* Equation 5.1) was used with the stage reduced by 1.0 m[27].

Table 6.1 Selected design features for the dam and HPP: Layout Option 3

Normal Operating Level (NOL)	532.0m
Number and type of turbines	2 x Kaplan
Total installed capacity	100 MW
Turbine efficiency	Variable, refer to Figure 5.1
River discharge at which generation ceases[28]	830 $m^3 s^{-1}$

Table 6.2 Option 3: dam level - storage volume - surface area

Level (mamsl)	Storage (10^6 m^3)	Surface area (km^2)
533.0^MWL	43.91[1]	2.38[1]
532.0^NOL	41.59[1]	2.26[1]
530.0^MOL	36.96	2.02
525.0	27.95	1.59
520.0	20.79	1.28
515.0	15.05	1.01
510.0	10.05	0.79
505.0^DSL	6.99	0.63

MWL: Maximum Water Level (= crest level)[29]
NOL: Normal Operating Level
MOL: Minimum Operating Level
DSL: Dead Storage Level (= gate invert level)
[1]interpolated

Six baseload scenarios were modelled for constant minimum EF releases of 0, 4, 6, 8, 12 and 16 $m^3 s^{-1}$. For all scenarios, the discharge time series at EF Sites 1, 3 and 4 remained unchanged[30] from previous (refer to Section 5.1.3) conditions.

[25] The catchment area factor for the dam, relative to the Rehman Bridge Gauge, is 1.006.
[26] e-mail correspondence with HBP, 12.03.2014
[27] This may be conservative (*ito.* power generation), since the valley slope is *c.* 0.004, which gives a fall of 2.4 m. Note, however, that the head losses in the *c.* 200 m long head and tailrace diversion tunnels have been neglected in the modelling (HBP and Mira Power, *pers com*).
[28] To prevent damage to the turbines due to high suspended sediment loads
[29] No overtopping - spillage is through radial gates

The operating rules used to compute baseload scenarios are as follows:

- the full river flow[31] at the dam site[32] is released through the dam into the downstream reach if the discharge at the dam site is either:
  - less than that calculated using a minimum turbine discharge ratio of 0.2[33] (*c*. 78% efficiency - refer to Figure 5.1), or
  - greater than 830 $m^3 s^{-1}$;
- else, the minimum EF is released through the dam.
- A minimum discharge ratio of 0.4 applies to the second turbine (*c*. 90% efficiency)[34].
- The dam stage is maintained at the NOL.

As mentioned above, EF Site 2 lies in the dam backup for Layout Option 3. The Poonch River in the study area is generally characterised by pool-rapid channel type morphology, with (less common) riffle features composed of cobbles. This channel type morphology occurs at all EF sites - refer to Figure 2.2 to Figure 2.9, and is also the case for the 'dewatered' section between the dam and tailrace outfall (Figure 6.1). The hydraulic characteristics of the (existing) EF Site 2 are therefore eminently transferable to a (hypothetical) EF site located in the short (*c*. 900 m long) dewatered section immediately below the dam. It was therefore not unnecessary to establish a new EF Site 2.

Catchment area factors (refer to Table 5.1) for EF Sites 2, 3 and 4 (relative to the dam) are 1.001, 1.016 and 1.091, respectively.

An illustration of the discharge time series at EF Site 2 for the baseload scenario with a minimum constant EF of 8 $m^3 s^{-1}$, is plotted in Figure 6.2. For all scenarios, a summary of the annual water balance volumes and power generation for Layout Option 3 are given in Table 5.6. The average annual power generation is *c*. 3.4% less than for Option 1 (*cf*. 378.3 *vs*. 392.1 $GWha^{-1}$), since even with more efficient Kaplan turbines, a minimum discharge ratio has been applied. Also, the available generation head is less (*cf*. daily average of 55.4 *vs*. 60.5 m for Layout Options 3 and 1, respectively).

---

[30]Since EF Site 1 is located upstream of the HPP; EF Sites 3 and 4 are downstream of the tailrace outfall but these are baseload scenarios with a constant NOL in the diversion dam.

[31] *ie*. no flow diversion for power generation

[32] Essentially Baseline minus evaporation

[33] *c*. 20 $m^3 s^{-1}$ for one turbine, since head-dependent

[34] This increases the power generation by *c*. 2.5GWa^{-1} through a higher overall efficiency. Flow through the first turbine may need to be reduced from maximum capacity to compensate for the second turbine's higher (minimum) discharge ratio of 0.4.

Figure 6.1 **The dewatered section of the Poonch River between the proposed Gulpur Dam Site and tailrace outfall (Option 3), using a 1 November 2005 (low flow) aerial view.**

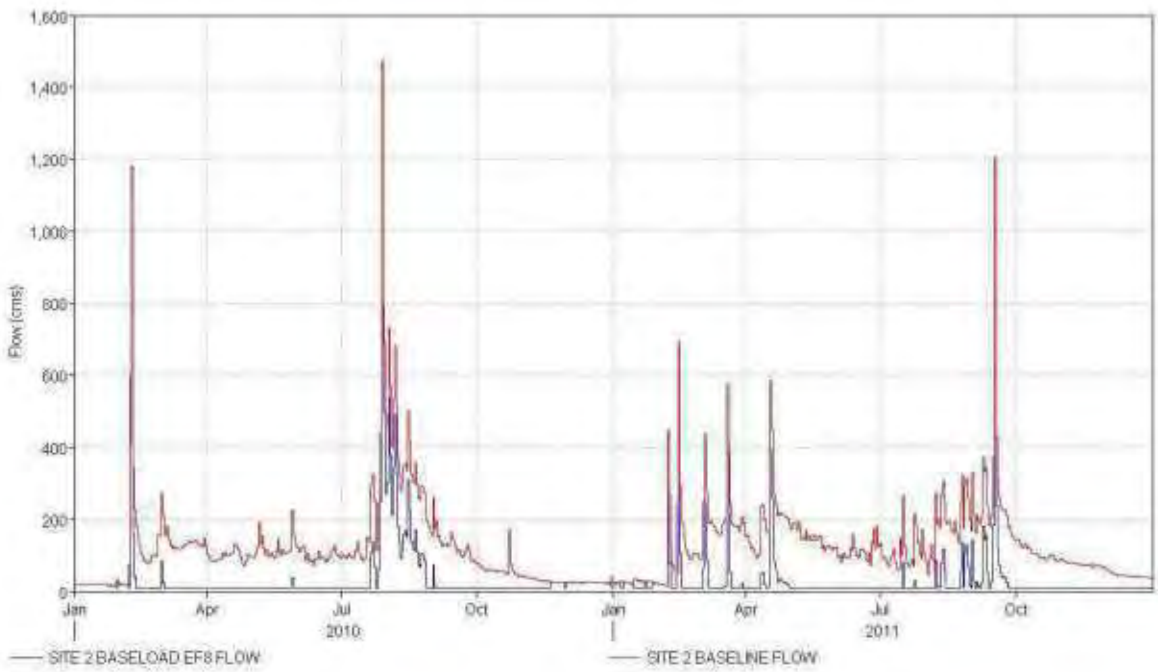

Figure 6.2 **Discharge time series for the period 1 January 2010 to 31 December 2011, showing the Baseline (historical) average daily flows at EF Site 2 (red) and those resulting from Baseload Scenario G8OR[35] (blue) (cms = $m^3 s^{-1}$)**

[35] An 8 $m^3 s^{-1}$ minimum release from the Gulpur Dam with (baseload) Operational Rules

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SKAT, 1985. Local Experience with Micro-Hydro Technology. 171 pp. Available at: http://www.fastonline.org/CD3WD_40/CD3WD/APPRTECH/SK30LE/EN/B1080_1.HTM (Adapted from James Leffel & Co.)

Appendix H: Environmental Flow Assessment

See following pages.

Gulpur Hydropower Project

Environmental Flow Assessment
Technical Report

In association with

Hagler Bailly Pakistan

March 2014

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List of Acronyms

AJK	Azad Jammu and Kashmir
BAU	Business As Usual
DRIFT	Downstream Response to Imposed Flow Transformation
DSS	Decision Support System
EF	Environmental Flow
HBP	Hagler-Bailley Pakistan
HPP	Hydroelectric Power Plant
MAR	Mean Annual Runoff
ND	No Dam
NOL	Normal Operating Level
Pro	Protection in terms of management interventions to reduce non-flow related impacts on the riverine ecosystem

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 The Poonch River

The Poonch River originates in the western foothills of the Pir Panjal Range, and the steep slopes of the Pir Panjal form the upper catchment of the river (Figure 1.1). The river is narrow and descends steeply until it reaches the foothill areas where the gradient flattens out and the river widens as it is joined by several tributaries. The river flows into the Mangla Lake about 30 km downstream of Kotli, near Chomukh in Mirpur District of Azad Jammu and Kashmir (AJK). Mangla Lake is the reservoir of Mangla Dam, situated at the confluence of the Poonch and Jhelum Rivers.

Flows in the Poonch River are highest in the summer months driven first by snow melt and then by the monsoon rains. Summer water temperatures in the lower Poonch River approach 30° C.

The Poonch River within AJK has been notified as a national park by the AJK Wildlife and Fisheries Department. There are also plans to have part of the lower catchment declared a national park, the Chameri National Park, by 2014.

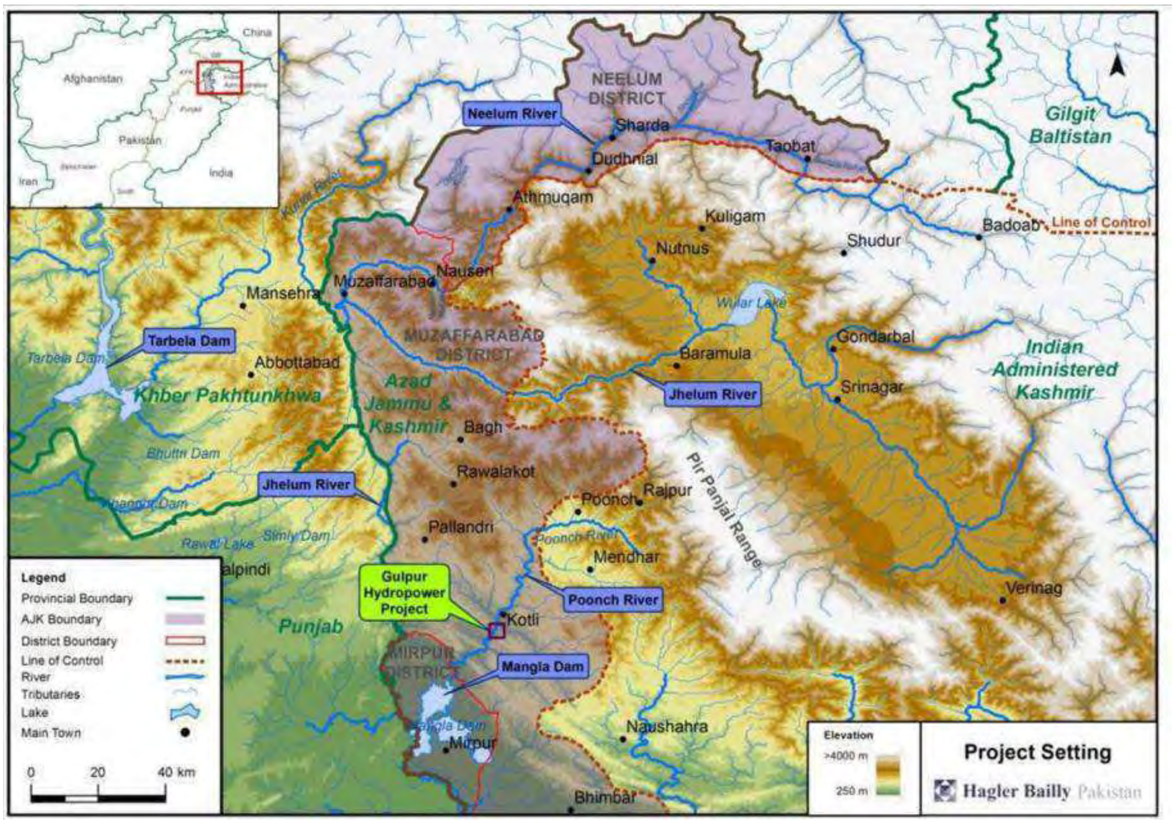

Figure 1.1 The Poonch River and Gulpur HPP setting

1.1.2 The Proposed Gulpur Hydropower Plant

Mira Power Limited is planning to develop the Gulpur Hydropower Project (HPP) on the Poonch River in AJK (Figure 1.2). The proposed Gulpur HPP is a run-of-the-river type facility with a 35-m weir[1] on the Poonch River. Two options were considered for the location of the weir (Figure 1.2):

- Option 1: Just downstream of its confluence with Bann Nullah
- Option 3: Approximately 6 km downstream of Bann Nullah close to the power house.

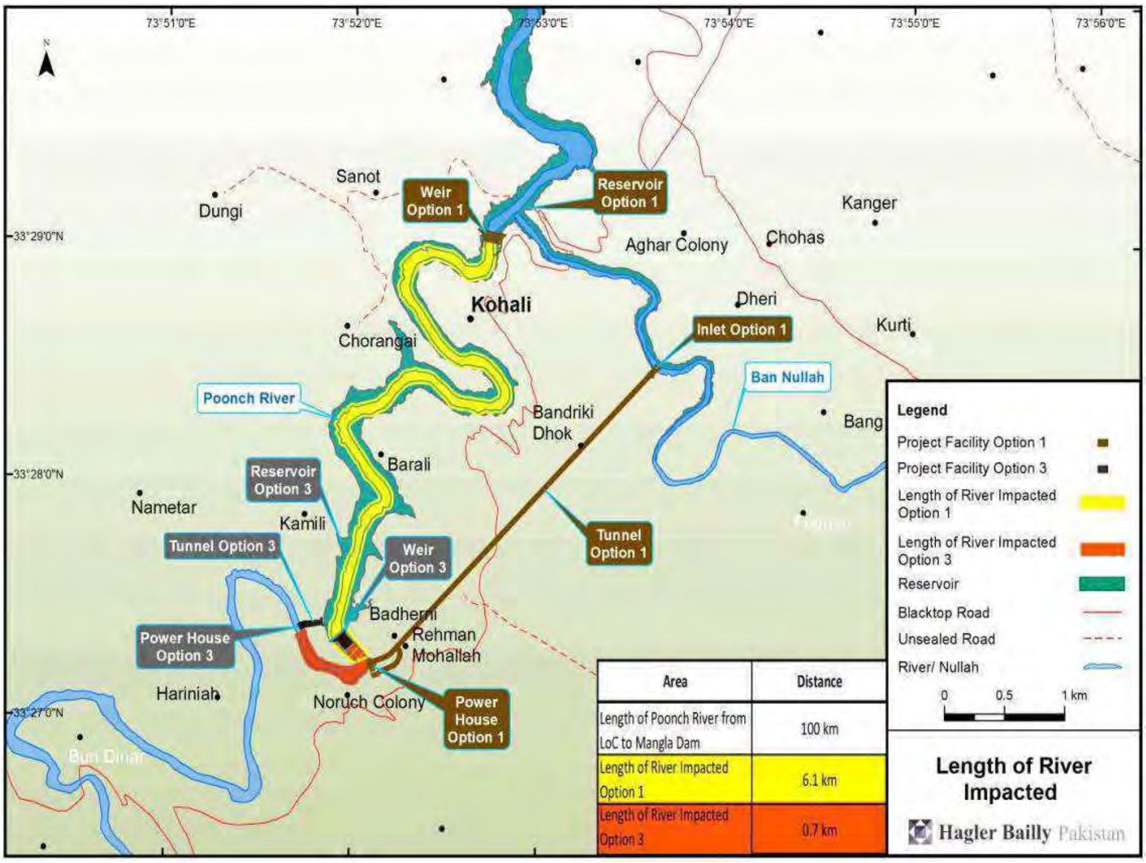

Figure 1.2 Gulpur HPP: planned project facilities, showing the positions for Option 1 and Option 3.

Option 2, originally considered but later discarded, was similar in design to Option 1 except for that the weir was located c. 2.5 km downstream of that in Option 1.

For Option 1, Figure 1.2 shows the planned Project facilities. The weir (middle top of Figure 1.2) will create a reservoir just downstream of the confluence of the Poonch River and the Bann Nullah. The water from the reservoir will be diverted to a 3.1-km headrace tunnel. The intake of the tunnel will be located within the reservoir in the Bann Nullah about 2 km upstream of the confluence. A powerhouse will be constructed on the left bank of the

[1] In fact a 35-m high wall, with release structures, is a dam. We have retained the term 'weir' in line with other project literature.

Poonch River about 6.1 km downstream of the weir. After passing through the powerhouse the water will be discharged back into the Poonch River.

For Option 3, the weir will be situated c. 6 km downstream of the confluence of the Poonch River and the Bann Nullah and the water from the reservoir will be diverted to a short (<1 km) headrace tunnel. The intake of the tunnel will be located at the weir. A powerhouse will be constructed on the left bank of the Poonch River about 0.75 km downstream of the weir. After passing through the powerhouse the water will be discharged back into the Poonch River.

This report deals with Option 1 and Option 3.

The timing of the proposal for Option 3 meant that it was not under consideration when the EF sites (Section 2) were selected. Thus, for completeness, the validity of using these results to evaluate Option 3 is discussed in Section 2.1.

1.1.3 Assessment of the potential impacts on biodiversity

Mira Power Limited engaged Hagler-Bailly Pakistan to conduct an assessment of potential impacts of the proposed Gulpur HPP on biodiversity and to identify mitigation and management measures to address potential impacts. As part of this assessment, Hagler-Bailly Pakistan appointed Southern Waters to assist with an Environmental Flow (EF) assessment for the Poonch River upstream and downstream of the proposed Gulpur HPP in AJK.

1.2 THE ENVIRONMENTAL FLOW ASSESSMENT

1.2.1 Objectives

The objectives of the EF assessment were:

- to evaluate the present day condition (i.e., the present structure and functioning) of the Poonch River from upstream of Gulpur HPP to Mangla Dam;
- to evaluate how the condition of the river could change under different operational scenarios for the proposed Gulpur HPP.

1.2.2 Scope of Work

Southern Waters' Scope of Work was to work with the local river specialists appointed by Hagler-Bailly Pakistan and to provide support and advice on the following:

- Delineation of river basin and selection of representative sites for the EF assessment.
- Selection of scenarios for the EF assessment.

- Recommendations for collection of primary data for the configuration of the DRIFT [2] EF assessment model.
- Incorporation of hydrological data provided by Hagler-Bailly Pakistan into the DRIFT model and selection of ecologically-relevant flow indicators.
- Modelling and incorporation of hydraulic relationships based on survey data provided by Hagler-Bailly Pakistan into the DRIFT model.
- Selection of discipline indicators for the DRIFT model.
- Setting up, population and calibration of the DRIFT Decision Support System (DSS).
- Simulation of scenarios.
- Report writing.

The Scope of Work was restricted to an assessment of the riverine biophysical aspects of the Gulpur HPP, and did not include an assessment of the consequent social and economic impacts of the project.

All of the local and international EF team members visited the Poonch River upstream and downstream of the proposed Gulpur HPP on the 9th and 10th November 2013. Thereafter (11th -13th November 2013), the initial population of data into the DRIFT Decision Support System was completed in a workshop situation in Islamabad. Subsequent discussions and model calibration were done using email and Skype.

1.2.3 The EF assessment process

DRIFT (Downstream Response to Imposed Flow Transformations) is an holistic EF assessment approach (Brown *et al.* 2013) that, in this project, was applied at the level of the Poonch River basin in Pakistan. The objective was to describe the present condition of the river ecosystem and then, through scenarios, to predict how this could change with different design and operation of the Gulpur HPP. The social consequences of the predicted river changes can also be predicted using DRIFT, but this was done outside of the DRIFT process in this project.

Changes in the hydrological regime drive the assessment process. Each scenario would change flow conditions along the river in a different way, with possible different repercussions for the river system. Once these hydrological changes have been simulated, then the DRIFT software provides predictions of the consequent changes in the biotic and abiotic aspects of the river.

1.2.4 Team

The EF team members are listed in Table 1.1.

[2] Downstream Response to Imposed Flow Transformations.

1.3 THIS REPORT

This report provides the results for an initial suite of scenarios assessed for Options 1 and 3 (Section 1.1.2), which were selected in discussion with the Hagler-Bailly Pakistan and Client. Each scenario consists of a different permutation of operation options for Gulpur HPP.

Note: Following this report, discussions and stakeholder consultations, a suite of ten additional scenarios were evaluated using the DRIFT DSS set up as described in this report. These scenarios, the reasons for their selection and their ecological outcomes with respect to river condition are addressed in Appendix C.

Table 1.1 EF team

Name	Organisation	Position on team
Mr Vaqar Zakaria	Hagler-Bailly Pakistan	Project Director
Dr Cate Brown	Southern Waters	EF Task Leader
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Dr Mehr Ali Sha	NESPAK	Hydrology
Dr Andrew Birkhead	Streamflow Solutions	Hydraulic and scenario modeling
Dr Mohammed Rafique	Sub Hagler-Bailly Pakistan[3]	Fish ecology
Mr Mark Rountree	Fluvius Consultants	Geomorphology
Ms Fareeha Irfan Ovais	Sub Hagler-Bailly Pakistan	Manager
Mishkatullah	Sub Hagler-Bailly Pakistan	Macroinvertebrates
Mr Hussain Ali	Hagler-Bailly Pakistan	Field work and data collation
Dr Jackie King	Water Matters	Quality control

The layout of this report is as follows:

Section 1: Provides the background to the river, study objectives and Scope of Work.

Section 2: Gives the location and Present Ecological Status of the EF sites used in the assessment.

Section 3: Lists the DRIFT biophysical indicators.

Section 4: Outlines the scenarios assessed and the hydrological data on which the assessment was based.

Section 5: Describes how the scenario data were used in the DSS. Additional detail on the DRIFT process is provided in Appendix A and the explanations for the Response Curves used are in Appendices B.

Section 6: Presents the predicted changes in individual biophysical indicators for each EF site.

Section 7: Lists the references used in the report.

[3] Subconsultant to Hagler-Bailly Pakistan

2 *EF SITES*

The Gulpur HPP assessment concentrated on four EF sites on the Poonch River, one of which was upstream of Gulpur HPP (Table 2.1; Figure 2.1). The sites were selected on the basis of a catchment delineation exercise (HBP 2014), specifically considering:

- geomorphologically different river reaches;
- biological variations along the length of the river;
- different social uses of the river;
- different types and levels of impacts likely to be incurred as a result of Gulpur HPP operation;
- access and safety.

The Present Ecological Status of the sites is also provided in Table 2.1, with discipline specific details available in HBP (2014). In summary, the Present Ecological State of the Poonch River within the study area is mostly category C (moderately modified from natural condition).

Table 2.1 Sites for Gulpur EF assessment.

EF Site No.	Site	Description	Coordinates	Present Ecological State
1	Kallar Bridge	Situated upstream of the full supply level of the reservoir.	33°34'43.81"N; 73°56'5.04"E	C
2	Borali Bridge	Situated between the weir and the tailrace	33°28'20.99"N; 73°52'9.63"E	C
3	Gulpur Bridge	Situated c. 7 km downstream of the tailrace.	33°26'58.25"N; 73°50'13.81"E	C
4	Billiporian Bridge	Situated c. 16 km downstream of the tailrace, c. 12 km upstream of the full supply level of Mangla Dam.	33°22'59.93"N; 73°47'24.42"E	C

The flow regimes at the EF sites will be affected by Gulpur HPP in three main ways (see also Section 4).

- EF Site 1 flow regime will not be affected, but the river ecosystem at this point will be affected by the barrier effect of Gulpur weir. This will stop or reduce the movement of plants and animals along the river, as explained further below.
- EF Site 2 will be affected by a decrease in river flow as a result of the upstream diversion of water into a tunnel to the power house. It will also be affected by the barrier effect of Gulpur weir, which will have consequences as mentioned above and will also alter the thermal, sediment and physicochemical regimes along the river downstream of the weir.
- EF Sites 3 to 4 will be affected by releases from the Gulpur tailrace and by the barrier effect of Gulpur weir. These two sites will be used to predict any anticipated recovery of the river ecosystem from the peaking flow releases from the tunnel.

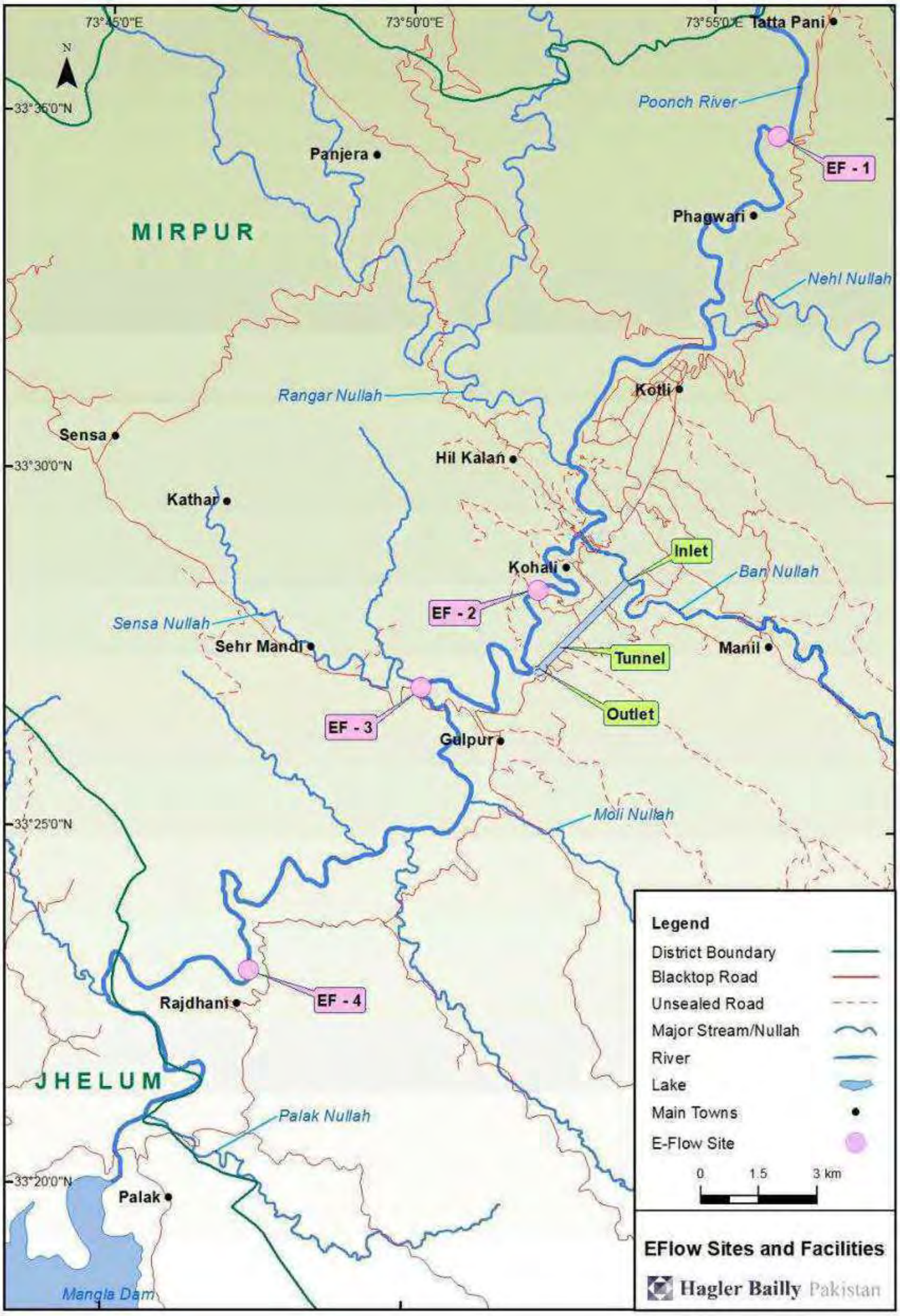

Figure 2.1 **Map of the study area showing the location of the EF sites for the Gulpur HPP assessment in relation to Option 1.**

2.1 *INCLUSION OF OPTION 3*

As mentioned in Section 1.1.2, Option 3 had not yet been proposed at the time that the EF sites were selected. In Option 3, the weir is located *c.* 5.9km further downstream[4] than for Option 1, and the dewatered river reach has been reduced to *c.* 900 m. This meant that EF Site 2, which represented the reach between the weir and the tailrace for Option 1, was outside of the reach between the weir and the tailrace for Option 3. When Option 3 was proposed, consideration was given to establishing a new EF Site 2, but it was decided that this was not necessary for the reasons given below.

The original EF Site 2 was selected to represent the reach of the Poonch River from the weir to the tailrace in Option 1 (River Zone B; Hager-Bailey Pakistan 2013). River Zone B encompasses the weir to the tailrace in Option 3. Thus, EF Site 2 was in fact selected to represent the weir to the tailrace in Option 3.

The EF sites are located in a single long steep reach of the river. Hydrological and land-use impacts are ubiquitous in this region, and the geomorphological character of all sites is thus considered to be comparable. An analysis of the proportional representation of habitat types in the full Zone B against the portions that would be affected by Option 3 (Table 2.2) shows that the latter is similar to the full zone. The hydraulic characteristics of the (existing) EF Site 2 are therefore transferable to a (hypothetical) EF site located in the short (*c.* 900 m long) dewatered section immediately below the weir.

Table 2.2 Proportional representation of habitat types in the full Zone B against the portions that would be affected by Option 3 (from HBP 2014)

Zone	Length (km)	Habitat Type (%)			
		Pools/Glides	Rapids	Riffles	Total
Zone B	17	16%	36%	47%	100%
Option 3 portion	0.7	19%	28%	54%	100%

The pressures on the river in the lower portion of River Zone B are similar to those in the upper portion (where EF Site 2 is situated), although there is less cultivation in the lower part of the catchment. The Present Ecological Status of both is Category C and the fish communities are identical (HBP 2014).

While it is possible that there will be slight differences between the responses of the river to releases from the weir in the reaches between the weir and the tailrace for Options 1 and 3, the resolution of an EF study is insufficiently detailed to articulate these. Furthermore, the inherent uncertainty in making predictions about future condition far outweighs any minor differences that may exist.

[4] The catchment area factor for the dam, relative to the Rehman Bridge Gauge, is 1.006.

The results presented for the reach between the weir and the tailrace for Option 1 may overstate the impacts for the reach between the weir and the tailrace for Option 3. This is because Option 3 reach is considerably shorter (Section 1.1.2), and may thus be more influenced by ameliorating edge effects between Zone B and Zone C (e.g., Levin 2009).

In conclusion, it is the considered opinion of the EF team that EF Site 2 can be used to provide the outcomes for the reach between the weir and the tailrace for both Option 1 and Option 3.

3 *THE USE OF INDICATORS*

In the DRIFT process, the hydrological simulations form the foundation upon which the biophysical and social predictions of change are built. The EF team chose a range of hydrological indicators, and biophysical indicators that they believe respond to flow changes (Table 3.1).

Table 3.1 Discipline indicators used in the DSS.

Discipline	Indicators	EF sites
Hydrology	Mean annual runoff	1-4
	Dry season onset	1-4
	Dry season minimum 5-day discharge	1-4
	Dry season duration	1-4
	Dry season average daily volume	1-4
	Dry season within day range in discharge	3-4
	Dry season maximum instantaneous discharge	3-4
	Dry season minimum instantaneous discharge	3-4
	Wet season onset	1-4
	Wet season maximum 5-day discharge	1-4
	Wet season duration	1-4
	Wet season flood volume	1-4
	Wet season within day range in discharge	3-4
	Wet season maximum instantaneous discharge	3-4
	Wet season minimum instantaneous discharge	3-4
	Transition 1 within day range in discharge	3-4
	Transition 1 maximum instantaneous discharge	3-4
	Transition 1 minimum instantaneous discharge	3-4
	Transition 2 average daily volume	1-4
	Transition 2 within day range in discharge	1-4
	Transition 2 maximum instantaneous discharge	1-4
	Transition 2 minimum instantaneous discharge	1-4
	Transition 2 recession shape (slope of decrease in flow)	1-4
Hydraulics	Minimum 5-day dry season fish breeding habitat[5]	1-4
	Depth	1-4
	Minimum 5-day average velocity (across the cross-section)	1-4

[5] Fish breeding habitat was the number of metres of the cross-section where depth is between 0.25 and 0.5 m, and velocity is between 0.1 and 0.7 m^3s^{-1}. These are important habitat depth and velocity ranges for Mahaseer and Kashmir Catfish, but also for the smaller fish.

Discipline	Indicators	EF sites
Geomorphology	Active channel width	1-4
	Area of silt/mixed bars (regardless of level of inundation)	1-4
	Area of cobble bars (regardless of level of inundation)	1-4
	Median bed sediment size (armouring)[6]	1-4
	Depth of pools	1-4
	Area of secondary channels and backwaters	1-4
	Suspended sediment load.	1-4
Water quality	Nutrient concentration	1-4
	Temperature	1-4
Riparian vegetation	Dry bank trees and shrubs	1-4
Algae	Periphyton biomass	1-4
Macroinvertebrates	Simuliidae	1-4
	EPT biomass	1-4
Fish	Pakistani labeo	1-4
	Mahaseer	1-4
	Twin-banded loach	1-4
	Kashmir catfish	1-4
	Garua bachwaa	1-4
	Snow trout	1
Wildlife	Fish-eating wildlife (Otter, common leopard)	1-4
	Wildlife that drink from the main river (Barking deer)	1-4
	Riverine insectivores (White-capped redstart)	1-4
Management issues (non-flow related)	Selective fishing pressure	1-4
	Non-selective fishing pressure	1-4
	Mining – sand and gravel	1-4
	Mining – cobble and boulder	1-4
	Water quality	1-4

Response curves were then compiled that described the relationships between the driving (flow) and responding (biophysical) indicators. In some cases, indicators responded indirectly to flow changes through an intermediary influence. Fish, for instance, might be responding directly to pool depth or nutrient levels, which in turn might be driven by flow changes. These intermediaries reflect that flow may not be the only driver used in a response

[6] **Bed sediment type (armouring; as % of 2013):**

0	surface dominated by sand and silt
15	interstitial spaces filled with sand, silt and some gravel
50	some infilling of interstitial spaces by fines
100	2013 conditions (cobble bed with open interstitial spaces, little gravel)
150	cobbles (open) and boulders
200	boulders and bedrock
250	bedrock channel base

curve. The full system of links between driver and responding indicators is a complex web of response curves within the DRIFT DSS.

Each response curve describes the expected impact of a single type of flow or other driving change on the abundance of a single responding biophysical indicator, on a response scale of 0 (no response) to 5 (critically high response). A change in flow could thus be followed through various linked indicators to a change in river condition. The ratings of change were also converted to percentages for use in some meetings and reports. In total, about 106 response curves were created per site for the project and housed in the custom-built Poonch River DSS.

In the DSS, for each site and scenario, each year's value for a driving indicator is linked with each response curve that employs that driver and the corresponding value of the responding indicator is recorded. An indicator such as Dry Season Onset, for instance, would have 52 values from a 52-year simulated flow regime of the calendar week in which the onset occurred. Through a response curve, this would produce 52 annual values for the predicted abundance of, for instance, the indicator 'Pakistani labeo'.

The scores from all the response curves for any one indicator were combined in various ways, so that measures of change could be expressed as time-series per indicator, per discipline, or as overall ecosystem integrity. For the latter, results were provided on a scale of A to E, where A represented a pristine ecosystem and E a critically modified one with few, if any, intact ecosystem functions and thus of little value to people (King and Brown 2010).

The DRIFT DSS and process are described in more detail in Appendix A. The response curves for EF Site 2 are given in Appendix B.

3.1 INDICATORS EXCLUDED FROM THE CALCULATION OF THE OVERALL INTEGRITY SCORE

Overall ecosystem integrity is predicted for each site/scenario as a measure of how far the scenarios would move each indicator away from or back toward the natural situation. It is usually calculated as a function of all the values of all the indicators but for the Gulpur HPP project certain indicators were excluded.

- The algal indicators, because is difficult to assign a consistent score for algae that indicates whether a change in abundance is a move toward or away from natural. While small variations in the abundance algae are natural, both a large increase and a large decrease in their abundance represent a move away from natural for the system.
- The terrestrial wildlife indicators, because they have an indirect link to the river ecosystem. They may be affected by changes in the river, but also by a wide range of impacts that have little or nothing to do with the river. They were thus not considered in this study.

3.2 *INDIVIDUAL INDICATOR SCORES DENOTING MINIMUM DEGRADATION*

The 'minimum degradation' designation refers to a scenario(s) that is expected to result in a small change in river condition. It is defined as follows:

If the overall CHANGE in the Integrity Score of a scenario at a site is a drop of less than 0.5 from baseline (2013) conditions, then the flow change represented by the scenario is deemed to have had a minimal negative impact on the existing ecosystem condition at that site, that is, there will be minimal additional degradation.

The drop of 0.5 in the Integrity score can keep the river in the same condition category or drop it a lower one, in both cases still representing minimum degradation:

- if the condition of an ecosystem is in the upper or middle part of a category, a drop of 0.5 in the Integrity Score could be insufficient to result in a drop to a lower ecological category (for instance, an upper B category condition could drop to a lower B condition).
- if an ecosystem is already in the lower part of a category, a drop of 0.5 in the Integrity Score from Baseline could result in a drop to the next lower category (for instance, a lower B category condition could drop to an upper C condition).

According to this definition 'minimum degradation' does not equate with 'no impact', as some impact has been allowed for.

3.3 *UNCERTAINTY*

With contemporary understanding of how river ecosystems function, it has become easier to predict WHAT will change and the DIRECTION of change. It is less easy to predict by HOW MUCH ecosystem components will change and HOW LONG it will take. Recognising this, the indicators are chosen as the WHAT, and the response curves show in which DIRECTION they are expected to change. Predictions of by HOW MUCH each indicator might change are less certain and so are captured using severity ratings; these are broad ranges of change from baseline, which is the 2013 condition (Table 3.2).

The incoming flow regime for any chosen scenario/site accesses the response curves and produces a prediction of change for each indicator and for the ecosystem as a whole. Although these are given by the DSS as precise numbers, they are best interpreted through a search for broad trends of change. In Table 3.3, for instance, one would expect: all but indicator 2 to decrease in abundance from the 2013 condition; indicators 1, 6, 7 and 8 to show more change than the others; and Scenarios 1 and 2 to have the most impact on the river while Scenario 3 has the least impact.

Table 3.2 **DRIFT severity ratings and their associated abundances and losses (King and Brown 2010)**

Severity rating[1]	Severity of change	% abundance change
5	Critically severe	501% gain to ∞ up to pest proportions
4	Severe	251-500% gain
3	Moderate	68-250% gain
2	Low	26-67% gain
1	Negligible	1-25% gain
0	None	no change (represents Baseline)
-1	Negligible	80-100% retained
-2	Low	60-79% retained
-3	Moderate	40-59% retained
-4	Severe	20-39% retained
-5	Critically severe	0-19% retained includes local extinction

Table 3.3 **Example of depicting trends: the mean percentage changes, relative to 2013, of eight ecosystem indicators under four development scenarios.**

Indicator	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Percentage change				
1	0	-50	-50	-33	-33
2	0	19.0	19.0	6.1	14.2
3	0	-21.2	-20.0	-2.3	-6.4
4	0	-15.1	-15.0	1.0	0
5	0	-2.3	-3.3	0	-1.6
6	0	-49.7	-48.2	-7.2	-17.8
7	0	-79.5	-78.2	-13.6	-35.9
8	0	-65.5	-62.8	-9.4	-28.4

Change: 10-20% 20%-40% >40%

HOW LONG BEFORE CHANGE STARTS is addressed through the DRIFT time-series, which depict baseline conditions and future change over the span of years used in the hydrological simulations (in the case of the Poonch River, the 52 years from 1960 to 2012). These prediction of onset of change are based on past climate conditions, and so may differ in reality, depending on future climatic conditions.

[1] A negative score is a loss in abundance relative to Baseline, a positive is a gain. Zero severity is the Baseline situation.

4 SCENARIOS EVALUATED

The EFs assessment included consideration of ten flow scenarios[7]. The hydrological modeling underlying the generation of flow scenarios is explained in HBP (2014).

Operation of Gulpur HPP will result in releases down the Poonch River from the reservoir at the weir, and releases into the river from the tailrace[8] downstream of EF Site 2.

Thus, the EF sites are each affected in different ways by Gulpur HPP:

EF Site 1 (Kallar Bridge):	Situated upstream of the full supply level of the reservoir. This is a control site that will experience no effect on flows from Gulpur HPP. However, biotic communities at EF Site 1 may be affected by the barrier effect of the weir itself, which could halt or reduce the upstream movement of aquatic animals, and by the presence of the reservoir immediately downstream.
EF Site 2 (Borali Bridge):	Situated between the weir and the tailrace. This site will be affected by water being diverted to the power house from the reservoir, and by releases/spills down the river from the reservoir.
EF Site 3 (Gulpur Bridge):	Situated downstream of the tailrace. This site will be affected by releases down the tailrace and by releases/spills down the river from the reservoir.
EF Site 4 (Billiporian Bridge):	As for EF Site 3 but probably less affected as impact of the weir should decrease with distance downstream

The scenarios differ from one another in terms of the minimum dry season release from the reservoir. Additionally, each scenario has a 'protection' (Pro) and a 'business as usual (BAU) option, which refer to the influence of non-flow related impacts on the integrity of the riverine ecosystem (Section 5.2). These impacts are related primarily to fishing and mining of sand and boulders. ALL of the scenarios, with the exception of the No Dam options incorporate the design sediment control operating rules (Section 5.5.1). One scenario considers peaking-power releases (Section 5.4).

The protection levels incorporated into the scenarios address pressures on the river ecosystem that are not related to flow changes. Three protection levels have been used:

[7] Note: Subsequent to the completion of this report, a suite of ten additional scenarios was evaluated using the DRIFT DSS set up as described in this report. These scenarios, the reasons for their selection and their ecological outcomes with respect to river condition are addressed in Appendix C.

[8] The outlet back into the river after power generation.

- Protection Level 1 (Pro 1) = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time
- Protection Level 2 (Pro 2) = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over time
- Business as usual (BAU) = - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years.

The minimum releases shown in each scenario are constant releases through the year. In addition, floods that cannot be harnessed by the weir will spill into the downstream river during the wet season. With the current design parameters, discharges greater than 198 m^3s^{-1} will result in spills from the weir.

The ten scenarios are (additional detail is provided in the Hydrology Report):

ND[9]Pro1:	No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level 1
NDBAU:	No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level BAU
NDPro2:	No Gulpur HPP in place; flow and sediment regimes the same as 2013 but with Protection Level 2
G[10]4BAU	A 4 m^3s^{-1} minimum release from the Gulpur weir and baseload power releases at the tailrace. Protection level BAU. Design sediment control operating rules.
G4Pro2	A 4 m^3s^{-1} minimum release from the Gulpur weir and baseload power releases at the tailrace. Protection Level 2. Design sediment control operating rules.
G8BAU	An 8.0 m^3s^{-1} minimum release from the Gulpur reservoir and baseload power releases at the tailrace. Protection level BAU. Design sediment control operating rules.
G8PeakBAU	An 8.0 m^3s^{-1} minimum release from the Gulpur weir and PEAKING-power releases at the tailrace Protection level BAU. Design sediment control operating rules.
G8Pro2	An 8.0 m^3s^{-1} minimum release from the Gulpur weir and baseload power releases at the tailrace. Protection Level 2. Design sediment control operating rules.
16BAU	A 16 m^3s^{-1} minimum release from the Gulpur weir and baseload power releases at the tailrace. Protection level BAU. Design sediment control operating rules..
G16Pro2	A 16 m^3s^{-1} minimum release from the Gulpur weir and baseload power releases at the tailrace. Protection Level 2. Design sediment control operating rules.

To keep the number of scenarios to manageable level, Protection Level 1 was not run for the release scenarios.

[9] ND = No dam; Pro 1, 2 and BAU refer to protection levels
[10] G4 and similar indicate various minimum release scenarios from Gulpur HPP

4.1 EXAMPLES OF SCENARIO FLOW REGIMES

Figure 4.1 shows the ND (no dam) flow regime at EF Site 2 for the first two years of the period modelled (1960-1961). These two years are fairly typical of the flow regime. Figure 4.2 shows the same two years for the G16BAU and G16Pro2 scenarios (minimum release of 16 m^3s^{-1}).

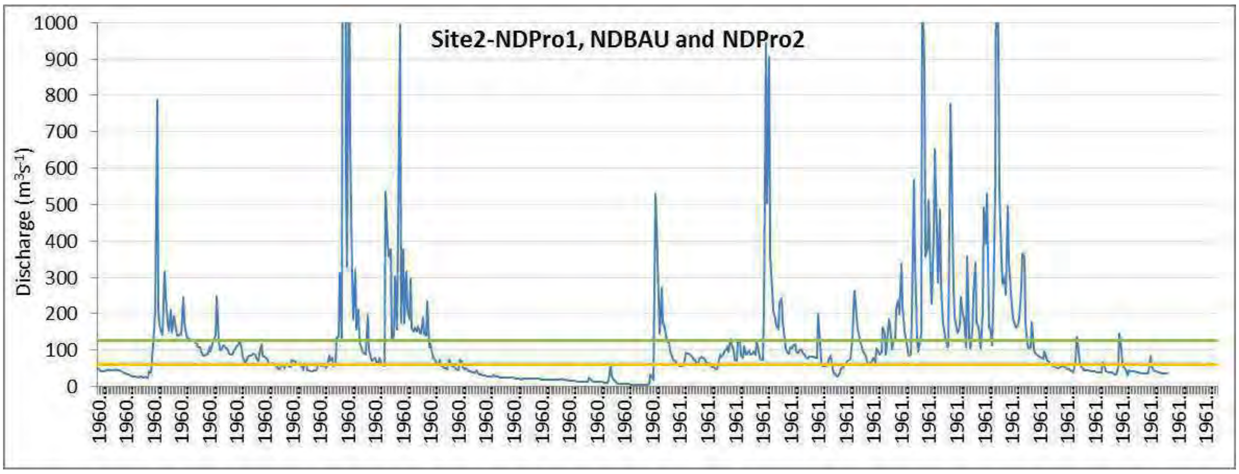

Figure 4.1 Flows at EF Site 2 with no dam in place, with the average T1/Wet season threshold (green line) and average Dry/T1 threshold (orange).

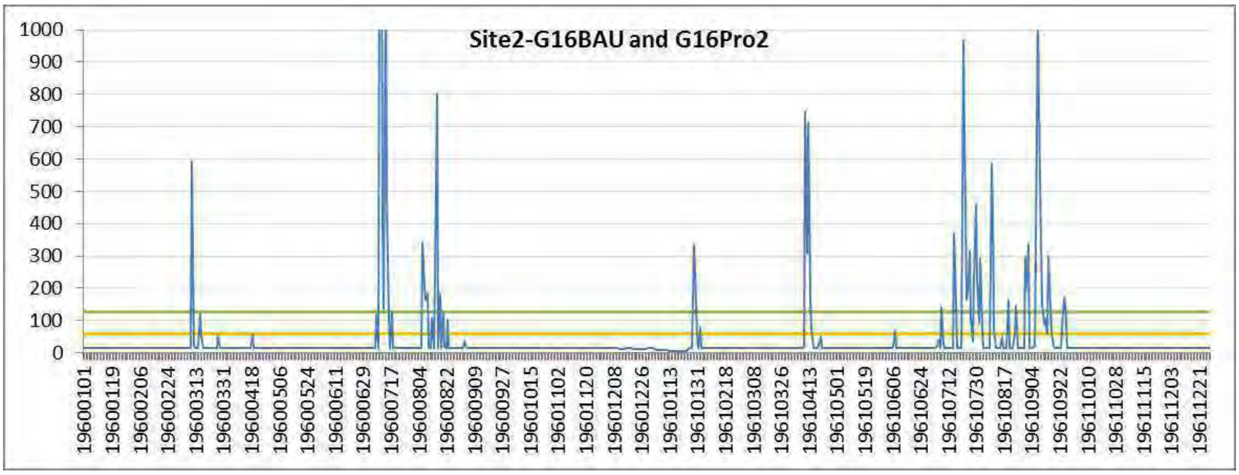

Figure 4.2 Flows at EF Site 2 with Gulpur HPP in place, a dry-season release of 16 m^3s^{-1} and spills, with the average T1/Wet season threshold (green line) and average Dry/T1 threshold (orange)

Figure 4.3 is an example of the flow regime at EF Site 3 associated with the G16 (minimum release of 16 m^3s^{-1}) and baseload power generation. This shows the recovery to close to the ND flow regime.

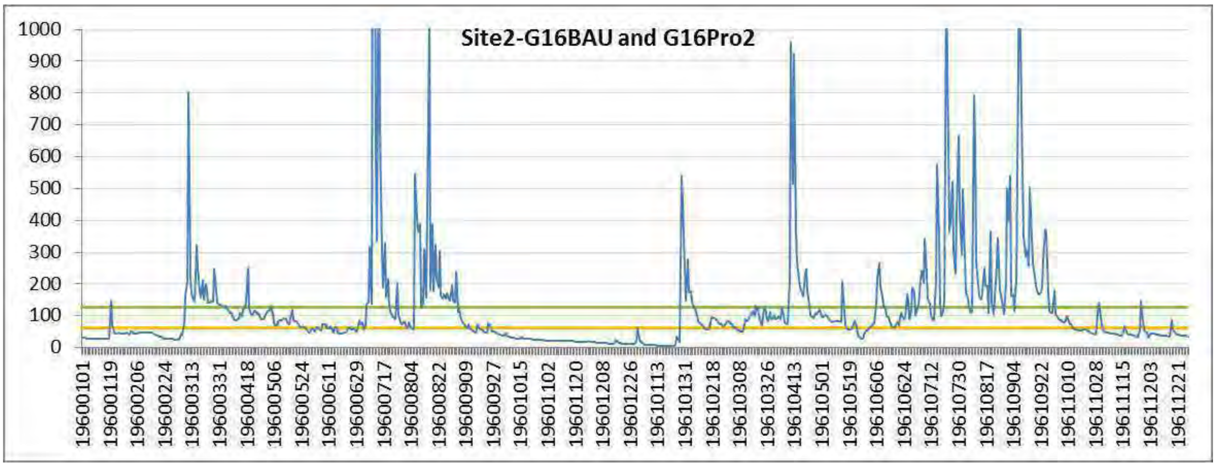

Figure 4.3 **Flows at EF Site 3 with Gulpur HPP in place, baseload power production, a dry-season release of 16 m^3s^{-1} and spills, with the average T1/Wet season threshold (green line) and average Dry/T1 threshold (orange).**

4.2 *OPERATING RULES FOR BASELOAD RELEASE SCENARIOS*

Baseload release scenarios, as modeled, involve the generation of electricity 24 hours a day, seven days a week.

As per instruction from Hagler-Bailly Pakistan and Mira Power, the baseflow release scenarios for the EF study assumed average annual power generation assuming an average daily CONSTANT flow from the turbines (**i.e.** no minimum cutoff discharge) and 90% turbine efficiency irrespective of the discharge passing through them. Power generation linked with each scenario was calculated using an efficiency curve for Francis turbines from the literature, where the efficiency drops sharply below a discharge ratio (actual to installed) below **c**. 0.5. Power generation linked with each scenario is expressed as a reduction (%) from a baseline condition of zero EF-release. The baseline modelled generation was 407.8 GWh, which compared favourably with 408.6 GWh provided in the design report.

There remain some uncertainties around the baseload operation of the HPP, however. The EF scenario modelling suggests that constant releases of c. 4, 8 or 16 m^3s^{-1} are not realistic given the design of Gulpur HPP as they would result in seriously sub-optimal efficiencies and would put a strain on the turbines. The design reports imply that the discharge through one of the three 33.33-MW turbines could be in the range 33-66 (where 66 m^3s^{-1} is the installed capacity). This being the case, shut-off of the turbines for part of the day could be expected when the inflow is less than **c.** 33 m^3s^{-1}. This could then result in sudden discharge pulses from the tailrace outfall that propagate downstream. It is therefore strongly recommended that Mira Power consider analysis of additional, more realistic, baseload scenarios (For these analyses see Appendix C).

4.3 *OPERATING RULES FOR PEAKING SCENARIOS*

For peaking flow scenarios for the EF study a variable efficiency curve for the turbines was applied, with a minimum discharge ratio of 0.5 (consistent with what is inferred in the design reports: 33-66 m^3s^{-1} per turbine; three turbines with a maximum generation capacity of 198 m^3s^{-1}). This resulted in lower absolute power generation values than for the baseload scenarios with 90% efficiency (Section 4.2).

The operating rules used to generate the flows for the peak power generation scenario (G8PEAKBAU) were as follows:

- The water level in the weir was allowed to range between 539 m and 540 m, where 540 m is the Normal Operating Level (NOL). This is on a DAILY basis (i.e., the level at 24:00). However, during the course of a day, the level may, for a few hours, be lower or higher due to short-term changes in storage. From the results, these "within-day" levels actually range from 538.8m to 540.8m - still well below the maximum allowed water level of 543.6m. The levels were kept as high as possible to increase the head and hence reduce the discharge for a given power output.
- The min partial load factor was 0.5 (i.e. 50% of maximum turbine discharge capacity).
- A variable turbine efficiency was applied, which reduced to 72.5% at 50% turbine discharge ratio.
- Turbines were operated successively to maximum capacity. For example, Turbine 2 was only switched on once Turbine 1 reached maximum generating capacity. The operating ranges were (approximately, as they are head dependent): 33-66, 99-132 and 165-198 m^3s^{-1}.
- Priority was given to operation during PEAK, followed by STANDARD and lastly OFF-PEAK demand times.
- In consultation with HSP and NESPAK, the following times were used: Peak: 18:00 - 21:00, Standard: 06:00 - 18:00 and 21:00 - 23:00, Off-peak: 00:00 - 06:00. When there is insufficient water to generate at maximum capacity, the discharge through the turbines is reduced - the above generation times are adhered to.

An example of the peaking releases modelled using the operating rules described above is provided in Figure 4.4.

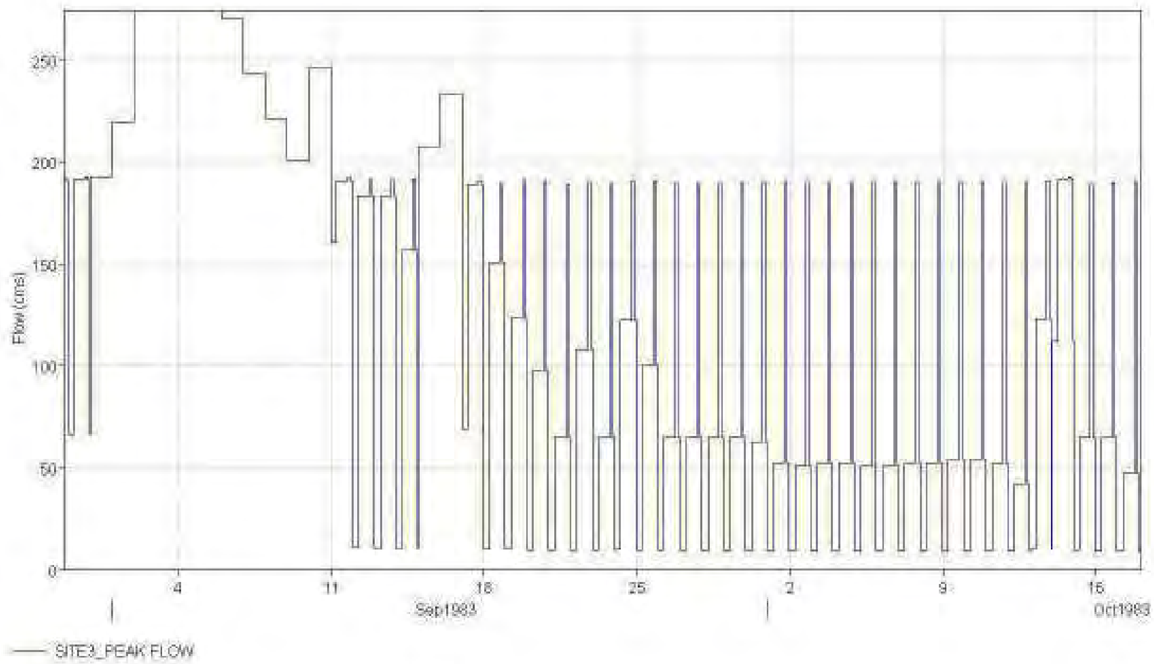

Figure 4.4 **An example of the peaking releases modelled using the operating rules described in Section 4.3.**

5 *USE OF DATA FOR THE SCENARIOS*

5.1 ANALYSIS OF THE FLOW REGIME

The hydrological record for the Poonch River suggests that this is a flashy system, with two periods where floods are frequent. The seasons for the EF assessment were:

- Dry season
- Transitional season 1 (which may incorporate some of the snow-melt season).
- Wet season (which incorporates the monsoon floods, but may also incorporate snow-melt).
- Transitional season 2.

The rules for defining the seasons for the Poonch River are provided in Table 5.1.

The start and end dates of each season are defined for every year of the hydrological time-series. Examples of seasonal divisions for two years are shown in Figure 5.1.

Table 5.1 Rules for defining the four ecological seasons in the Poonch River.

Transition	Rule for transition from season to season	Average values over the 52 year record for each site			
		EF Site 1	EF Site 2	EF Site 3	EF Site 4
Dry Season to Transition 1 threshold	Up-crossing over 10 x minimum 5-day dry-season discharge	40.75	60.00	61.20	65.72
Transition 1 to Wet season threshold	Up-crossing over 1 x mean annual discharge (i.e. 1 x MAR)	85.33	125.65	128.16	137.62
End of Wet Season	Down-crossing below 1 x mean annual discharge				
Transition 2 to Dry season	Average recession rate over 10 days >-0.7 m3 s-1 d-1 (or down-crossing of 10 x minimum 5-day dry season discharge)	-1.91	-2.813	-2.869	-3.080

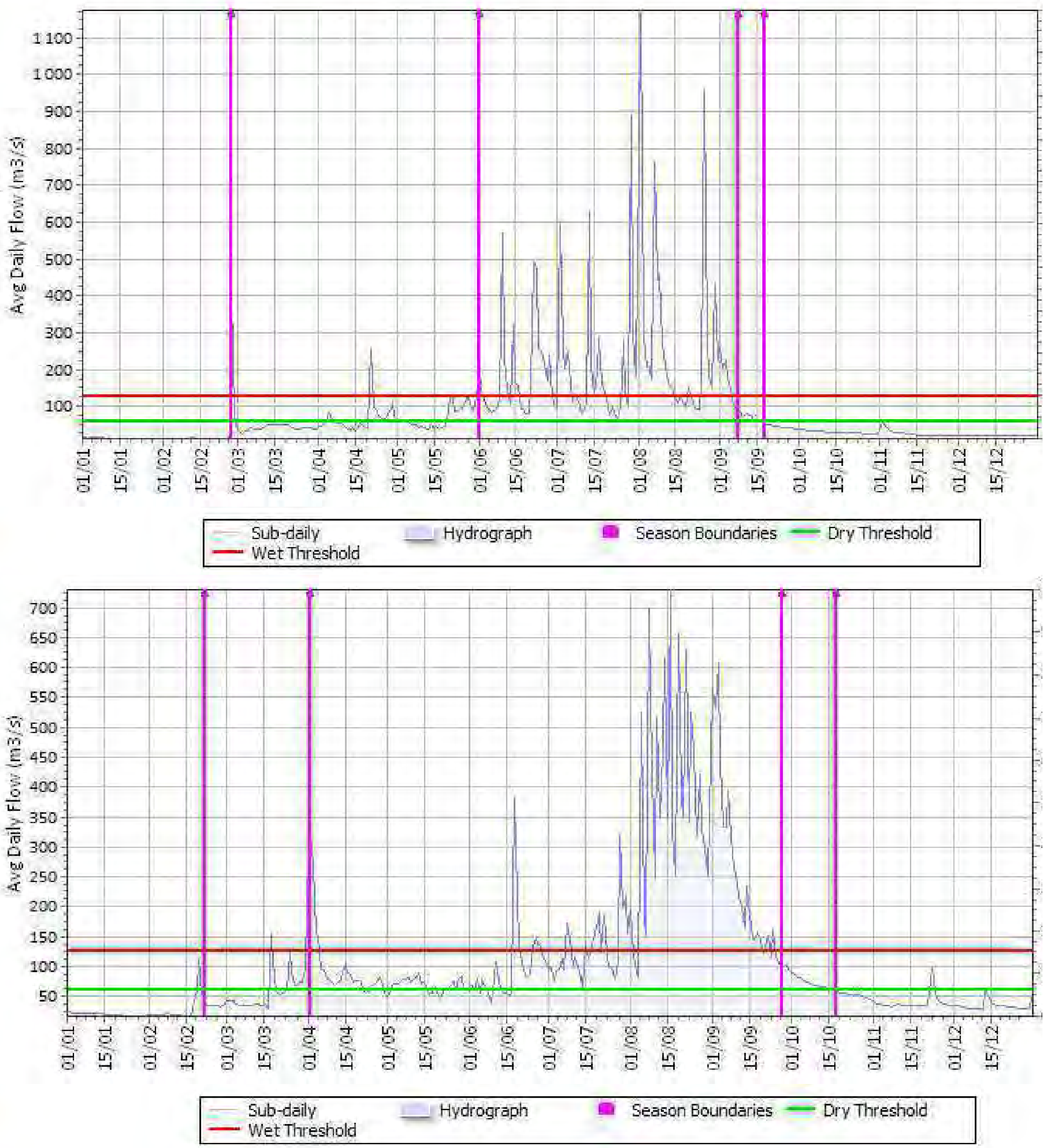

Figure 5.1 **Printscreen from the DRIFT-DSS showing examples of seasonal divisions (top=1972, bottom = 1983).**

The indicators reported for each scenario at each site are briefly described in Table 5.2.

Table 5.2 Flow indicators described for each scenario in results sections.

Indicator	Description	Units
Mean annual runoff	Average of all the years' Mean Annual Runoffs	Million cubic metres per annum
Median annual runoff	Median of all the years' Mean Annual Runoffs	Million cubic metres per annum
Dry season onset	Median of all the years' dry season onsets	Week of the year
Dry season minimum 5-day discharge	Median of all the years' dry season minimum 5 day average discharge	$m^3.s^{-1}$
Dry season duration	Median of all the years' dry season durations	Days
Wet season onset	Median of all the years' wet season onsets (week of year)	Week of the year
Wet season peak 5-day discharge	Median of all the years' wet season maximum 5 day average discharge	$m^3.s^{-1}$
Wet season duration	Median of all the years' wet season durations	Days

5.2 *CONSIDERATION OF NON-FLOW RELATED IMPACTS ON THE RIVERINE ECOSYSTEM*

There are numerous non-flow related pressures on the Poonch River that negatively affect the ecological integrity of the system. These are detailed in HBP (2014). Of these, the following were included in the DRIFT DSS:

- River mining. Mining of river sediment is limited by accessibility of mining locations. The locations where mining takes place are shown in Figure 5.2. The demand for river sediments is driven by the construction of roads (boulders and cobbles), and new homes (building sand). The expansion of the road network and increased stability and accessibility has led to increased mining activities in the last 10-20 years. The improved road network is also opening up additional areas for access for sand and cobble mining. River mining destroys aquatic habitats at the point of mining activities but also changes the size and amount of sediment that is distributed downstream, which can affect aquatic habitats in the downstream reaches. Changes to aquatic habitats as a result of mining have knock-on effects on the fish and other biota.
- Fishing. The impact of fishing pressure on the river ecosystem is dependent on the methods used, number of fishermen, and the location and timing of the fishing activities. In general, fishing in the tributaries, in particular during breeding migrations, is more harmful to fish populations than fishing at other locations and other times of the year. For the purposes of this study, two fishing methods have been incorporated as non-flow pressures:

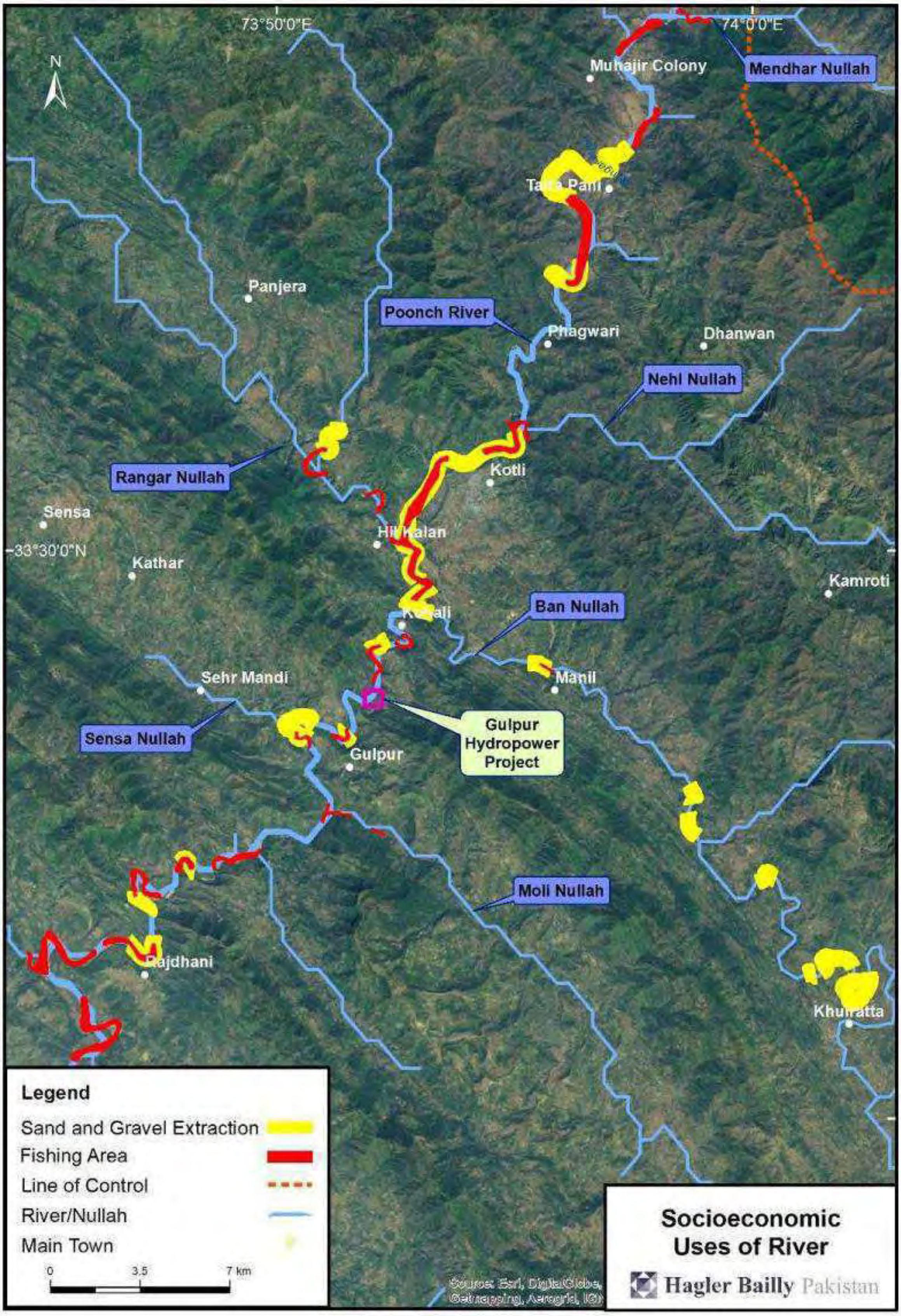

Figure 5.2 **Socio-economic uses of the river, which represent non-flow related impacts on the river ecosystem**

- *Selective fishing pressure*: fishing using selective gear such as cast nets and fishing rods. This type of fishing tends to target specific species and the adult populations.
- *Non-Selective fishing pressure*: fishing using non-selective methods such as explosives and poisons. This type of fishing tends to result in large collateral losses of non-target fish and other species, as well as indiscriminant loss of early life stages (fry, fingerlings, eggs and larvae). It may also cause localized habitat destruction. Gills nets have been included under non-selective fishing.

- Nutrient enrichment. Nutrient levels 30 years ago would have been about 23% of what they are now (using a 5% annual rate of increase based on a population growth rate of about 2%, urban growth rate of 5%, and income growth rate of about 5%). Use of products that generate nutrients are related to income growth rate. No water treatment to meet this expansion has been put in place. We assume that if the trend continues forward at the same rate, the increase will be by a factor of 4.32 in 30 years.
- Removal of riparian bushes and trees. The communities cut the vegetation on the river banks and on the flood plains to meet their requirements for fuel wood and fodder. Grazing by livestock also degrades the riparian vegetation. Localized damage to riparian vegetation also occurs when access roads for extraction of sand and gravel are constructed along the river banks, and the labour engaged for sand and gravel mining also harvests fuel wood along the banks for cooking purposes. Alien invasive species such as *Lantana camara* have also occupied areas that have suffered a high level of disturbance. If the past trends of usage were to continue, which is highly likely given non-availability of natural gas as household fuel and rising prices of commercial fuels such as kerosene and LPG (bottled gas), the vegetation cover along the riverbanks would be expected to reduce to half of the present levels over the next 52 years.

Typically fishing pressure will taper off once the target fish populations decline to the point where the catch does not justify the effort of fishing. This phenomenon has not been included in the DSS, as there are no data available to suggest what level this occurs at in the Poonch River.

The non-flow related pressures influencing each of the indicators are given in Table 5.3. In many cases a pressure affects an indicator directly, such as fishing a targeted species. However, pressures can also affect an indicator through knock-on effects. For instance, mining activities directly affect the geomorphological habitat indicators and the changes in habitat then have a knock-on effect on fish and invertebrate.

Wildlife indicators were not included in the management scenarios as the pressures on wildlife differ from those on the river.

Table 5.3 The target end values (after 52 years, relative to 2013) used in the DSS for each of the indicators under the three management options: Business and Usual (BAU), Protection Level 1 (Pro 1) and Protection Level 2 (Pro 2). ** = direct impacts, * = affected mainly by knock on effects.

Indicator		Present Ecological State at all sites (2013)	30 years ago	2013	BAU (in 52 years)	Pro 1 (in 52 years)	Pro 2 (in 52 years)	Fishing pressure - selective	Fishing pressure - non-selective	Mining - sand and gravel	Mining - cobble and boulder	Eutrophication	Harvesting riparian bushes
Geomorphology	Active channel width	B	98	100	110	102	100		**	**		**	
	Area of silt/mixed deposits			100	90	95	100		**	**		**	
	Area of cobble bars			100	75	95	98			**		**	
	Median bed sediment size (armouring)			100	80	90	98		**	**		**	
	Depth of pools			100	90	98	100		**	**		**	
	Area of 2º channels and backwaters			100	88	98	98		**	**		**	
Water quality	Nutrients	B	25	100	200	140	120				**		
	Temperature		-	100	100	100	100						
Algae	Periphyton biomass	B		100	120	110	105				**		
Riparian vegetation	Dry bank trees and shrubs	D	200	100	50	80	150		**	**		**	*
Macro-invertebrates	Simuliidae	B	90	100	115	110	105		*	*		*	
	EPT biomass		110	100	85	95	95		*	*		*	
Fish	Pakistani labeo	C/D	200	100	10	40	150	**	*	*		*	
	Mahaseer		200	100	10	40	150	**	*	*		*	
	Twin-banded loach		150	100	50	100	125		*	*	*	*	
	Kashmir catfish		150	100	50	100	125	**	*	*	*	*	
	Garua bachwaa		200	100	10	40	150	**	*	*	*	*	
	Snow trout		200	100	50	60	150	**	*	*	*	*	
Wildlife	Fish-eating wildlife	D	Management issues not considered for wildlife.										
	Wildlife water needs												
	Riverine insectivores												

5.2.1 Values used for non-flow related impacts.

To recap, the three protection levels are:

- Protection Level 1 (Pro 1) = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time
- Protection Level 2 (Pro 2) = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over time
- Protection Level BAU = Business as usual - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years.

The five non-flow related drivers used are:

1. Selective fishing pressure (linked to all fish indicators)
2. Non-selective fishing pressure (linked to all fish indicators and invertebrate indicators)
3. Sediment mining (linked to relevant geomorphological indicators)
4. Nutrient enrichment (linked to relevant water quality indicators)
5. Harvesting of riparian bushes and trees (linked to vegetation indicators)

These non-flow related pressures reside as response curves under any relevant indicator. Selective fishing, for instance, will appear as a response curve under each fish indicator, its shape reflecting current understanding of the original abundance of the indicator, its present abundance and its expected abundance in 52 years under different protection measures (end values). Non-selective fishing, on the other hand, will also have a response curve for aquatic invertebrates as they can be affected by pressures such as explosives or poisons.

The end values (Table 5.3) were decided in team consultations, and some explanation of them is provided in Table 5.4**Error! Not a valid bookmark self-reference.**. Essentially, the relevant experts were asked how the abundance of each indicator has changed (if at all) from its condition 30 years ago and what would have been the main drivers of change. They were also asked what abundance level they would expect it to reach in the future under the three protection measures. Thus, in Table 5.3, the *Pakistani labeo* for instance, is shown as twice as abundant 30 years ago than at present and is expected to drop to 10% of its present abundance in 52 years if future trends reflect past trends (Protection level BAU). Enhancing protection to Level 1, however, would see its abundances decline more slowly over the 52 years to 40% of present, while Protection Level 2 would increase abundances to 150% of present.

To ensure that the DSS adheres to the targets shown in Table 5.3, the response curves for each non-flow indicator were set at the following values:

- BAU = A gradual increase in 2013 pressures from 100% in 2013 to 200% over 52 years.

Table 5.4 Comments on trends in indicators over time

Indicators		Comments
Geomorphology	Active channel width	There is possibly that here has been some channel widening associated with cobble bar removal/mining , as the resultant lower bars are more easily eroded.
	Area of silt/mixed deposits	A slight decrease may have occurred relative to natural conditions as a result of sand mining in last 10-20 years. It is unlikely that elevated erosion in the catchment has offset this.
	Area of cobble bars	A decline of the bars began in the last 10-20 years (associated with accelerated catchment development, and thus increased mining).
	Median bed sediment size (armouring)	Erosion in the catchment and mining has slightly changed the nature of the bed sediments, probably resulting in some infilling of interstitial spaces.
	Depth of pools	Possibly a minor decrease in pool depth as a result of mining activities in last 10-20 years.
	Area of secondary channels and backwaters	Possibly a very minor decrease in secondary channels as a result of a reduction in channel width and loss of cobble bars.
Water quality	Nutrients	Nutrient levels 30 years ago would have been about 23% of what they are now (using a 5% annual rate of increase based on a population growth rate of about 2%, urban growth rate of 5%, and income growth rate of about 5%).
	Temperature	Not applicable.
Algae	Periphyton biomass	There are probably been a small increase in periphyton associated with increased nutrient loading in the river. However, the naturally high flows and sediment loads would have counteracted this somewhat.
Riparian vegetation	Dry bank trees and shrubs	There has been severe degradation (harvesting) of vegetation on the banks over the years
Macro-invertebrates	Simulidae	Possible minor increases related to increased nutrients in the river. But also negatively affected by non-selective fishing activities such as blasting and poisoning.
	EPT biomass	Possible minor increases related to increased nutrients in the river. But also negatively affected by non-selective fishing activities such as blasting and poisoning.
Fish	Pakistani labeo	Decline in mahaseer as it is the main target for fishing in the Poonch River, and is under severe fishing pressure (2013).
	Mahaseer	Under similar threats from fishing pressure as the mahaseer because of similar occurrence and size. mahaseer and labeo are caught using the same size nets.
	Twin-banded loach	Mainly impacted by non-selective fishing, such as blasting and poisoning. Note: A change in focus to target this species to supply the pet trade is possible, but has not been taken into account. Should this occur and go unchecked, this species is likely to become extinct in the Poonch River within 20 years.
	Kashmir catfish	Under similar threats from fishing pressure as the loach.
	Garua bachwaa	Under similar threats from fishing pressure as the mahaseer and has a similar response.
	Snow trout	Only uses this stretch of river in winter so protection measures in the river would be diluted by less protection elsewhere. Extreme protection measures do help them because their breeding is protected downstream and harvesting is reduced

Indicators		Comments
Wildlife	Fish-eating wildlife	Represented by the otter, such wildlife is estimated to have declined to a PES of C due to multiple pressures from people
	Wildlife water needs	Represented by the barking deer, such wildlife is estimated to have declined to a PES of F due to multiple pressures from people
	Riverine insectivores	Represented by the white-capped redstart, such wildlife is estimated to have declined to a PES of C due to multiple pressures from people

- Pro 1 = 2013 pressures fixed for the next 52 years.
- Pro 2 = 2013 pressures halved over the next 5 years and then stable at that level for the next 48 years.

All other indicators were switched on and the DSS calibrated to achieve the target values.

For mining, these levels of protection could be achieved through redirecting mining activities to the coarse sediments trapped in the backup zone of Gulpur weir, and barring the collection of sediment for commercial uses at other sites within a 10-km radius of the backup zone of Gulpur weir. This could reduce the area affected by sediment mining in the Poonch River and its tributaries by 40-60%.

For fishing, the named levels of protection could be achieved through banning (and policing) all non-selective fishing, which could result in an 80-90% reduction in these activities. Fishing pressure could also be reduced by redirecting some of the selective fishing to the Gulpur reservoir, and possibly introducing feed into the reservoir to boost the fish populations.

For nutrients, these levels of protection could be achieved through the construction and operation of sewage effluent treatment plants, and other means of reducing the inflow of raw sewage into the rivers.

For bushes and trees, these levels of protection could be achieved through improved community awareness, and command and control measures to reduce harvesting in riparian areas. This is possible because, although the communities have a high level of dependence on bushes and trees for subsistence uses, the hilly terrain through which the Poonch River flows result in the river banks constituting just a small fraction of the area that the communities harvest.

Additional details on the management activities underlying Protection Level 1 and 2 are provided in HBP (2014).

Protection Level 1 maintains non-flow-related pressures on the river at 2013 levels, i.e., no increase in human-induced catchment pressures over time.

The end values for the BAU scenarios are conservative since the DSS was calibrated with double the 2013 mining and fishing pressure from 2014 but the BAU scenarios themselves incorporated a gradual increase in pressure over 52 years, which gives a mean BAU 'pressure' of 149% over the record not 200%. Thus, excluding flow changes, the final result for the BAU scenarios will be less than the value provided in Table 5.3.

A similar situation applies for Protection Level 2, except that the 2013 mining and fishing pressures were decreased over the first five years, reaching the target level of (reduced) pressure in the fifth year.

5.3 CONSIDERATION OF BARRIER EFFECTS AS A RESULT OF GULPUR WEIR

At 35 m, the Gulpur HPP weir will present a considerable barrier to in-channel movement of abiotic and biotic components of the river ecosystem. The abiotic components, as well as water, include sediments of different sizes (boulders, cobbles, gravel, sand, mud and silt). The biotic components include migrating fish, drifting macroinvertebrates and floating plant seeds. Of these, the following barrier effects were incorporated into the EF scenarios:

- Trapping of bedload and suspended sediments moving down the river (see Section 5.3.1);
- Barriers to fish movement between over-wintering areas in Mangla Lake and breeding areas in the tributaries upstream of the weir (e.g., Pakistani labeo, mahaseer, Garua bachwaa; see Section 5.3.2).
- Barriers to fish movement between over-wintering areas in the lower parts of the Poonch River and breeding areas in the upper parts of the river (e.g., Snow trout; see Section 5.3.2).
- Fragmentation of the habitat of fish resident in the Poonch River (Kashmir catfish and twin-banded loach; see Section 5.3.2).

5.3.1 Sediment trapping and flushing

Estimates of the reduced bedload were developed based on the design and operation of, and catchment area affected by, Gulpur HPP, together with consideration of sediment inflows from tributaries and the availability of sediment which could be reworked and entrained from the bed and banks. The basic assumptions were:

- Sand and larger calibre sediments will settle out in the reservoir
- Clays and silts will stay in suspension.
- Peak sediment load downstream of the dam will increase in the wet season due to bottom-release flushing for sediments.

The estimated percentage reduction (relative to 2013 conditions) of bedload load at each of the EF sites is provided in Table 5.5.

Table 5.5 **The estimated percentage reduction (relative to 2013 conditions) of bedload inflows at each of the EF sites following dam closure.**

Location	Proportion of catchment affected by dam	Estimated % reduction in bedload
EF Site 1	0	0
EF Site 2	100	90
EF Site 3	98	85
EF Site 4	93	75

A time-series of the suspended load was developed using observed suspended sediment measurements and the daily discharge record. Annual suspended sediment-discharge rating curves were calculated for each year of the record (Table 5.6), and these were used to generate a daily suspended sediment load curve.

One sediment flushing scenario was considered (i.e., the sediment flushing regime is the same in all the 'dam' scenarios) limited to the wet season only. Due to this annual bottom-release flushing, large increases in peak wet season suspended sediment load values can be expected at EF Site 2. These impacts however reduce downstream due to dilution and mixing.

Table 5.6 **The modelled median suspended sediment loads (PPM) at the EF sites in 2013 and, following dam closure, under scenarios releasing 4, 8 and 16 m^3s^{-1} EF releases. Suspended sediment load peaks are italicised.**

Location	2013	4-m^3s^{-1}release	8-m^3s^{-1}release	16-m^3s^{-1}release
EF Site 1	49	n/a	n/a	n/a
Max peak:	*40 000*	*n/a*	*n/a*	*n/a*
EF Site 2	76	3	5	12
Max peak:	*40 000*	*60 000*	*60 000*	*60 000*
EF Site 3	77	54	54	54
Max peak:	*40 000*	*56 000*	*56 000*	*56 000*
EF Site 4	84	72	72	72
Max peak:	*40 000*	*52 000*	*52 000*	*52 000*

5.3.2 Barrier to fish movement

The influence of the Gulpur weir and reservoir on fish populations at EF Sites 1, 2, 3 and 4 is driven by two factors:

1. The barrier presented by the weir to fish migrating upstream and downstream. It is expected that upstream migration will be halted by the weir, but that there will be some downstream movement through the spills and EF releases. The bulk of the tributaries of the Poonch River that are used for breeding by Pakistani labeo, mahaseer are located upstream of Gulpur HPP (refer to HBP 2014 for details). However, fish restricted to the lower part of the Poonch River by Gulpur HPP will breed in the main river to some extent and will also migrate to breeding grounds in the tributaries downstream of Gulpur HPP (Table 5.7).

2. Pakistani labeo, snow trout and mahaseer will most likely colonise the reservoir, which may lead to a slight increase in their populations at EF Site 1.
3. Unlike Pakistani labeo, mahaseer, the bulk of the favoured breeding sites for garua are located downstream of the Gulpur weir. Garua bachwaa is also unlikely to colonise the reservoir. Thus, it is expected that the population upstream of the dam will be compromised by the weir.

The loach and catfish are non-migratory, and will not inhabit the reservoir, so any influence of the reservoir is expected to be very small, and was excluded from consideration.

The year-on-year predicted percentage influence of the Gulpur weir and reservoir on fish populations (relative to 2013 conditions) used in the DSS is provided in Table 5.7.

Table 5.7 The estimated year-on-year percentage influence of the Gulpur weir and reservoir on fish populations (relative to 2013 conditions)

EF site	Influence of the reservoir (barrier and refuge)					
	Pakistani labeo	Mahaseer	Twin-banded loach	Kashmir catfish	Garua bachwaa	Snow trout
EF Site 1	+5%	+10%	-	-	-95%	+5%
EF Site 2	-90%	-85%	-	-	-	-
EF Site 3	-90%	-85%	-	-	-	-
EF Site 4	-90%	-85%	-	-	-	-

The long-term trends in populations should not be confused with possible short-term localized changes. For instance, it is conceivable that fish migrating upstream may congregate downstream of the dam wall, leading to a localized increase in numbers at particular time of the year.

To estimate the influence of the barrier created by Gulpur weir on the fish, the extent to which they breed at different locations was assessed. For each fish indicator, it was estimated what percentage breeds in the Jhelum River, what percentage breeds downstream of the planned barrier on the Pooch River and what percentage upstream of the planned barrier (Table 5.8). These values were used to predict the remaining population of fish at the EF sites.

Table 5.8 Estimated percentage of fish populations breeding in different areas

Fish	Jhelum River	Poonch River, downstream of Gulpur weir	Poonch River, upstream of Gulpur weir
Pakistani labeo	40	30	30
Mahaseer	0	10	90
Garua Bachwaa	0	80	20
Snow trout	0	0	100

5.4 *CONSIDERATION OF IMPACTS IN OTHER BASINS*

The considerations provided here for the scenarios EXCLUDE consideration of the possible cumulative impacts on biota in the Poonch River resulting from developments in other parts of the catchment. For instance, labeo migrate between Mangla Dam and river environments (Table 5.8), spending much of the dry season in the lake and the wet season in the rivers, where they breed. From Mangla Dam, the fish have two options for their wet season migration, the Poonch River or the Jhelum River. Thus, the future of the labeo in the catchment is not 100% dependent on the future of any one river. In theory, if the Poonch River becomes unavailable, the fish can breed in the Jhelum River and *vice versa*. In practice, however, both the Poonch and the Jhelum Rivers are targeted for HPP developments. If developments on the Jhelum River go ahead, this will increase the predicted impacts (particularly on fish) of Gulpur HPP in the Poonch River.

5.5 *INCORPORATION OF HYDRAULIC DATA*

Survey data of cross-sections at the Gulpur EF sites (Table 2.1) were used to model the hydraulics of the sites and the fish hydraulic habitat available over a range of flows (specialist report on hydraulics). The hydraulic modelling enabled hydraulic indicators (Table 3.1) to be inserted into the DSS and used to estimate flow and sediment-driven changes in habitat. The data used to calculate the hydraulic indicators are presented in the Hydraulics Report.

6 *BIOPHYSICAL RESULTS FOR THE SCENARIOS*

For each scenario, the predicted changes in the study rivers are evaluated per site as:

1. estimated mean percentage change from baseline[11] in the abundance, area or concentration of key indicators;
2. time-series of abundance, area or concentration of key indicators under the flow regime resulting from each scenario.

The predicted changes in Overall Ecosystem Integrity, relative to baseline, associated with each scenario at each site are provided in Sections 6.1 to 6.4, and the combined integrity is provided in Section 6.5.

6.1 GULPUR EF SITE 1 (KALLAR BRIDGE)

There are no flow changes at EF Site 1 associated with Gulpur HPP as the site is upstream of the reservoir. However, EF Site 1 will be affected by the barrier that the Gulpur weir poses to, in particular, fish. For that reason two 'Gulpur' scenarios are included below: GXBAU, and GXPro 2. Under the GX scenarios EF Site 1 is not affected by the releases but is affected by the presence of the dam; X = can be a 4, 8 or 16 m^3s^{-1} release.

6.1.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 1

The main characteristics of the flow regimes Gulpur EF Site 1 associated with each of the scenarios are summarised in Table 6.1. The release scenarios from Gulpur HPP do not apply at EF Site 1. Explanation of the flow indicators is given in Section 5.1.

Table 6.1 Characteristics of the flow regime for each scenario at Gulpur EF Site 1 (Kallar Bridge). Median values are given for the flow indicators.

Scenario/EF indicator	Mean annual runoff	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	**m^3s^{-1}**	**m^3s^{-1}**	**weeks[12]**	**m^3s^{-1}**	**days**	**weeks**	**m^3s^{-1}**	**days**
NDPro1	85.83		40	13.68	113.5	7	483.67	225
NDBAU	85.83		40	13.68	113.5	7	483.67	225
NDPro2	85.83		40	13.68	113.5	7	483.67	225
G4BAU								
G4Pro2								
G8BAU								
G8PeakBAU	As for No Dam option.							
G8Pro2								
G16BAU								
G16Pro2								

[11] Baseline ecological conditions are those measured in 2013.
[12] Weeks = calendar weeks

6.1.2 Mean percentage changes

The mean percentage changes (relative to baseline) for the ecosystem indicators for the scenarios at Gulpur EF Site 1 (Kallar Bridge) are given in Table 6.2.

Table 6.2 Gulpur EF Site 1: The mean percentage changes (relative to 2013 for the indicators for the scenarios. Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%. GX = 4; 8 or 16 m^3s^{-1} releases (EF Site 1 is upstream of the weir, and is not affected by releases but is affected by the presence of the weir).

Indicators		NDPro1	NDBAU	NDPro2	GXBAU	GXBPro2
Geomorphology	Active channel width	-0.8	-0.8	-0.8	-0.8	-0.8
	Area of silt/mixed deposits	-2.8	-3.7	4.6	-3.7	4.6
	Area of cobble bars	2.3	-15.7	2.0	-15.7	2.0
	Bed sediment type (armouring)	-0.8	-28.2	-2.4	-28.2	-2.4
	Depth of pools	0.0	-17.4	-3.1	-17.4	-3.1
	Area of secondary channels and backwaters	-9.6	-10.5	-0.1	-10.5	-0.1
Water Quality	Nutrients	26.8	105.7	10.7	105.7	10.7
	Temperature	0.3	0.3	0.3	0.3	0.3
Algae	Periphyton biomass	1.0	20.7	-2.7	20.7	-2.7
Riparian vegetation	Dry bank trees and shrubs	-19.6	-35.7	27.4	-35.7	27.4
Macro-invertebrates	Simulidae	1.5	-17.2	-4.0	-17.2	-4.0
	EPT biomass	8.1	7.7	-7.8	-2.2	-14.6
Fish	Pakistani labeo	-63.7	-86.4	61.8	-79.2	69.0
	Mahaseer	-59.8	-96.5	46.7	-81.7	79.9
	Twin-banded loach	4.3	-69.8	34.3	-87.2	23.3
	Kashmir catfish	-2.9	-66.8	30.6	-83.6	21.5
	Garua bachwaa	-65.5	-99.9	73.1	-100.0	8.0
	Snow trout	-50.2	-60.7	57.1	-29.9	88.1
Wildlife	Fish-eating wildlife	-22.3	-33.0	19.0	-18.0	28.8
	Wildlife water needs	0.0	0.0	0.0	0.0	0.0
	Riverine insectivores	-0.9	2.2	-6.7	-5.3	-11.8

The values provided in Table 6.2 are averages for the last 30 years of the record (1982-2012). This is because the influence of the management options takes *c*. 5-10 years to take effect, and so the early part of the record can be quite different from the middle and later parts (see time-series graphs in Section 6.1.3).

6.1.3 Time-series

The time-series for the scenarios for the biophysical indicators (Figure 6.1 to Figure 6.6) show the annual changes in abundance behind the mean values given in Table 6.2. The period simulated is 1960-2010. These show the year-on-year changes in each indicator in response to the prevailing conditions. These conditions, derived using the historical flow records (1960-2012), show the predicted response for each indicator, under the condition specified in each scenario, should the same flow conditions be replicated into the future. In the plots, some scenario lines are hidden underneath others. Where the visible scenarios are quite different, the location of the hidden scenario(s) is given in the text. One representative set of scenarios with the HPP in place is shown in the plots – it is irrelevant which flow release level is used as these do not have an upstream effect. They are included because the weir has an effect on the biota, as a barrier.

1.1.1.1 Geomorphology

There are no geomorphological changes expected at EF Site 1 as a result of the presence of Gulpur weir (Figure 6.1).

The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in mining activities in the main channel and tributaries, which will lead to some infilling of interstitial spaces by fines (see Section 3) relative to the 2013 condition as sand, cobbles and boulders are removed from the system. This will be accompanied by small reductions in cobble bars and slight infilling of the pools. Conversely, the protection measures associated with Pro2 should result in a decline in the current mining operations, with a concomitant coarsening of the substrate.

Figure 6.1 **Time-series of predicted changes in geomorphological indicators at EF Site 1. Scenario lines not visible are hidden by those showing.**

1.1.1.2 Water Quality

No water quality changes are predicted at EF Site 1 as a result of the presence of Gulpur weir (Figure 6.2). The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in the amount of nutrients entering the river from towns and settlements in the upper catchment. The protection measures associated with Pro2 should result in decreased nutrient inflows into the system.

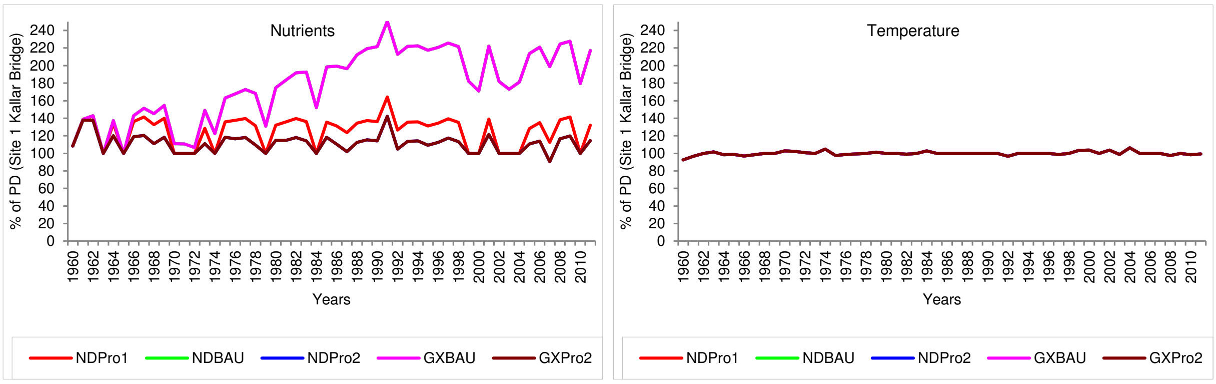

Figure 6.2 **Time-series of predicted changes in water quality indicators at EF Site 1. Scenario lines not visible are hidden by those showing. The two Pro 2 scenarios are together and the two BAU scenarios are together.**

1.1.1.3 Algae

There are no algal changes expected at EF Site 1 as a result of the presence of Gulpur weir (Figure 6.3). The differences between the scenarios are driven by the two management options. The increased nutrients associated with BAU are expected to result in increased periphyton growth.

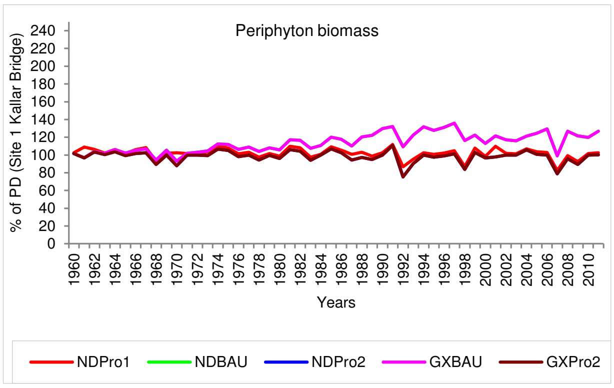

Figure 6.3 **Time-series of predicted changes in algal indicators at EF Site 1. Scenario lines not visible are hidden by those showing.**

1.1.1.4 Riparian Vegetation

There are no changes in riparian vegetation expected at EF Site 1 as a result of the presence of Gulpur weir (Figure 6.3). The differences between the scenarios are driven by the two management options. The BAU scenario is expected to result in an increase in the harvesting and utilization of trees and shrubs from the riparian area, whereas the Pro2 protection measures will be aimed at halving harvesting in the riparian area, which should result in an increase in the density of riparian vegetation.

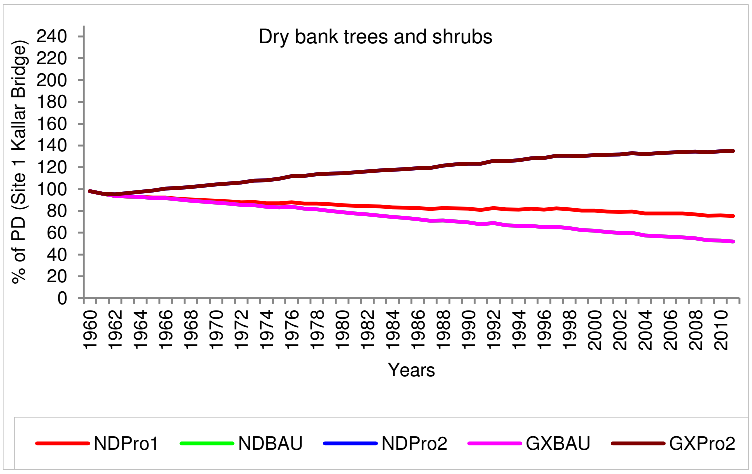

Figure 6.3 **Time-series of predicted changes in vegetation indicators at EF Site 1. Scenario lines not visible are hidden by those showing:**

1.1.1.5 Macroinvertebrates

The changes in macroinvertebrates at EF Site 1 are mostly related to the differences between the management options, the most significant of which is the increase in nutrients, leading to an increase in periphyton (Figure 6.4). This affects both the habitat available for EPT and the food available for Simuliidae. Overall, however, abundances do not change noticeably from 2013 values.

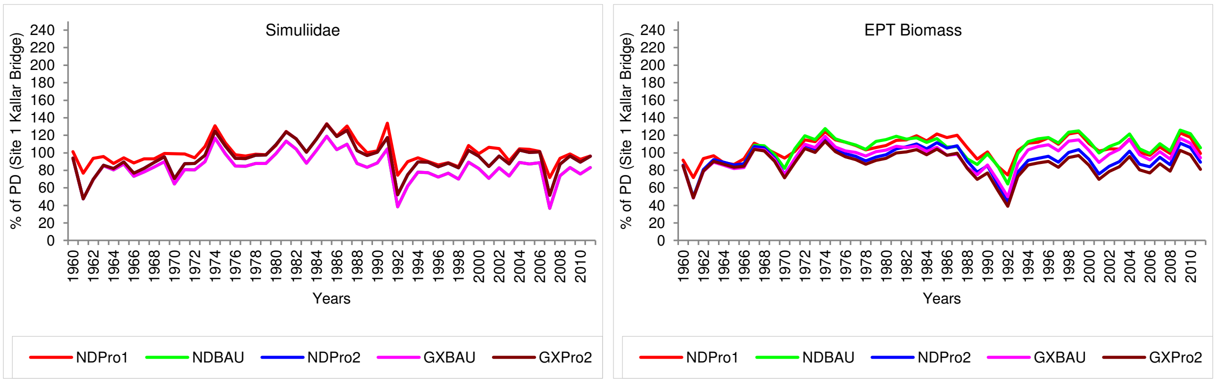

Figure 6.4 **Time-series of predicted changes in invertebrate indicators at EF Site 1. Scenario lines not visible are hidden by those showing.**

1.1.1.6 Fish

The protection measures associated with Pro 2 are expected to increase fish populations at EF Site 1 relative to the BAU scenarios, where fishing pressures are expected to double (Figure 6.5). In addition, with Gulpur weir in place, it is expected that, provided the water levels do not fluctuate excessively, the Pakistani labeo, mahaseer and snow trout and snow trout will colonise the Gulpur reservoir. This may result in an increase in these fish at EF Site 1 relative to the no dam (ND) scenarios, *viz.*: More fish under GxBAU than under NDBAU, and more fish under GxPro2 than under NDPro2.

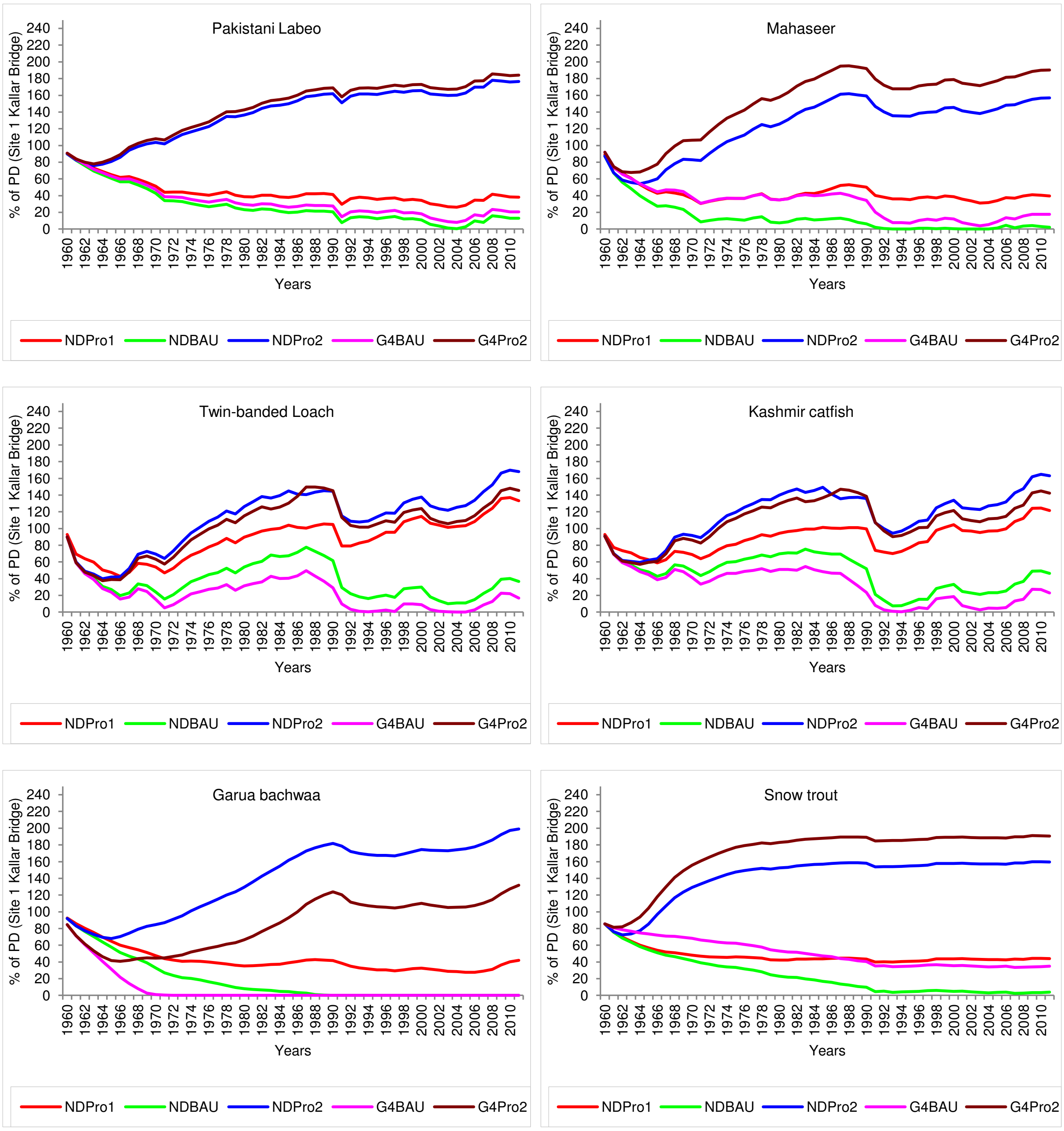

Figure 6.5 **Time-series of predicted changes in fish indicators at EF Site 1. Scenario lines not visible are hidden by those showing.**

Garua is not expected to colonise the reservoir, and will also lose access to many of its favoured breeding areas, which are downstream of the weir, however, there are some remaining breeding sites upstream of the reservoir, and garua will benefit from the expected increase in the other fish, which it eats. The net result for garua is difficult to predict, but is expected to maintain abundances similar to those in 2013 under GXPro2.

1.1.1.7 *Wildlife*

There are no major changes in wildlife dependent on the river for drink or those dependent on aquatic insects for food as a result of the presence of Gulpur weir (Figure 6.6). The fish-eating wildlife is expected to follow similar trends to the fish, albeit at a lower magnitude of reaction.

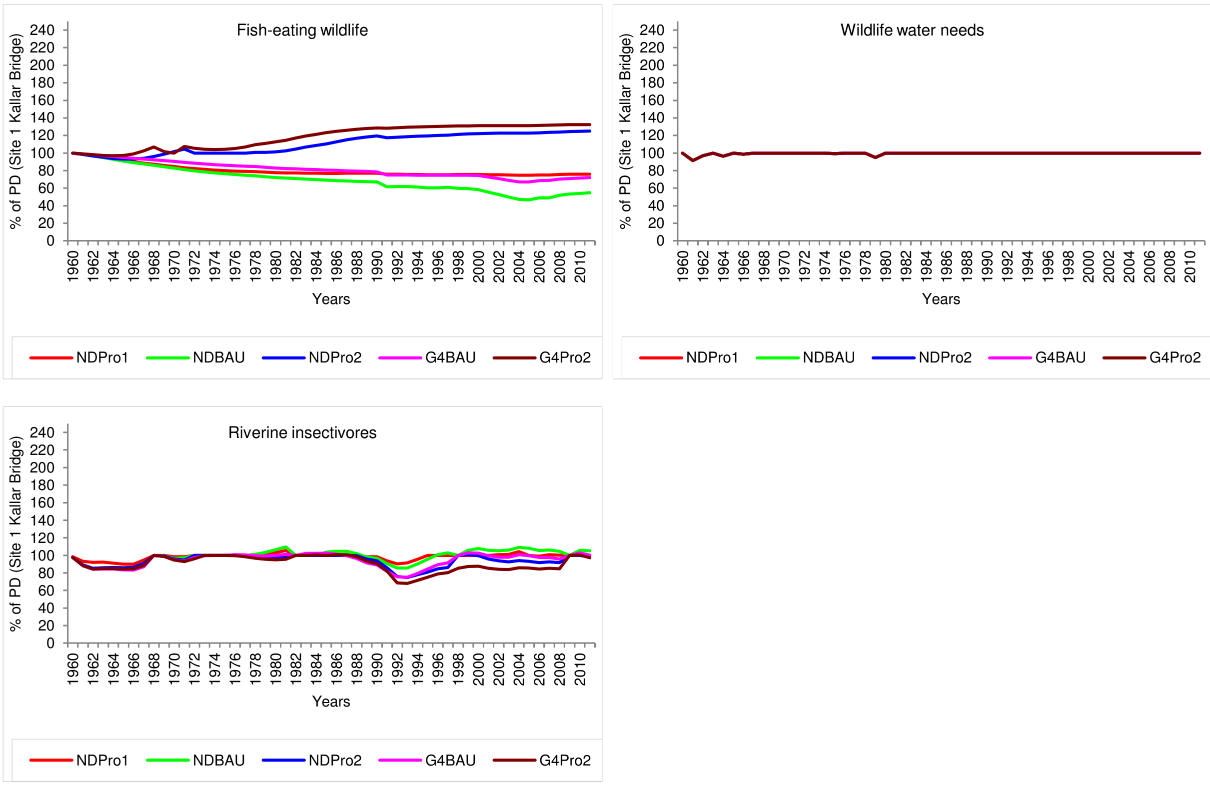

Figure 6.6 Time-series of predicted changes in wildlife indicators at EF Site 1. Scenario lines not visible are hidden by those showing.

6.1.4 Overall Ecological Integrity

The Overall Ecological Integrity for each scenario at Gulpur EF Site 1 is illustrated in Figure 6.7.

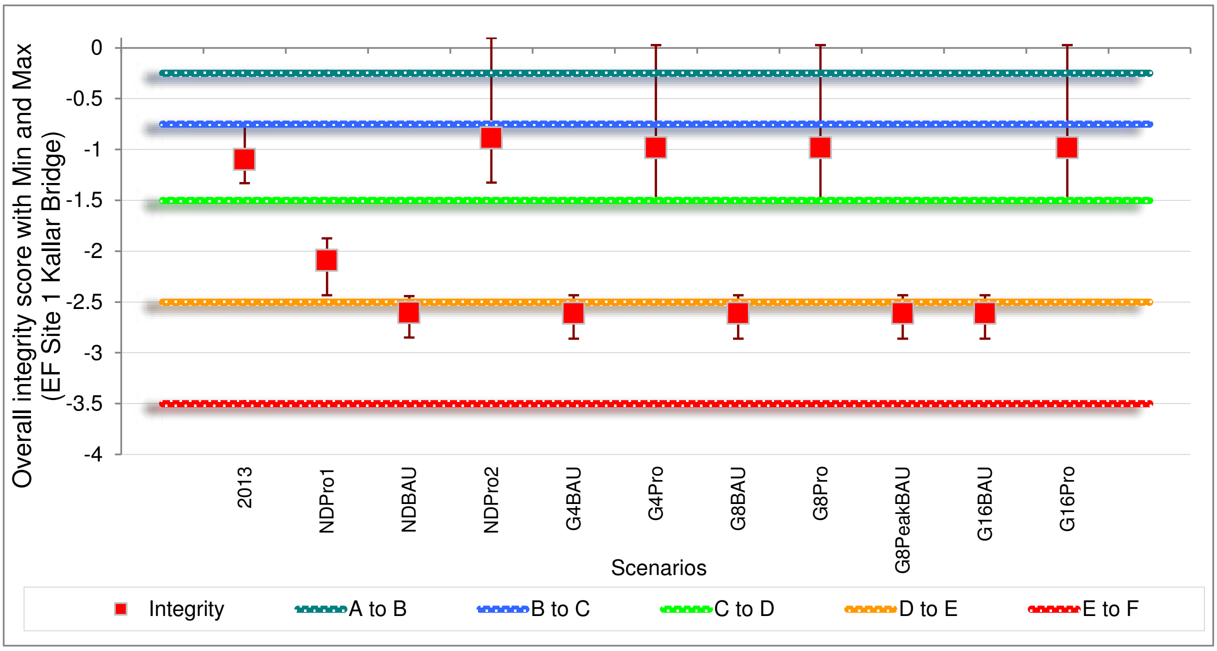

Figure 6.7 **Overall ecosystem integrity scores for the scenarios at Gulpur EF Site 1 (Kallar Bridge). Baseline (2013) integrity is shown as a blue diamond.**

6.2 *GULPUR EF SITE 2 (BORALI BRIDGE)*

EF Site 2 is located between the weir and the tailrace. As such it represents the potentially 'dewatered' zone and is directly affected by EF releases made at the weir. It is also affected by the barrier that Gulpur weir poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir, such as an increase in zooplankton, a decrease in oxygen or a change in water temperature.

6.2.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 2

The main characteristics of the flow regimes at Gulpur EF Site 2 associated with each of the scenarios are summarised in Table 6.3. Peaking flows (Scenario G8PeakBAU) do not apply at Gulpur EF Site 2 because this is upstream of the point where water is released back into the river from the turbines.

Table 6.3 Characteristics of the flow regime of each scenario at Gulpur EF Site 2 (Borali Bridge). Median values are given for the flow indicators.

Scenario/EF indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	**m^3s^{-1}**	**weeks[13]**	**m^3s^{-1}**	**days**	**weeks**	**m^3s^{-1}**	**days**
NDPro1	126.38	40	20.14	114	7	712.20	225
NDBAU	126.38	40	20.14	114	7	712.20	225
NDPro2	126.38	40	20.14	114	7	712.20	225
G4BAU	28.38	34	4.04	203.	13	521.74	143
G4Pro2	28.38	34	4.04	203	13	521.74	143
G8BAU	31.78	34	8.04	203	13	522.14	143
G8PeakBAU	Not applicable to EF Site 2.						
G8Pro2	31.78	34	8.04	203	13	522.14	143
G16BAU	38.70	34	16.04	201	13	522.50	143
G16Pro2	38.70	34	16.04	201	13	522.50	143

6.2.2 Mean percentage changes

The mean percentage changes (relative to Baseline) for the indicators for the scenarios at Gulpur EF Site 2 (Borali Bridge) are given in Table 6.4.

The values provided in Table 6.4 are averages for the last 30 years of the record (1982-2012). This is because the influence of the management options takes *c*. 5-10 years to take effect, and so early part of the record can be quite different from the middle and later part (see time-series graphs in Section 6.2.3).

[13] Weeks = calendar weeks

Table 6.4 Gulpur EF Site 2: The mean percentage changes in abundance (relative to Baseline) for the indicators for the scenarios. Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.

Indicators		NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G16BAU	G16Pro2
Geomorphology	Active channel width	-0.7	-0.7	-0.7	-49.8	-49.8	-46.8	-46.8	-21.9	-21.9
	Area of silt/mixed deposits	-3.2	-8.7	0.7	-15.5	-10.0	-17.8	-11.3	-21.0	-12.8
	Area of cobble bars	2.3	-15.7	1.0	-47.0	-23.5	-47.0	-23.5	-47.0	-23.5
	Bed sediment type (armouring)	-13.4	-21.1	-6.5	23.1	37.7	24.7	39.3	26.4	41.0
	Depth of pools	4.1	-7.6	3.1	-47.7	-30.3	-30.6	-13.2	-18.9	-1.5
	Area of 2o channels and backwaters	-9.6	-10.5	-0.1	-43.8	-36.1	-43.8	-36.1	-43.8	-36.1
Water Quality	Nutrients	26.8	105.7	10.7	132.6	29.8	126.1	23.1	111.0	12.0
	Temperature	0.3	0.3	0.3	-1.1	-1.1	1.7	1.7	6.1	6.1
Algae	Periphyton biomass	-1.1	9.8	-2.1	5.4	1.5	4.3	0.9	2.3	0.1
Riparian vegetation	Dry bank trees and shrubs	-19.6	-35.7	27.4	-42.4	20.7	-42.4	20.8	-42.3	20.8
Macro-invertebrates	Simulidae	-6.2	-10.7	-1.9	6.3	18.3	14.6	26.7	32.7	45.3
	EPT biomass	5.0	8.2	-5.7	-14.0	11.1	-11.9	3.7	1.2	2.1
Fish	Pakistani labeo	-58.8	-77.0	58.1	-99.6	-25.7	-98.8	-4.6	-98.1	6.7
	Mahaseer	-55.1	-92.3	51.2	-100.0	-92.9	-100.0	-86.6	-99.9	-41.1
	Twin-banded loach	-1.4	-54.4	46.5	-100.0	-89.6	-100.0	-79.6	-93.0	-20.7
	Kashmir catfish	-8.0	-61.7	15.3	-100.0	-90.8	-100.0	-87.5	-98.6	-54.4
	Garua bachwaa	-59.5	-94.0	85.6	-95.0	-88.8	-95.0	-88.1	-95.0	-12.3
Wildlife	Fish-eating wildlife	-53.0	-84.2	37.8	-100.0	-36.9	-100.0	-11.0	-100.0	-5.3
	Wildlife water needs	0.0	0.0	0.0	-100.0	-100.0	-59.6	-59.6	0.0	0.0
	Riverine insectivores	-1.8	2.7	-5.2	-38.2	0.4	-33.0	-7.3	-5.3	-5.5

6.2.3 Time-series

The time-series for the scenarios for the biophysical indicators (Figure 6.8 to Figure 6.14) show the annual changes in abundance behind the mean values given in Table 6.4. The period simulated is 1960-2010. These show the year-on-year changes in each indicator in response to the prevailing conditions. These conditions, derived using the historical flow records (1960-2012), show the predicted response for each indicator, under the condition specified in each scenario, should the same flow conditions be replicated into the future. In the plots, some scenario lines are hidden underneath others. Where the visible scenarios are quite different, the location of the hidden scenario(s) is given in the text.

1.1.1.8 Geomorphology

The changes in geomorphology at EF Site 2 (Figure 6.8) are driven by:

- reduced bedload supply;
- reduced suspended sediment supply for much of the year as a result of trapping of sediments in the reservoir;
- higher peaks in suspended sediment during summer flushing, and,
- reduced flows in the dry, transitional and wet seasons, which would reduce sediment movement in the reach represented by EF Site 2.

The overall predictions, relative to the no dam (ND) scenarios, are that channel width would decrease, with a gradual armouring of the river bed and a reduction in secondary channels and backwaters.

The effects of the two management options (BAU and Pro 2) are overlaid on the effects of the weir, in that BAU is expected to result in a decrease in sediment size and pool depth.

1.1.1.9 Water Quality

There are no water quality changes expected at EF Site 2 as a result of the presence of Gulpur weir (Figure 6.9). There may be some small temperature effect associated with the releases but, provided there is no stratification in the reservoir[14], these are expected to be minor. The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in the amount of nutrients entering the river from towns and settlements in the upper catchment. The protection measures associated with Pro2 should result in decreased nutrient inflows into the system.

[14] Given the size of the reservoir relative to inflow, and the release schedules envisaged, stratification is unlikely (NESPAK pers. comm.).

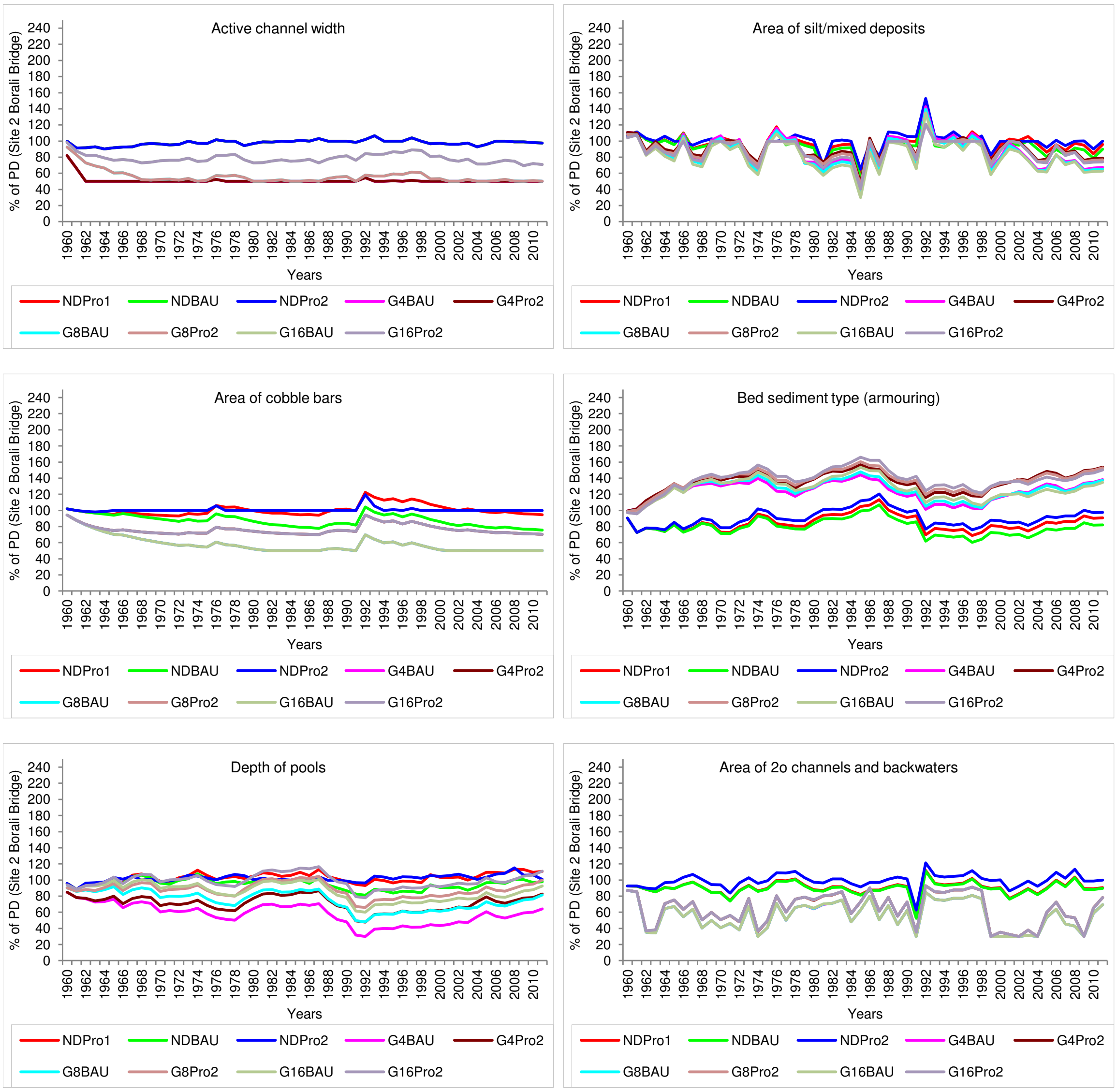

Figure 6.8 Time-series of predicted changes in geomorphological indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

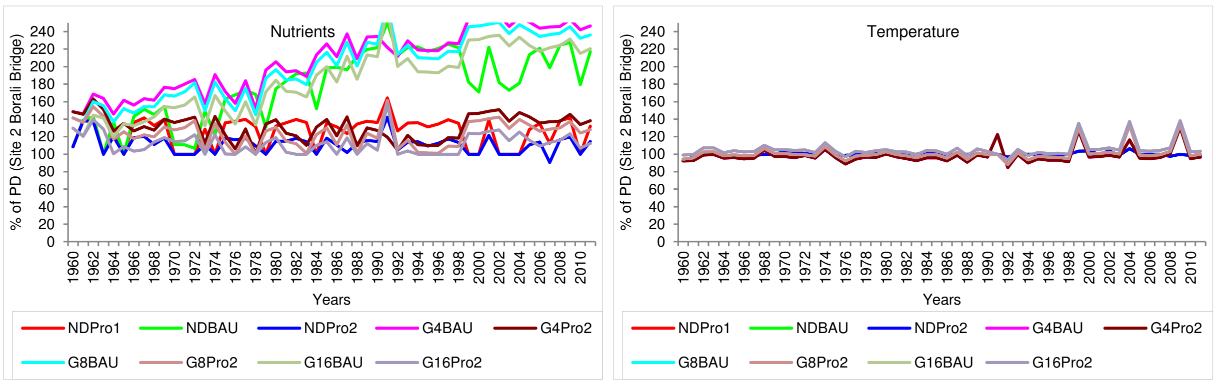

Figure 6.9 Time-series of predicted changes in water quality indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

1.1.1.10 *Algae*

The periphyton changes predicted for EF Site 2 are likely to take the form of sporadic changes in periphyton densities in response to climatic and catchment conditions (such as inflows of nutrients; Figure 6.10). It is extremely difficult to predict where, when and over what area these will occur. However, the lower flows and clearer water at EF Site 2 will increase the chance of periphyton growth.

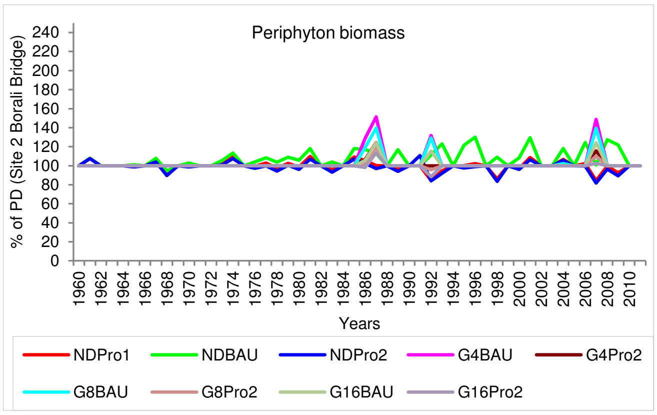

Figure 6.10 Time-series of predicted changes in algal indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

1.1.1.11 *Riparian Vegetation*

The reduced flows downstream of Gulpur weir, combined with the barrier to the downstream movement of seeds, are expected to result in a small decline in riparian vegetation at EF Site 2 (Figure 6.11). The main differences between the scenarios, however, are driven by the two management options. BAU is expected to result in an increase in the harvesting of shrubs and trees from the riparian area, whereas the protection measures associated with Pro2 should result in decreased harvesting and increased density of the riparian vegetation.

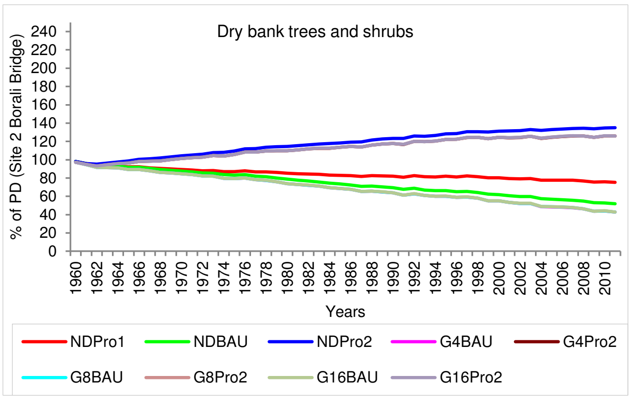

Figure 6.11 Time-series of predicted changes in vegetation indicators at EF Site 2. Scenario lines not visible are hidden by those showing. G4Pro2 and G8Pro2 are under G16Pro, and G4BAU and G8BAU are under G16BAU.

1.1.1.12 Macroinvertebrates

The lower constant flows at EF Site 2 under G4, G8 and G16 are likely to favour Simuliidae, many species of which favour stable low flows (Figure 6.12). Their food source is also likely to increase slightly, through conditions that favour plankton. Simuliids could also increase in abundance with the expected decline in fine sediments and armouring of the river bed (Berry et al 2003).

A drop in turbidity of the water column can increase primary and secondary production, which will provide more food for invertebrates (Huggins et al. 2007). The expected decline in suspended sediments will also reduce abrasion, and will favour higher populations of invertebrates. However, a slight decline in EPT is predicted related to reduction in available habitat (Figure 6.12), probably exacerbated by competition from other aquatic life such as Simuliidae.

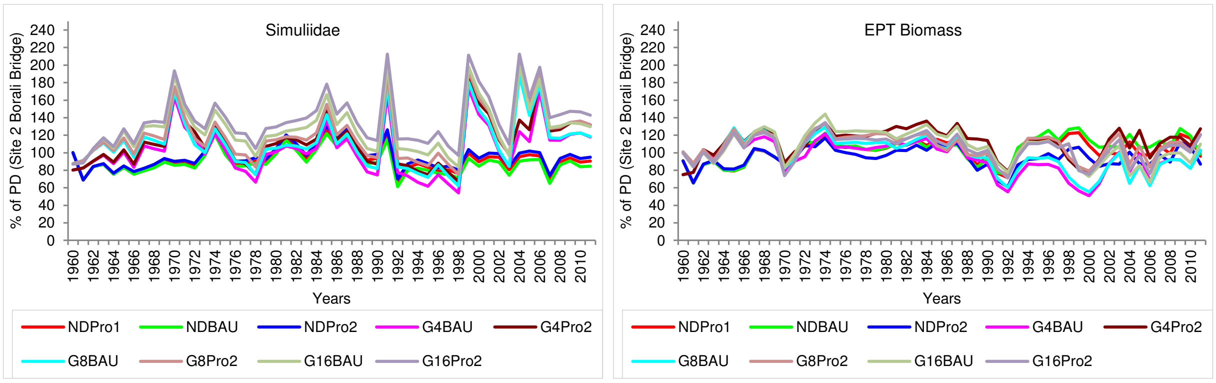

Figure 6.12 Time-series of predicted changes in invertebrate indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

1.1.1.13 Fish

The three no dam (ND) scenarios predict similar changes in fish populations as for EF Site 1 (Figure 6.13). The effect of Gulpur weir is related to:

- significantly reduced flows in the dry, transitional and wet seasons, which are expected to reduce available habitat;
- reduction in macroinvertebrates, which are a food source for some of the fish;
- the barrier to longitudinal movement of Pakistani labeo, mahaseer and garua backwaa, but particularly mahaseer, because about 90% of its breeding habitat is located upstream of the weir, and it does not breed in the Jhelum River (see Section 5.3.2).

BAU scenarios are all predicted to result in extremely low number of fish at EF Site 2, regardless of whether or not Gulpur weir is present.

Similarly, the release of 4 m^3s^{-1} is predicted to result in the elimination of most species from this reach or reduction to extremely low numbers, but releases of 8 and 16 m^3s^{-1}, together with Protection Level 1 protection measures, are expected to maintain most of the fish community, albeit in reduced numbers. Overall G16 would be better for fish community, although Pakistani labeo, mahaseer and garua backwaa are predicted to more abundant under 8 than G16, as there would be more periphyton available under the lower flows. Other species are not predicted to fare well under G8.

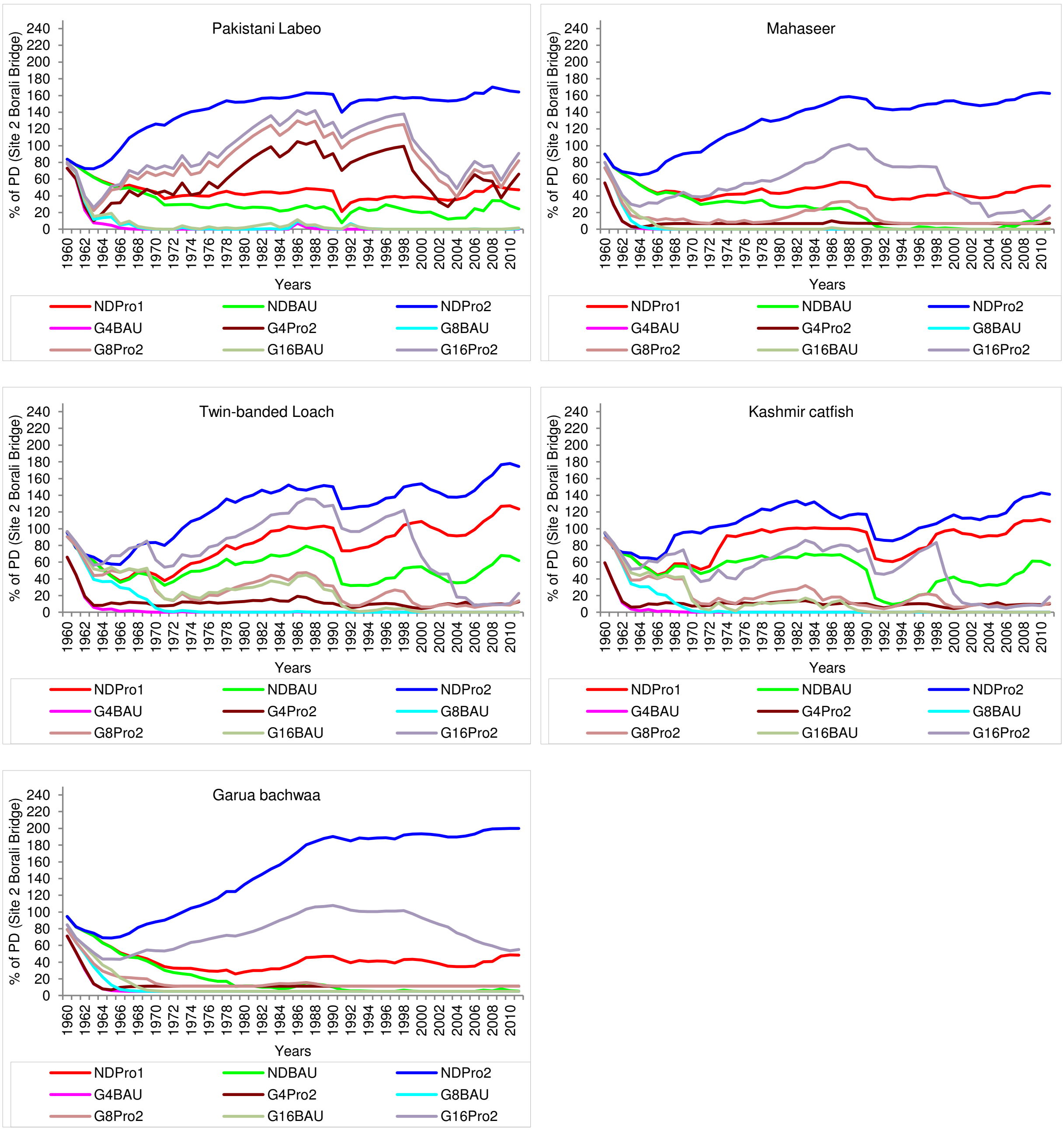

Figure 6.13 **Time-series of predicted changes in fish indicators at EF Site 2. Scenario lines not visible are hidden by those showing.**

1.1.1.14 *Wildlife*

It is expected that fish-eating wildlife, such as otter, would show very similar changes in abundance to their main food source, the fish. They would thrive under a scenario of no dam and level 2 protection measures but would likely disappear from this area under the three BAU scenarios (Figure 6.14).

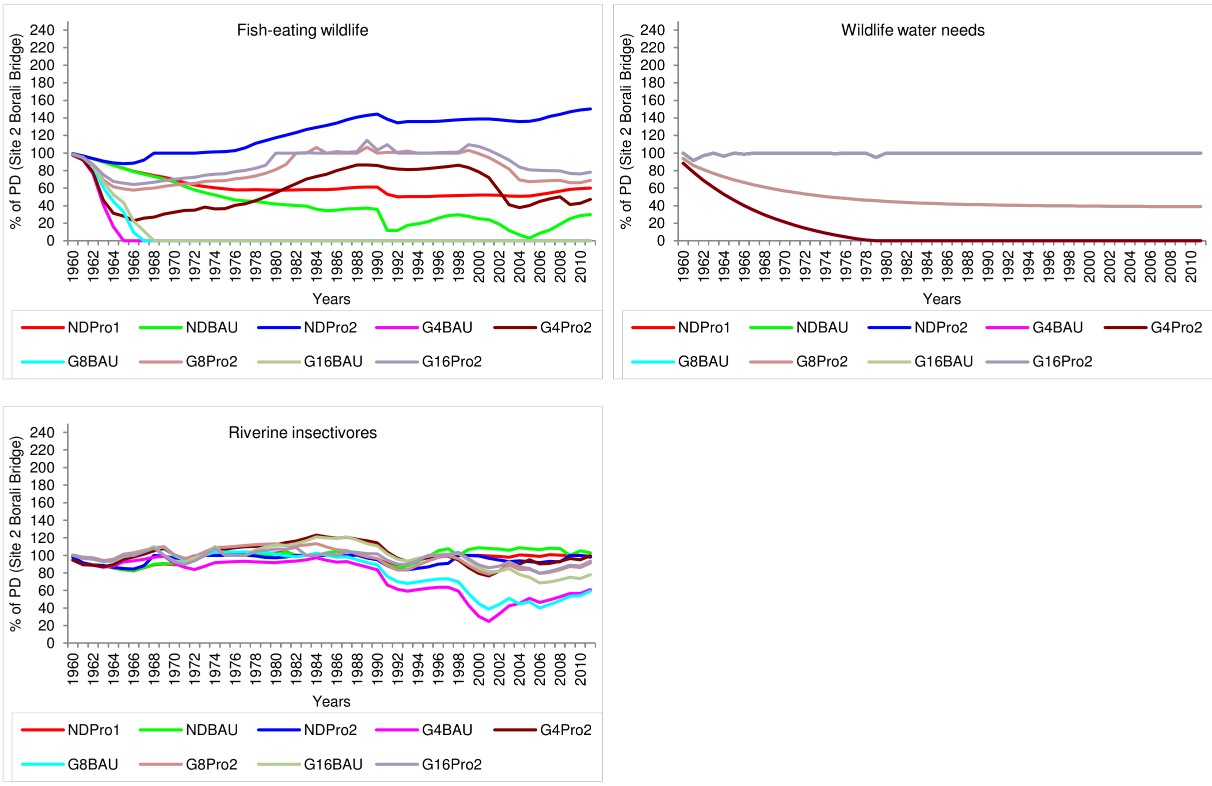

Figure 6.14 Time-series of predicted changes in wildlife indicators at EF Site 2. Scenario lines not visible are hidden by those showing. For wildlife water needs: NDPro1, NDBAU, NDPro2 and G16BAU are all hidden beneath G16Pro2; G8BAU is under G8Pro2; G4BAU is under G4Pro2.

Wildlife that is dependent on the river for drinking water are likely to be deterred if flows are too low and they have to walk some distance across the exposed rocky channel. For this reason, it is predicted that scenario G16 will have little or no impact on these wildlife, but scenario G8 could result in a decline in their numbers, and scenario G4 could result in the animals seeking other water sources. The protection levels proposed will not affect these animals.

The small insect-eating birds that rely on the river for food would decline in numbers as their food source (EPT invertebrates: mayflies, stoneflies, caddisflies) also declines. Among the scenarios that include the dam, those incorporating level 2 protection would enhance their numbers most and those that follow BAU would cause the greatest decline.

6.2.4 Overall Ecological Integrity

The Overall Integrity for each the scenarios at Gulpur EF Site 2 are illustrated in Figure 6.15.

All of the scenarios with Protection Level 2 are predicted to enhance the integrity of the river ecosystem at EF Site 2. River health would decline under the BAU scenarios, particularly with low releases from Gulpur weir in place, dropping two condition classes from baseline to a highly impacted E category.

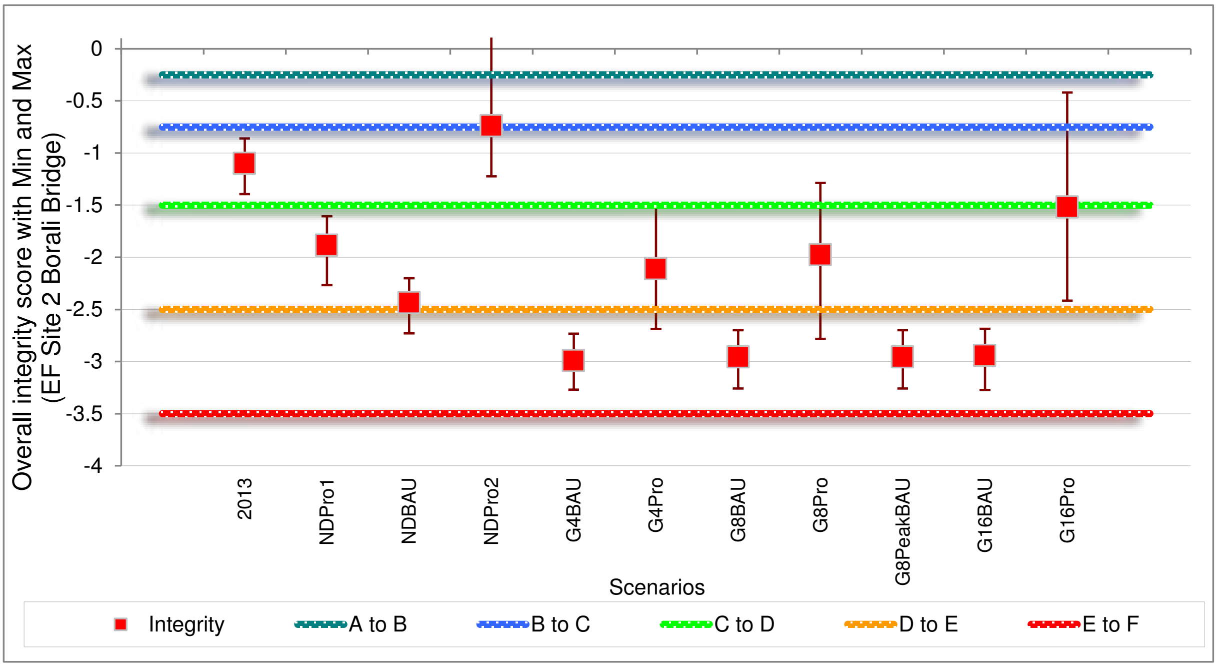

Figure 6.15 **Overall ecosystem integrity scores for the scenarios at Gulpur EF Site 2 (Borali Bridge). Baseline (2013) integrity is shown on the extreme left.**

6.3 *GULPUR EF SITE 3 (GULPUR BRIDGE)*

EF Site 3 is downstream of the Gulpur tailrace and so receives the flow returning to the river after diversion downstream of EF Site 1 and passage through the power house, plus any EF releases. As modelled, the flow at EF Site 3 is essentially the same as at EF Site 1. This is because the reservoir at the dam cannot store much water, and also because the approved design for the dam excludes peaking hydropower releases. In order to investigate the possible impact of peaking power releases, however, scenario G8PeakBAU is included in the analysis for Site 3.

In G8PeakBAU, flows in the river would be close to 199 m^3s^{-1} for about two hours per day, and 8 m^3s^{-1} for the remainder of the day. The transition between the high and low flows would be rapid, with the power-generating releases switched off and flows suddenly falling to a release for EF purposes. In the chosen peaking power scenario, the EF release was set at 8 m^3s^{-1}.

As with the other sites, EF Site 3 is also affected by the barrier that the Gulpur weir poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir or tunnel, such as an increase in zooplankton or a decrease in oxygen.

6.3.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 3

The main characteristics of the flow regimes at Gulpur EF Site 3 associated with each of the scenarios are summarised in Table 6.5. Table 6.5 has two extra columns relative to EF Site 1 and 2. This is to accommodate the summary information for G8PeakBAU, which is the range of discharge within a day in the wet and dry season. This is not relevant to the other scenarios, where discharge remains relatively constant throughout the day.

Table 6.5 Characteristics of the flow regime of each scenario at Gulpur EF Site 3. Median values are given for the flow indicators.

EF indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration	Dry season: Daily range	Wet season: Daily range
Units	m^3s^{-1}	weeks[15]	m^3s^{-1}	days	weeks	m^3s^{-1}	days	m^3s^{-1}	m^3s^{-1}
NDPro1	128.91	40	20.55	114	7	726.46	225	n/a	n/a
NDBAU	128.91	40	20.55	114	7	726.46	225	n/a	n/a
NDPro2	128.91	40	20.55	114	7	726.46	225	n/a	n/a
G4BAU	128.91	40	20.55	113	7	726.46	226	n/a	n/a
G4Pro2	128.91	40	20.55	113	7	726.46	226	n/a	n/a
G8BAU	128.91	40	20.55	113	7	726.46	226	n/a	n/a
G8PeakBAU	128.91	40	20.55	113	7	726.46	226	162.82	179.50
G8Pro2	128.91	40	20.55	113	7	726.46	226	n/a	n/a
G16BAU	128.91	40	20.55	113	7	726.46	226	n/a	n/a
G16Pro2	128.91	40	20.55	113	7	726.46	226	n/a	n/a

6.3.2 Mean percentage changes

The mean percentage changes (relative to Baseline) for the indicators for the scenarios at Gulpur EF Site 3 (Gulpur Bridge) are given in Table 6.6. The values provided in Table 6.6 are averages for the last 30 years of the record (1982-2012). This is because the modeled influence of the management options takes c. 5-10 years to take effect, and so early part of the record can be quite different from the middle and later part (see time-series graphs in Section 6.3.3).

6.3.3 Time-series

The time-series for the scenarios for the biophysical indicators (Figure 6.17 to Figure 6.23) show the annual changes in abundance encapsulated in the mean values given in Table 6.6.

[15] Weeks = calendar weeks

Table 6.6 **Gulpur EF Site 3: The mean percentage changes (relative to 2013) for the indicators under the scenarios. Blue and green are major changes that represent a move towards natural: green = 40-70% change from baseline; blue = >70%. Orange and red are major changes that represent a move away from natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%.**

Indicators		NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
Geomorphology	Active channel width	-0.6	-0.6	-0.6	-1.3	-1.3	-1.3	-1.3	8.0	-1.3	-1.3
	Area of silt/mixed deposits	-3.3	-8.8	0.7	-10.4	-0.4	-10.3	-0.4	-10.5	-10.3	-0.4
	Area of cobble bars	2.3	-15.7	2.0	-44.3	-18.5	-44.3	-18.5	-44.3	-44.3	-18.5
	Bed sediment type (armouring)	-12.3	-20.0	-5.4	12.6	27.2	12.5	27.1	22.9	12.5	27.1
	Depth of pools	0.8	-10.9	1.2	-22.5	-5.1	-22.5	-5.1	-21.1	-22.5	-5.1
	Area of 2° channels and backwaters	-9.2	-10.1	0.3	-13.1	-2.7	-13.1	-2.7	-12.0	-13.1	-2.7
Water Quality	Nutrients	31.6	111.7	14.1	110.4	12.8	110.4	12.8	111.4	110.4	12.8
	Temperature	1.5	1.5	1.5	1.0	1.0	1.0	1.0	1.5	1.0	1.0
Algae	Periphyton biomass	-1.1	10.0	-2.1	8.5	-3.9	8.5	-3.9	-30.0	8.5	-3.9
Riparian vegetation	Dry bank trees and shrubs	-16.6	-30.4	29.3	-30.2	29.5	-30.2	29.5	-30.4	-30.2	29.5
Macro-invertebrates	Simulidae	-5.6	-10.1	-1.3	3.4	14.5	3.3	14.5	-7.1	3.3	14.5
	EPT biomass	5.0	7.9	-5.4	14.9	8.5	14.9	8.5	-28.0	14.9	8.5
Fish	Pakistani labeo	-59.1	-87.4	58.9	-88.3	62.7	-88.3	62.7	-100.0	-88.3	62.7
	Mahaseer	-58.4	-94.4	51.3	-100.0	-6.1	-100.0	-6.2	-100.0	-100.0	-6.2
	Twin-banded loach	-1.2	-53.3	48.2	16.3	93.2	16.1	93.2	-100.0	16.1	93.2
	Kashmir catfish	-7.9	-62.2	19.6	-20.1	76.2	-20.2	76.2	-100.0	-20.2	76.2
	Garua bachwaa	-60.3	-95.7	80.2	-98.6	67.0	-98.6	66.8	-100.0	-98.6	66.8
Wildlife	Fish-eating wildlife	-53.0	-99.2	39.3	-99.4	45.3	-99.4	45.3	-100.0	-99.4	45.3
	Wildlife water needs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riverine insectivores	-1.7	2.7	-4.5	2.5	-0.4	2.5	-0.4	-55.4	2.5	-0.4

The period simulated is 1960-2010. The plots show the year-on-year changes in each indicator in response to the prevailing conditions. These conditions, derived using the historical flow records, show the predicted response for each indicator, under the condition specified in each scenario, should the same flow conditions be replicated into the future. In the plots, some scenario lines are hidden underneath others. Where the visible scenarios are quite different, the location of the hidden scenario(s) is given in the text.

1.1.1.15 Geomorphology

The changes in geomorphology at EF Site 3 (Figure 6.16) are driven by:

- reduced bedload supply;
- reduced suspended sediment supply for much of the year as a result of trapping of sediments in the reservoir;
- higher peaks in suspended sediment during summer flushing; and,
- peaking power releases for several hours a day under G8PeakBAU.

The overall predictions, relative to the no dam (ND) scenarios, are that channel width would remain about the same, with a gradual armouring of the river bed under the higher flow and the peaking releases and a concomitant loss of cobble bars.

There is a chance that peaking releases will result in increased erosion, and bank slumping, but given the steep and rocky nature of the Poonch River, this is likely to be limited.

1.1.1.16 Water Quality

The scenarios with different release magnitudes b any one protection measure produce much the same plots indicating that no major water quality changes are predicted for EF Site 3 as a result of the presence of Gulpur weir (Figure 6.17). Some changes are predicted, however, due to the two management options. The BAU scenarios are expected to result in an increase in the amount of nutrients entering the river from towns and settlements in the upper catchment and thus higher levels in the river. The protection measures associated with Pro2 should result in decreased nutrient inflows into the system.

Figure 6.16 Time-series of predicted changes in geomorphological indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

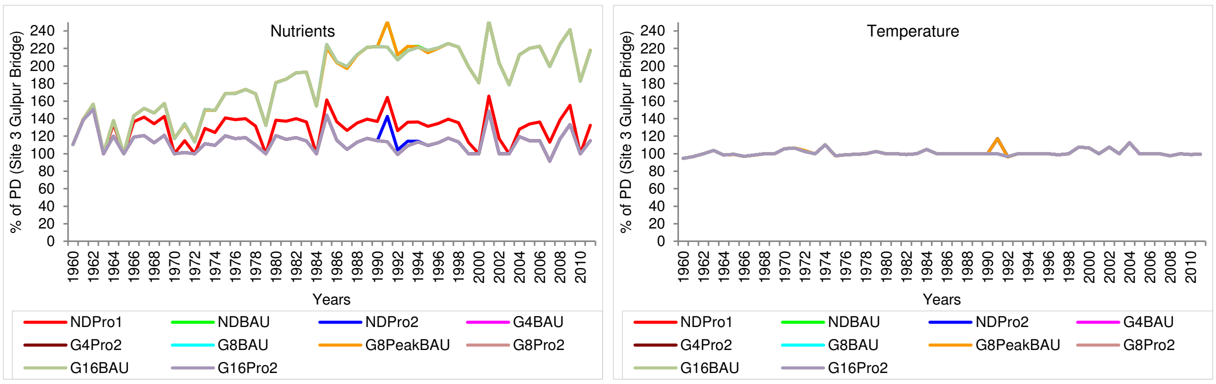

Figure 6.17 Time-series of predicted changes in water quality indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

1.1.1.17 *Algae*

With the exception of G8PeakBAU, the periphyton changes predicted at EF Site 3 are likely to take the form of sporadic changes in periphyton densities in response to climatic and catchment conditions (such as inflows of nutrients; Figure 6.18). Because of their ephemeral nature, it is not possible to predict where, when and over what area these will occur. However, the clearer water at EF Site 3 is expected to favour periphyton growth. This is true for all the 'G' scenarios except for G8PeakBAU, where the high daily releases are expected to flush periphyton from the channel, resulting in an overall decrease at EF Site 3.

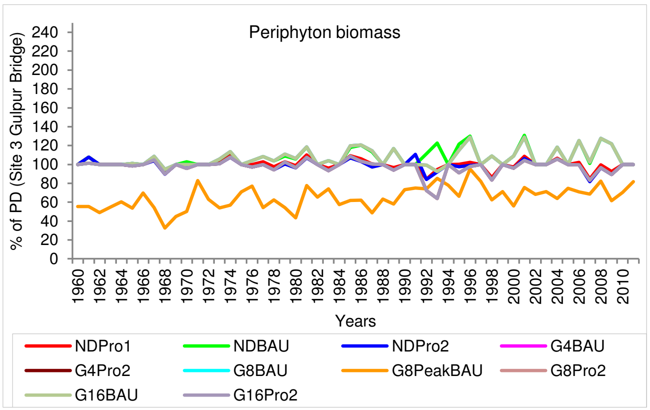

Figure 6.18 **Time-series of predicted changes in algal indicators at EF Site 3. Scenario lines not visible are hidden by those showing.**

1.1.1.18 *Riparian Vegetation*

There are no major changes in riparian vegetation expected at EF Site 3 as a result of the presence of Gulpur weir (Figure 6.19), but differences between the scenarios are expected because of the management options. The BAU scenario is expected to result in an increase in the harvesting and utilization of trees and shrubs from the riparian area, whereas the Pro2 protection measures will be aimed at halving harvesting in the riparian area, which should result in an increase in the density of riparian vegetation.

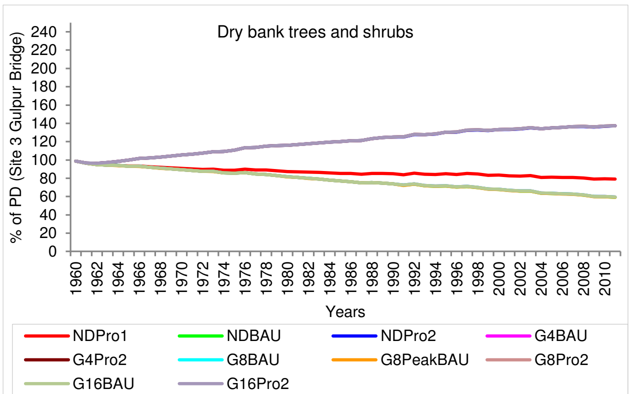

Figure 6.19 **Time-series of predicted changes in vegetation indicators at EF Site 3. Scenario lines not visible are hidden by those showing.**

1.1.1.19 Macroinvertebrates

Aquatic invertebrates would remain at approximately baseline abundances under all scenarios except that with peaking power G8PeakBAU (Figure 6.20). The abrupt changes in releases and mixture of very high flows (that can flush animals from their habitats) and low flows (that can leave them stranded away from the water) are expected to have a significant detrimental effect, particularly to the EPT species.

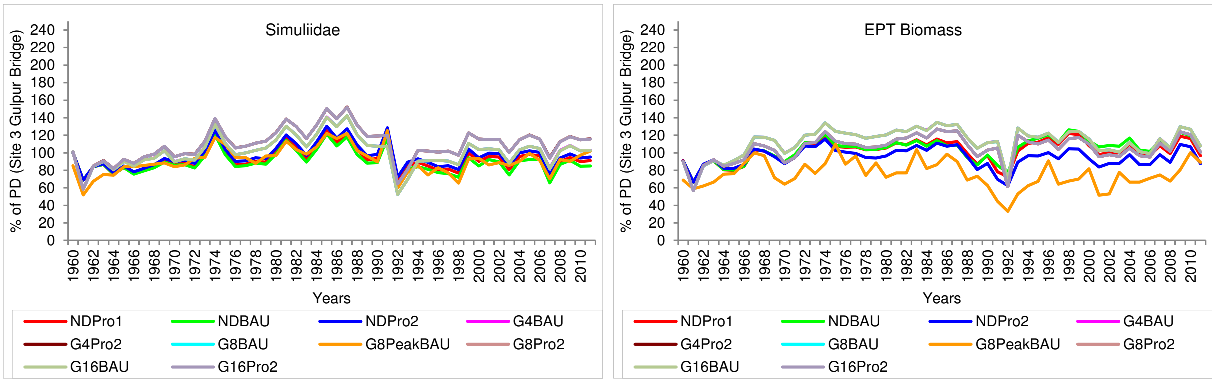

Figure 6.20 Time-series of predicted changes in invertebrate indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

1.1.1.20 Fish

The fish species (Figure 6.21) are predicted to increase in abundance, or at least maintain approximately baseline levels, under Protection Level 2, if there is no dam or no peaking releases from a dam. Under the BAU scenarios they would decline in abundance and under the peaking releases would probably disappear from this stretch of river.

1.1.1.21 Wildlife

Fish-eating wildlife at EF Site 3 are predicted to follow much the same patterns of abundance as the fish they eat., while no impacts are expected on the wildlife that depend on the rivers for water or invertebrate food from the non-peaking scenarios (Figure 6.22).

6.3.4 Overall Integrity

The Overall Integrity for each the scenarios at Gulpur EF Site 3 is illustrated in Figure 6.23. All of the scenarios with Protection Level 2 would enhance the integrity of the river ecosystem at EF Site 3. River health would decline under Protection Level 1 and the BAU scenarios, and would be deteriorate drastically under the peaking power scenario, dropping two condition classes from baseline to a highly impacted E (nearly F) category.

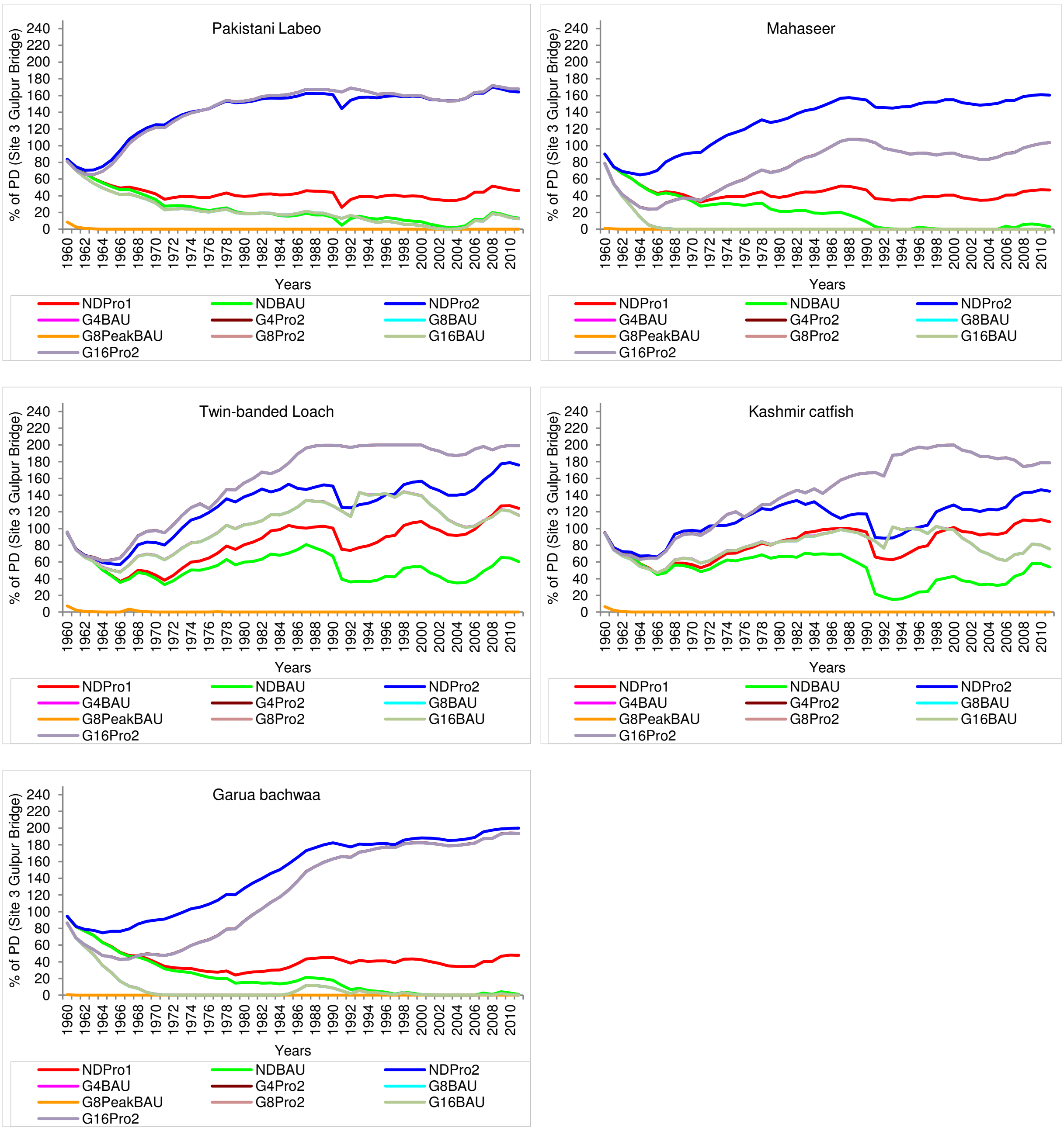

Figure 6.21 Time-series of predicted changes in fish indicators at EF Site 3. Scenario lines not visible are hidden by those showing. G4Pro2, G8Pro2 are under G16Pro2, and G4BAU and G8BAU are under G16BAU.

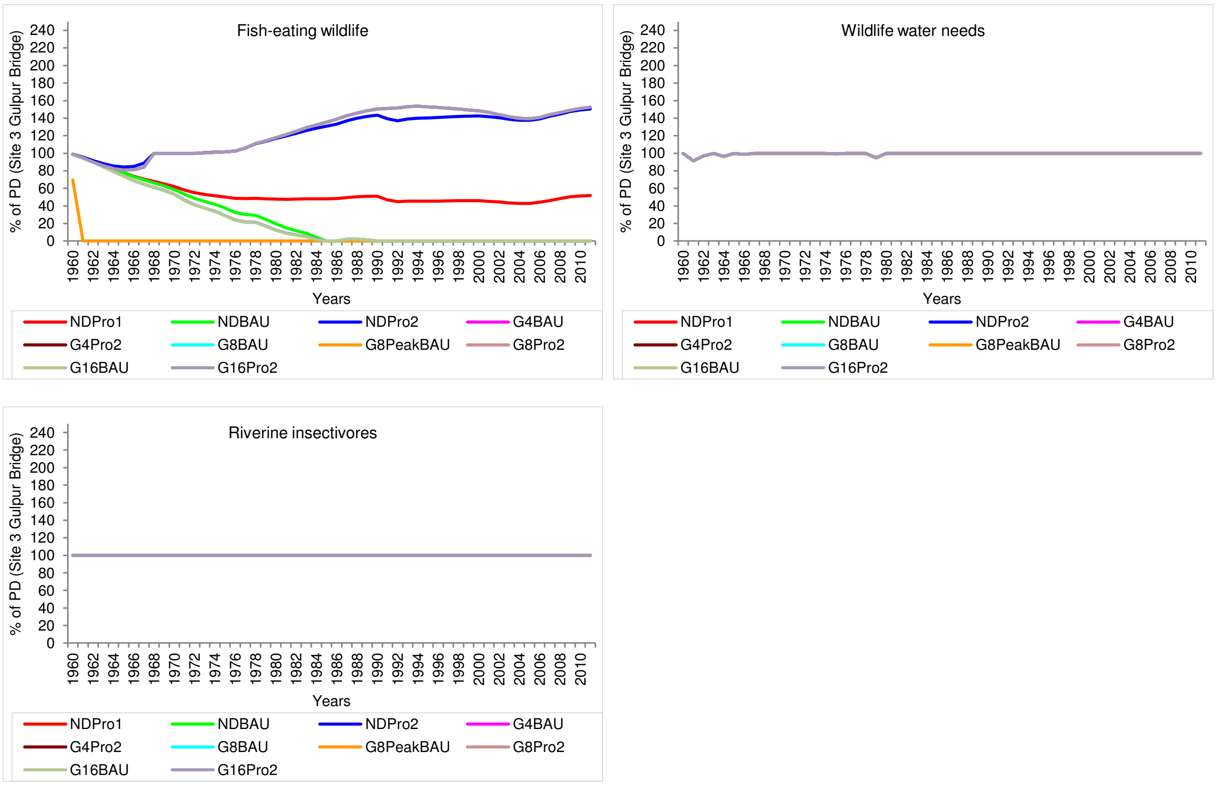

Figure 6.22 Time-series of predicted changes in wildlife indicators at EF Site 3. Scenario lines not visible are hidden by those showing. For wildlife water needs all the scenarios are underneath G16Pro2.

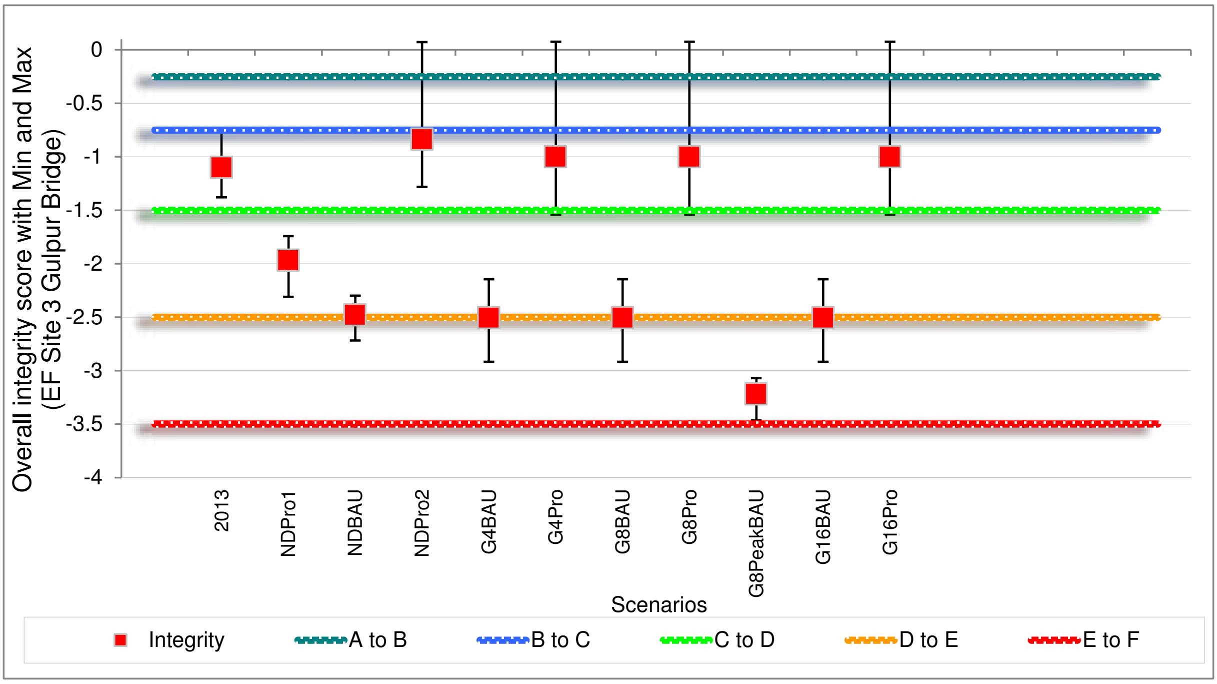

Figure 6.23 Overall ecosystem integrity scores for the scenarios at Gulpur EF Site 3 (Gulpur Bridge). Baseline (2013) integrity is shown on the extreme left.

6.4 *GULPUR EF SITE 4 (BILLIPORIAN BRIDGE)*

EF Site 4 is downstream of EF Site 3 and the Gulpur tailrace. As is the case with EF Site 3, it is mainly affected by flow returning to the river after passing through the power house. The site is also affected by the barrier that the Gulpur weir poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir or tunnel, such as an increase in zooplankton or a decrease in oxygen, but to a slightly lesser extent than is EF Site 3.

6.4.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 4

The main characteristics of the flow regimes at Gulpur EF Site 4 associated with each of the scenarios are summarised in Table 6.7.

Table 6.7 Characteristics of the flow regime of each scenario at Gulpur EF Site 4. Median values are given for the flow indicators.

EF indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration	Dry: Daily Range	Wet Daily Range
Units	**m^3s^{-1}**	**weeks[16]**	**m^3s^{-1}**	**days**	**weeks**	**m^3s^{-1}**	**days**	**m^3s^{-1}**	**m^3s^{-1}**
NDPro1	138.42	40.00	22.06	113.50	7.00	780.04	225.00	n/a	n/a
NDBAU	138.42	40.00	22.06	113.50	7.00	780.04	225.00	n/a	n/a
NDPro2	138.42	40.00	22.06	113.50	7.00	780.04	225.00	n/a	n/a
G4BAU	138.42	40.00	22.06	112.50	6.50	780.04	226.00	n/a	n/a
G4Pro2	138.42	40.00	22.06	112.50	6.50	780.04	226.00	n/a	n/a
G8BAU	138.42	40.00	22.06	112.50	6.50	780.04	226.00	n/a	n/a
G8PeakBAU	138.92	40.00	22.06	112.50	7.00	780.04	225.00	162.82	179.50
G8Pro2	138.42	40.00	22.06	113.00	6.50	780.04	226.00	n/a	n/a
G16BAU	138.42	40.00	22.06	113.50	7.00	780.04	225.00	n/a	n/a
G16Pro2	138.42	40.00	22.06	113.50	6.50	780.04	226.00	n/a	n/a

6.4.2 Mean percentage changes

The mean percentage changes (relative to Baseline) for the indicators for the scenarios at Gulpur EF Site 4 (Billiporian Bridge) are given in Table 6.8. The values provided in Table 6.8 are averages for the last 30 years of the record (1982-2012). This is because the influence of the management options takes c. 5-10 years to take effect, and so early part of the record can be quite different from the middle and later part.

[16] Weeks = calendar weeks

Table 6.8 **Gulpur EF Site 4: The mean percentage changes (relative to Baseline) for the indicators for the scenarios. Light blue = change 10-20%; green = change 20-40%; orange = change 4070%; red = change >70%. Baseline, by definition, equals 100%.**

Discipline	Indicators	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	164Pro2
Geomorphology	Active channel width	-0.6	-0.6	-0.6	0.5	0.5	0.5	0.5	9.4	0.5	0.5
	Area of silt/mixed bars	-3.4	-8.9	0.6	-9.1	0.4	-9.1	0.4	-9.2	-9.1	0.4
	Area of cobble bars	2.3	-15.7	2.0	-41.5	-15.0	-41.5	-15.0	-41.4	-41.5	-15.0
	Median bed sediment size (armouring)	-12.3	-20.0	-5.4	8.8	23.4	8.8	23.4	18.5	8.8	23.4
	Depth of pools	0.9	-10.8	1.2	-20.6	-3.1	-20.6	-3.1	-19.1	-20.6	-3.1
	Area of backwaters	-9.2	-10.1	0.3	-12.5	-2.2	-12.5	-2.2	-11.4	-12.5	-2.2
	Suspended sediment load.	-0.6	-0.6	-0.6	0.5	0.5	0.5	0.5	9.4	0.5	0.5
Water quality	Nutrient concentration	31.6	111.7	14.1	110.4	12.8	110.4	12.8	111.2	110.4	12.8
	Temperature	3.9	3.9	3.9	2.4	2.4	2.4	2.4	3.8	2.4	2.4
Algae	Periphyton biomass	-1.1	10.1	-2.1	8.4	-4.0	8.4	-4.0	-21.0	8.4	-4.0
Riparian vegetation	Dry bank trees and shrubs	-16.6	-30.4	29.3	-30.2	29.5	-30.2	29.5	-30.4	-30.2	29.5
Macroinvertebrates	Simuliidae	-5.6	-10.1	-1.3	0.8	11.6	0.8	11.6	-10.5	0.8	11.6
	EPT biomass	4.0	2.8	-6.5	13.0	6.5	13.0	6.5	-29.3	13.0	6.5
Fish	Pakistani labeo	-62.0	-87.7	55.9	-89.0	59.7	-89.0	59.7	-100.0	-89.0	59.7
	Mahaseer	-53.4	-86.9	55.8	-99.5	0.7	-99.5	0.7	-100.0	-99.5	0.7
	Twin-banded loach	-3.5	-43.4	33.6	6.5	73.2	6.5	73.2	-100.0	6.5	73.2
	Kashmir catfish	-56.0	-71.4	58.5	-47.1	87.8	-47.1	87.8	-100.0	-47.1	87.8
	Garua bachwaa	-42.9	-78.3	43.6	-98.0	22.8	-98.0	22.8	-100.0	-98.0	22.8
Wildlife	Fish-eating wildlife	-58.4	-99.9	33.2	-99.9	39.4	-99.9	39.4	-100.0	-99.9	39.4
	Wildlife that drink from the main river	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riverine insectivores	-1.5	-0.5	-5.3	3.7	-0.5	3.7	-0.5	-57.6	3.7	-0.5

6.4.3 Time-series

The time-series for the scenarios for the biophysical indicators for EF Site 4 are not shown as the patterns of change and the explanations therefore are basically the same as for EF Site 3 (Section 6.3.3).

6.4.4 Overall Integrity

The Overall Integrity for each the scenarios at Gulpur EF Site 4 are illustrated in Figure 6.24.

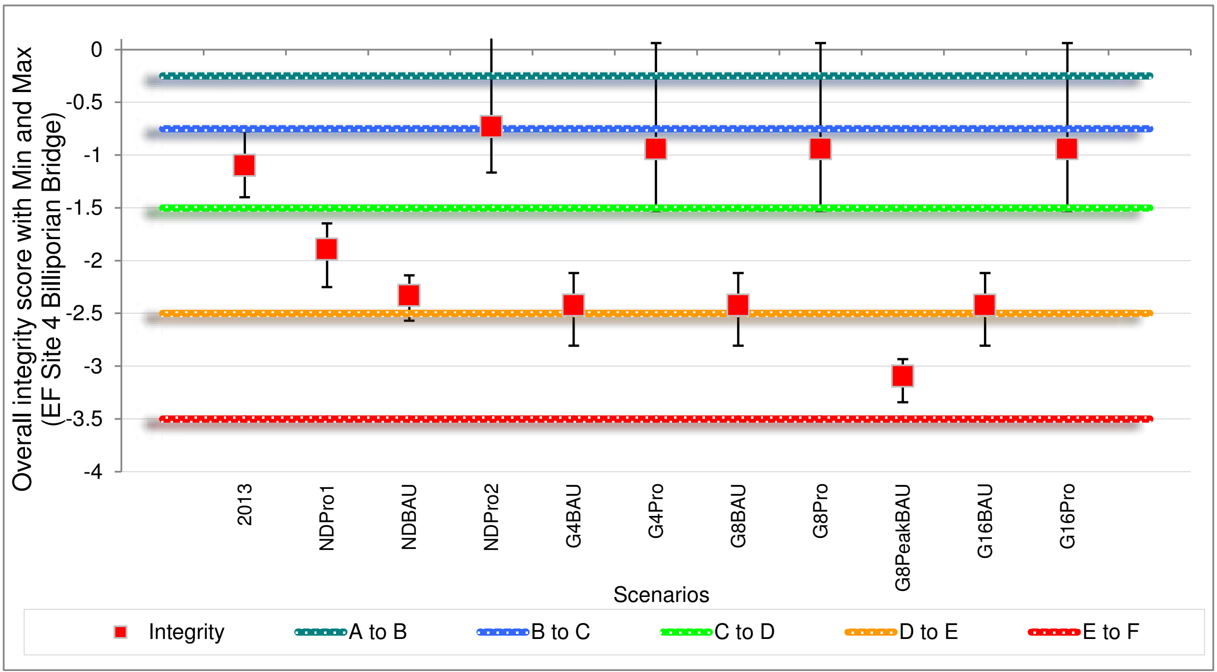

Figure 6.24 Overall ecosystem integrity scores for the scenarios at Gulpur EF Site 4 (Billiporian Bridge). Baseline (2013) integrity is shown on the extreme left.

6.5 *OVERALL INTEGRITY FOR ALL SITES AND ALL SCENARIOS*

The overall integrity scores for all sites and all scenarios are presented in Figure 6.25, which gives an indication of the distribution of impacts on the Poonch River in the study area.

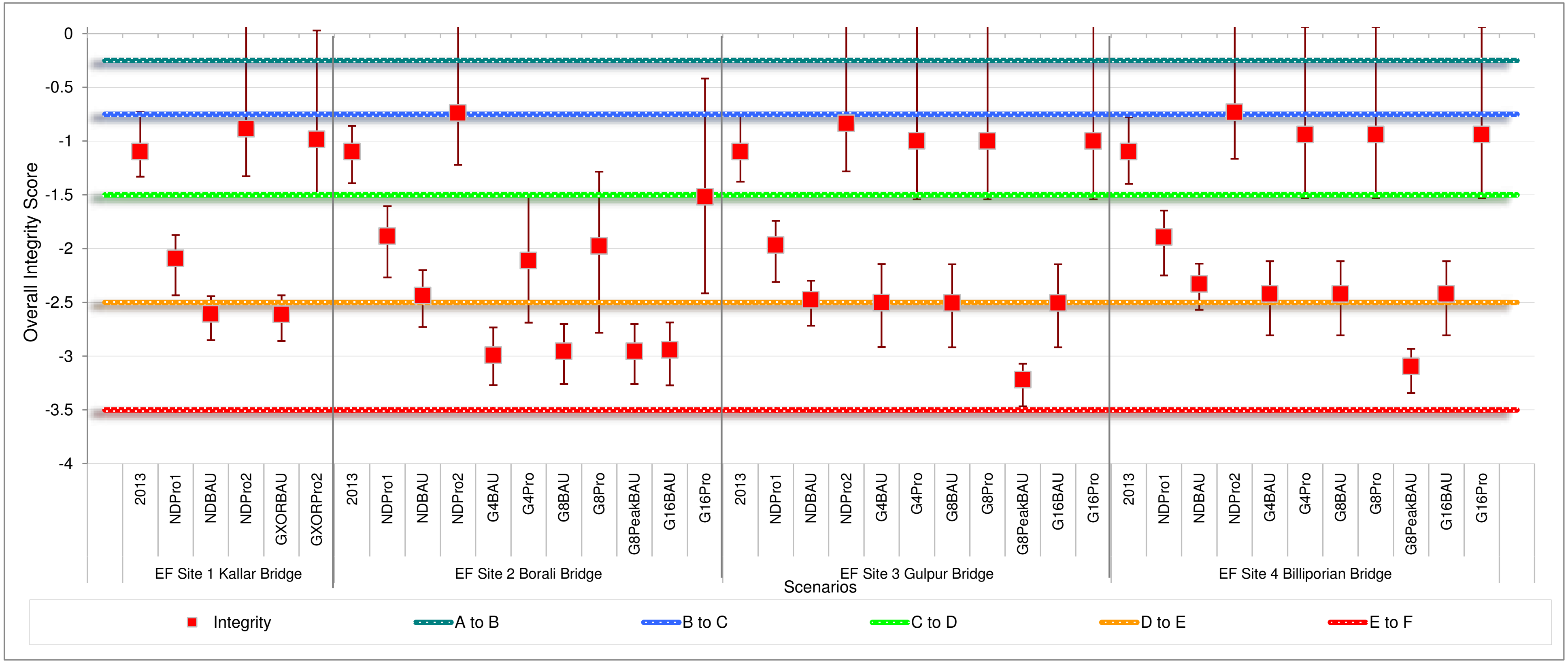

Figure 6.25 Overall integrity scores for all sites and all scenarios. Baseline (2013) integrity is labelled 2013.

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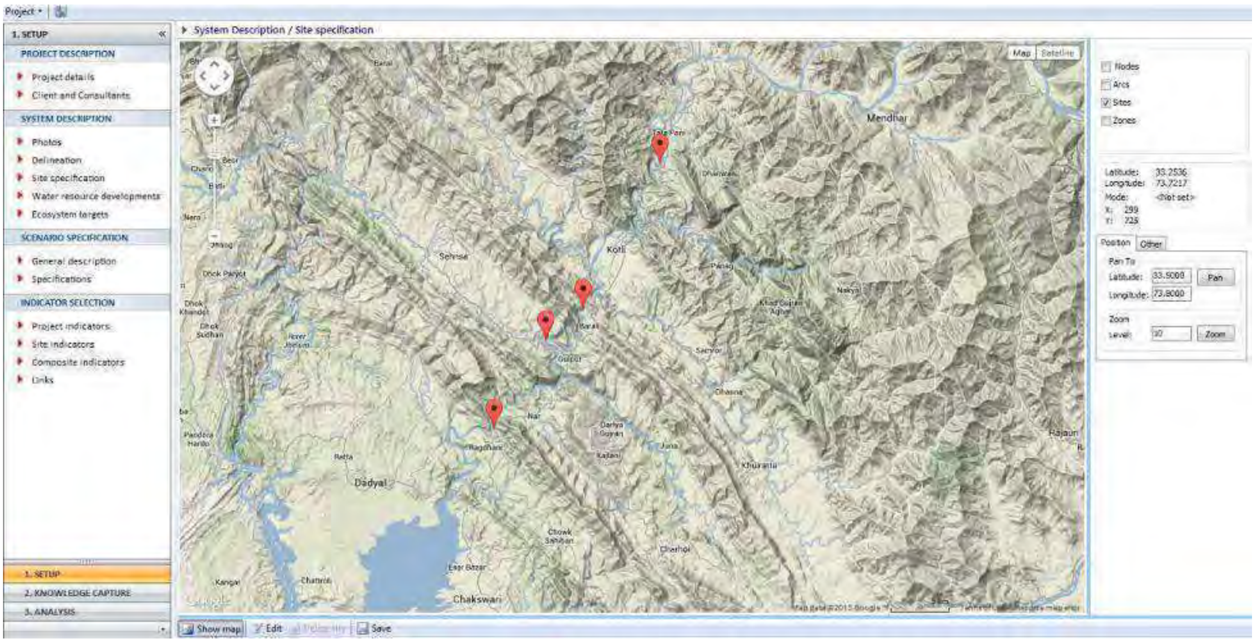
Appendix A. OVERVIEW OF DRIFT

A.1 DRIFT-DSS

The DRIFT-DSS is programmed using Delphi XE and uses a NexusDB v3 database. The software is designed for use in all computers running Windows XP and upwards, and the DSS supports both single-user and multi-user modes.

The DSS makes use of Google Earth (standard version) and Google Kml files (Appendix Figure 1). No licence is required but Google Earth Pro has useful tools to assist in system configuration, and is needed if the Google Earth images are used in any reports.

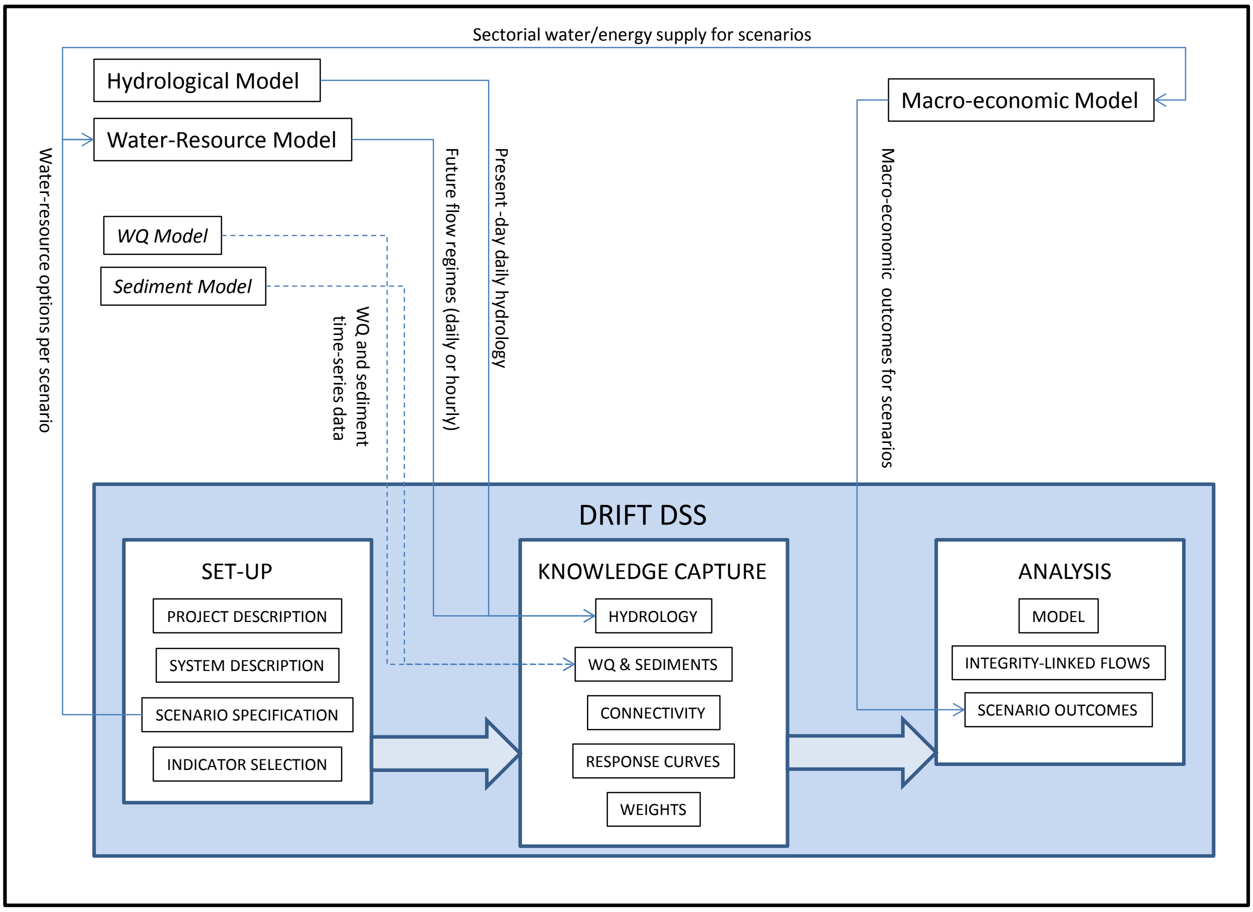


Appendix Figure 1 Screen shot of DRIFT map page showing the Poonch River, and the EF sites.

The DRIFT DSS is divided into three sections, each dealing with a different stage in the EF determination process. These are (Brown *et al*. 2013; Appendix Figure 2):

4. Set-up
5. Knowledge Capture
6. Analysis.

The first two sections deal with the population of the DSS and the calibration of the relationships that will be used to predict the ecosystem response to changes in flows. The third section is used to generate results once the first two sections have been populated, and to produce the reports and graphics detailing the predictions for the scenarios under consideration.



Appendix Figure 2 Arrangement of modules in the DRIFT-DSS and inputs required from external models.

All hydrological modelling is done outside of the DSS. The DSS is dependent on the outputs of two external models, namely:

- an Hydrological Model used to provide baseline basin hydrology; and
- a Water Resource Model used to predict the changes in the flow regime associated with the existing and proposed water-resource developments under the various scenarios.

The module groups in the DRIFT DSS and external models are shown in Appendix Figure 2, and an example of the DRIFT-DSS Response Curves entry datasheet for fish, showing Gulpur HPP data I shown in Appendix Figure 3. Additional detail on the DSS, including a User Manual, is available in Brown *et al.* (2013).

Appendix Figure 3 Example of the DRIFT-DSS Response Curves entry datasheet for fish, showing Gulpur HPP data.

A.2 Summary of DRIFT Process

DRIFT (Downstream Response to Imposed Flow Transformations; King *et al.* 2003) was used to evaluate different water management scenarios for the Poonch River upstream and downstream of Gulpur HPP for, *inter alia*, the following reasons:

1. It is a holistic interactive method, which provides the biophysical consequences for the downstream river for various scenarios of flow change. These scenarios can then be used to determine the impact of proposed operating rules for the dam, and possible mitigation thereof.
2. It is a published method (King *et al*. 2003), with a detailed User Manual (Brown *et al*., 2008), and as such is has been peer reviewed.
3. It has been widely applied in the Southern African Development Community, such as Lesotho (King *et al*. 2003), Mozambique (Beilfuss and Brown, 2010; Southern Waters 2011), Namibia (Southern Waters 2010), Peru (Norconsult and Southern Waters 2011), South Africa (e.g. Brown *et al*., 2006), Tanzania (PBWO/IUCN 2008), Zimbabwe (Brown 2007) and Sudan (Southern Waters 2009). It was used as the basis of a basin-wide EF assessment in the Okavango River Basin (Angola, Namibia and Botswana; King and Brown 2009), and has been used in Pakistan on the Neelum-Jhellum River (Southern Waters and Hagler-Bailly Pakistan 2013).
4. It is based on Response Curves constructed from any relevant knowledge including expert opinion and local wisdom and as such is suitable for use in regions where there are few biophysical data available for the flow-related aspects of the rivers, as was the case for the Poonch River
5. It aims to provide an objective and transparent assessment of the effects of changes in flow on the downstream environment based solely on structured consideration of the biophysical aspects thereof.

DRIFT is a data-management tool, allowing data and knowledge to be used to their best advantage in a structured way. Within DRIFT, each specialist, to derive the links between river flow and river condition, uses discipline-specific methods. The central rationale of DRIFT is that different aspects of the flow regime of a river elicit different responses from the riverine ecosystem. Thus, removal of part or all of a particular element of the flow regime will affect the riverine ecosystem differently than will removal of some other element.

In DRIFT, the long-term daily-flow time-series is partitioned into parts of the flow regime that are thought to play different roles in sculpting and maintaining the river ecosystem, such as the onset of important flow seasons, which may affect breeding cycles, or the magnitude of the annual flood, which may inundate a floodplain. This makes it easier for ecologists to predict how changes in the flow regime could affect the ecosystem. The 'parts' of the flow regime used in DRIFT are called flow indicators. In this project, these were (see **Table 3.1.**):

- Seasonal/daily variations
    - Mean annual runoff
    - Dry season onset
    - Dry season minimum 5-day discharge
    - Dry season duration
    - Dry season average daily volume
    - Wet season onset
    - Wet season minimum 5-day discharge
    - Wet season duration
    - Wet season flood volume
    - Transition 1 average daily volume
    - Transition 2 average daily volume
    - Transition 2 recession shape
- Hourly variations (required for sites downstream of the tailrace, which releases flows resulting from peak power generation):
    - Dry season within day range in discharge
    - Dry season maximum instantaneous discharge
    - Dry season minimum instantaneous discharge
    - Wet season within day range in discharge
    - Wet season maximum instantaneous discharge
    - Wet season minimum instantaneous discharge
    - Transition 1 within day range in discharge
    - Transition 1 maximum instantaneous discharge
    - Transition 1 minimum instantaneous discharge
    - Transition 2 within day range in discharge
    - Transition 2 maximum instantaneous discharge
    - Transition 2 minimum instantaneous discharge.

The variability of the flow regime in timing and magnitude, both in its natural state and in any future scenario, was captured automatically through instructions within the hydrological module of the DSS that identify the flow indicators year-by-year. Thus, for the Poonch River, the time-series are made up of annual time-series of each flow indicator for the 50 years of flow record. This means the specialists can consider a response to a condition for a particular time-step rather than thinking of an averaged response over several years. They can also use data from a particular year or season to calibrate time-series responses.

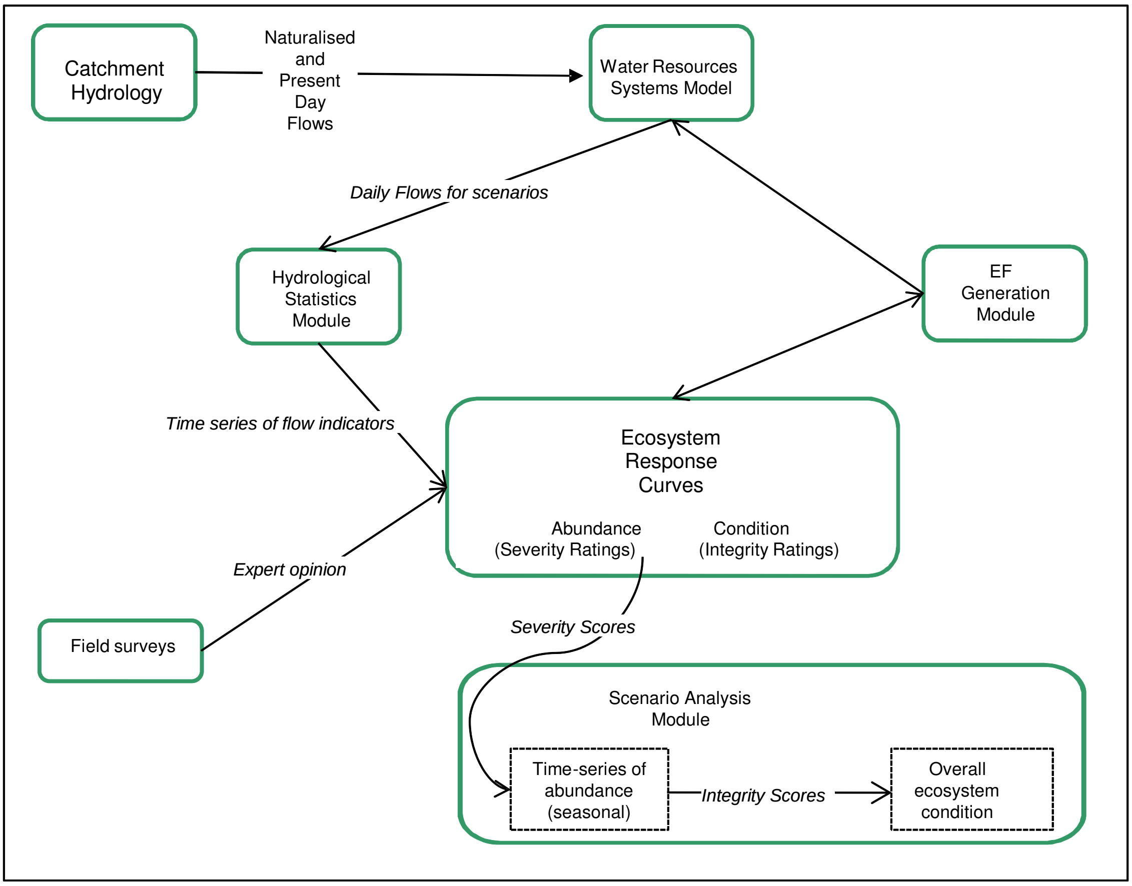
The study process was structured as follows:

1. The study focused on four EF sites on the Poonch River (Figure 2.1).
2. The flow changes that were evaluated encompass a mixture of:
    i. Changes in magnitude.
    ii. Changes in duration.
    iii. Changes in timing (e.g., delayed onset of wet season or range of hourly discharge fluctuations).
3. Specialists provided opinion on the consequences of these changes in the form of Response Curves. The disciplines represented were:
    i. Water quality
    ii. Hydraulics
    iii. Geomorphology
    iv. Algae
    v. Riparian vegetation
    vi. Invertebrates
    vii. Fish
    viii. Socioeconomics.
4. The database was used to evaluate
    i. changes in individual aspects of the ecosystem (e.g. fish, vegetation), for each site and scenario;
    ii. changes in the overall condition of the river, for each site and scenario.
5. The outputs of the DRIFT database are written up in Sections 6 and 7.

The basic sequence of activities in the DRIFT DSS can be summarised as follows (Appendix Figure 4):

1. Collect data for the study at the river.
2. Augment with expert knowledge for similar river systems and a global understanding of river functioning.
3. Construct relationships for the expected response of individual ecosystem indicators to changes in aspects of the flow regime (Response Curves).
4. Use Response Curves to predict time-series of abundance changes.
5. Adjust the severity ratings to integrity ratings by assigning a negative sign for a move away from the natural ecosystem condition and a positive for a move towards natural.
6. Model future changes in catchment hydrology.

7. Calculate annual flow indicator time-series.
8. Use Response curves to calculate severity scores and develop time-series of change in abundance for ecosystem indicators.
9. Calculate average severity score for each indicator for entire hydrological time-series.
10. Convert severity scores to Integrity Scores to predict overall ecological condition.



Appendix Figure 4 **Flow chart of DRIFT process**

A.1. RESPONSE CURVES[17]

Response Curves depict the relationship between a biophysical or socio-economic indicator and a driving variable (e.g., flow). In this EF assessment, Response Curves linked an indicator to any other indicator deemed to be driving change. The aim is not to ensure that every conceivable link is captured but rather to restrict the linkages to those that are most meaningful and can be used to predict the bulk of the likely responses to a change in the flow or sediment regimes of the river.

Response curves are constructed using severity ratings (Section A.2).

The full set of Response Curves for this study is shown in Appendix B.

[17] The bulk of this section is taken from Joubert *et al*., 2009.

The number of Response Curves constructed for an EF assessment depends on the level of detail at which a flow assessment is done. In this assessment, the specialists collectively completed Response Curves for EFs Site 2. These were used to evaluate scenarios by taking the value of the flow indicator for any one scenario and reading off the resultant value for the biophysical indicators from their respective Response Curves. Once this had been done the database combined these values to predict the overall change in each biophysical indicator and in the overall ecosystem under each scenario.

A.1.1. CONSTRUCTION OF THE RESPONSE CURVES

The Response Curves used in this project were constructed as follows:

- Draft curves constructed at a workshop in Islamabad attended by Southern Waters and Hagler-Bailly Pakistan team members.
- Draft curves re-evaluated by Southern Waters once the scenarios has been run, and adjusted where deemed necessary.
- Draft curves re-evaluated by Hagler-Bailly Pakistan using these scenarios as reference, and adjusted where deemed necessary.
- Final curves agreed on by Hagler-Bailly Pakistan and Southern Waters.

Note: The final curves and explanations for their shape are contained in the DRIFT DSS, and addressed in Appendices B and C.

A.1.2. RESPONSE CURVES AND CUMULATIVE CHANGE

The time-series approach means that the Response Curves are used to predict the likely seasonal change in an ecosystem indicator in response to the flow/sediment conditions experienced in that, or possibly preceding, seasons. For instance, the kind of question typically asked to facilitate setting the dry season discharge Response Curve for Kashmir catfish are:

- "If the dry season discharge declines from baseline values, what will be the consequences for the abundance of Kashmir catfish?":
  - Do Kashmir catfish use the main river in the dry season?
  - Do Kashmir catfish abundances change noticeably over the climatic range covered in the baseline, i.e., are they noticeably more abundant in wet years than in dry years, or vice versa?
  - What kinds of habitat do adult Kashmir catfish use in the main river?
  - Do Kashmir catfish breed in the dry season?
  - Do they breed in the main river or in the tributaries?
  - Where do Kashmir catfish lay their eggs?
  - What sorts of habitat do fry, fingerlings and juvenile trout use in the main river?
  - At what discharge(s) does the favoured habitat(s) disappear?
  - What is the consequence of these habitats not being available for one season?
  - If discharge reaches zero for one season, are there pools that the trout will be able to survive in?

- Can the Kashmir catfish survive for a dry season in pools?
- Is water temperature a concern, i.e., would winter temperature be an issue for Kashmir catfish if discharge dropped?
- What do Kashmir catfish adults/juveniles/fingerlings/fry eat?
- How will the food base be affected by changes in dry season lowflows?
- Etc.

Often, a species (such as Kashmir catfish will be expected to survive even an extremely-dry dry season, with possibly only minor changes (5-10%) in overall abundance if dry season flows drop to zero. If, however, the flows drop to this level in the dry season year after year, then the cumulative effect on trout populations is likely to be far greater. The time-series enable the DSS to capture this cumulative effect.

A.2. SCORING SYSTEM USED

Into the foreseeable future, predictions of river change will be based on limited knowledge. Most river scientists, particularly when using sparse data, are thus reluctant to quantify predictions: it is relatively easy to predict the nature and direction of ecosystem change, but more difficult to predict its timing and intensity. To calculate the implications of loss of resources to subsistence and other users in order to facilitate discussion and tradeoffs, it is nevertheless necessary to quantify these predictions as accurately as possible.

Two types of information are generated for each biophysical indicator, *viz*.:

- Severity ratings, which describe increase/decreases for an indicator in response to changes in the flow indicators, and;
- Integrity ratings, which indicate whether the predicted change is a move towards or away from natural, i.e., how the change influences overall ecosystem condition.

The severity ratings are used to construct the Response Curves. The Integrity ratings are used to describe overall ecosystem condition/health.

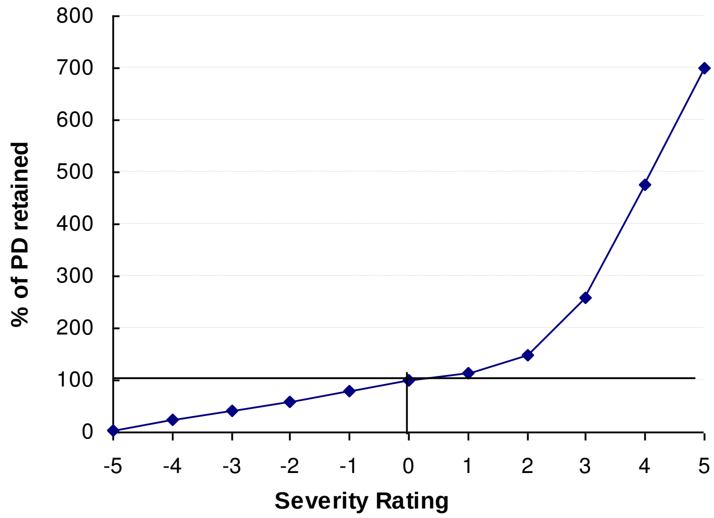
A.2.1. SEVERITY RATINGS

The severity ratings comprise 11-point scale of -5 (large reduction) to +5 (very large change; Brown *et al*., 2008; Appendix Table 1), where the + or – denotes an increase or decrease in abundance or extent. These ratings are converted to percentages using the relationships provided in Appendix Table 1. The scale accommodates uncertainty, as each rating encompasses a range of percentages; however, greater uncertainty can also be expressed through providing a range of severity ratings (i.e. a range of ranges) for any one predicted change (after King *et al*., 2003).

Appendix Table 1 **DRIFT severity ratings and their associated abundances and losses – a negative score means a loss in abundance relative to baseline, a positive means a gain.**

Severity rating	Severity	% abundance change
5	Critically severe	501% gain to ∞ up to pest proportions
4	Severe	251-500% gain
3	Moderate	68-250% gain
2	Low	26-67% gain
1	Negligible	1-25% gain
0	**None**	**no change**
-1	Negligible	80-100% retained
-2	Low	60-79% retained
-3	Moderate	40-59% retained
-4	Severe	20-39% retained
-5	Critically severe	0-19% retained includes local extinction

Note that the percentages applied to severity ratings associated with gains in abundance are strongly non-linear[18] and that negative and positive percentage changes are not symmetrical (Appendix Figure 5; King *et al*. 2003).



Appendix Figure 5 **The relationship between severity ratings (and severity scores) and percentage abundance lost or retained as used in DRIFT and adopted for the DSS. (PD=present day AND = 100%).**

For each year of hydrological record, and for each ecosystem indicator, the severity rating corresponding to the value of a flow indicator is read off its Response Curve. The severity ratings for each flow indicator are then combined to produce a severity score, which provides an indication of how abundance, area or concentration of an indicator is expected to change under the given flow conditions in each year, relative to the changes that would have been expected under baseline conditions in the catchment.

18 The non-linearity is necessary because the scores have to be able to show that a critically-severe loss equates to local extinction whilst a critically severe gain equates to proliferation to pest proportions.

A.2.2. INTEGRITY RATINGS

Integrity ratings use the absolute value of between 0 and 5 provided for the severity scores but include a negative or positive sign, depending on whether the change in abundance predicted by the severity score represents a shift to/away from naturalness, *viz*. (Brown and Joubert 2003):

- *toward natural* ecosystem condition is represented by a positive integrity rating; and
- *away from natural* ecosystem condition is represented by a negative integrity rating.

The integrity ratings are calculated using the average severity score for each ecosystem indicator over the entire hydrological time-series. The integrity ratings for each indicator are then combined to provide an Overall Integrity Score, which is used to place a flow scenario within a classification of overall river condition, using the South African eco-classification categories A to F (Appendix Table 2; Kleynhans 1996; Kleynhans 1999; Brown and Joubert 2003). The ecological condition of a river is defined as its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on a temporal and spatial scale that are comparable to the natural

Appendix Table 2 Definitions of the Present Ecological State (PES) categories (after Kleynhans 1996).

Ecological category	Description of the habitat
A	Unmodified. Still in a natural condition.
B	Slightly modified. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically / Extremely modified. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

characteristics of ecosystems of the region. For instance, if the present ecological status (PES) of a river is a B-category, a scenario that yields a negative Integrity Score would represent movement in the direction of a category C-F, whilst one with a positive score would indicate movement toward a category A, as follows:

If the Overall Integrity Score is positive, this denotes a move toward natural, i.e. restoration initiatives:

- ≤1 or ≥-1, the ecological condition will remain within the same category as present day/baseline;
- >1 and ≤2, the ecological condition will move one category closer to natural;
- >2 and ≤3, the ecological condition will move two categories closer to natural;
- Etc.

If the Overall Integrity Score is negative, this denotes a move away from natural:

- ≥-1, the ecological condition will remain within the same category as present day;
- <1 and ≥ 2, the ecological condition will move one category further away from natural;
- <2 and ≥ 3, the ecological condition will move two categories further away from natural;
- Etc.

Note : In South Africa, the D-category is considered to represent the lower limit of degradation allowable under sustainable development (e.g., Dollar et al. 2006; Dollar *et al*. 2010).

Overall Integrity Scores are calculated for the ecosystem as a whole, i.e., the combined effect of changes in the indicators. The results can be plotted as Overall Integrity Score (y-axis) vs. percentage or volume of MAR (x-axis) or, where there are relatively few points as in this project, simply as a plot of Overall Integrity Scores per site, which allows for easy comparison between sites. The categories actually represent points along a continuum, thus the 'divisions' between the categories are only guides as to the general position at which the ecological condition might be expected to shift from one category to the next. Furthermore, the rules for the integrity categories were developed on rivers outside of Kashmir, and have not been tested on Kashmir rivers. They provide an indication of the relative categories associated with each scenario and should not be misconstrued as an absolute prediction of future condition.

A.3. IDENTIFICATION OF ECOLOGICALLY-RELEVANT ELEMENTS OF THE FLOW REGIME

One of the main assumptions underlying the DRIFT EFs process is that it is possible to identify ecologically-relevant elements of the flow regime and isolate them within the historical hydrological record. Thus, one of the first steps in the DRIFT process is to identify the ecologically-important flow indicators, which are calculated per season for each year. The rules and thresholds for defining the seasons on the Poonch River are given in Section Table 5.1**.**, and the list of flow indicators calculated for Gulpur HPP are provided in Table 3.1.

A.4. MAJOR ASSUMPTIONS AND LIMITATIONS OF DRIFT

Predicting the effect of flow changes on rivers is difficult because the actual trajectory and magnitude of the change is additionally dependent on so many other variables, such as climate, sediment supply and human use of the system. Thus, several assumptions underlie the predictions. Should any of these assumptions prove to be invalid, the actual changes may not match the predicted changes. This does not necessarily make the predictions themselves incorrect or invalid, but simply means that the surrounding set of circumstances that support the predictions has changed.

The following important major assumptions apply:

- The baseline hydrology closely approximates the actual flow conditions in the river over the period of record.
- Different parts of the flow regime sustain the river ecosystem in different ways. Changing one part of the flow regime will change the river in a different way than will changing another part.
- It is possible to identify ecologically-relevant elements of the flow regime and isolate them within the historical hydrological record (see Section A.3)
- Measure flows in the Poonch River were used as the baseline flow for predicting change, and change was expressed as a percentage move towards or away from the 2013.
- Changes include flow and non-flow related changes.
- Three of the scenarios: NDBAU, NDPro1 and NDPro 2 do not include any flow changes associated with Gulpur HPP, and only include predictions of ecosystem condition expected after 52 years with different levels of non-flow anthropogenic pressure on the system.
- Predicted changes in ecological status are relative to the baseline ecological state (2013).
- Predictions are based on a 52-year horizon.

The main limitation is the paucity of data. This is a universal problem, as ecosystems are complex and we will probably never have complete certainty of their present and possible future characteristics. Instead it is essential to push ahead cautiously and aid decision-making, using best available information. The alternative is that water resource development decisions are made without consideration of the consequences for the supporting ecosystems, eventually probably making management of sustainability impossible. Data paucity is addressed in the DRIFT process by accessing every kind of knowledge available - general scientific understanding, international scientific literature, local wisdom and specific data from the river under consideration or from similar ones – and capturing these in a structured process that is transparent, with the DSS inputs and outputs checked and approved at every step. The Response Curves used (and the reasoning used to construct them) are available for scrutiny within the DSS and they, as well as the DRIFT DSS, can be updated as new information becomes available.

A second aspect of the paucity of data is that it is neither known what the river was like in its pristine condition nor exactly how abundant each ecosystem aspect (sand bars, fish, etc.) was then or is now. To address this, all DRIFT predictions are made relative to the baseline situation (there will be a little more, or a lot less, than today, and so on), as explained further below.

These inherent uncertainties also mean that the trends and relative position of the scenarios are more reliable predictors of the impacts of the scenarios than are their absolute values. Also, DRIFT is designed to predict overall condition, and focusing on one indicator to the exclusion of others is not recommended.

A.5. REFERENCES

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Appendix B: Response Curves

B.1 Water Quality Response-curve Explanations

The explanations of the Response Curves are tabulated as **Exhibit B.1**. Concentration of nutrients the river**.**

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

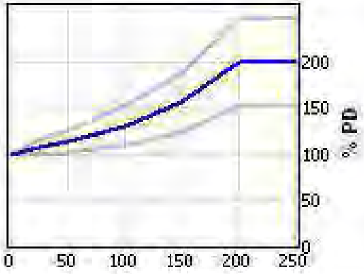
Exhibit B.1: Concentration of Nutrients the River

Concentration of nutrients the river

Response curve	*Explanation*
Eutrophication [D season]	Eutrophication is defined as the excessive richness of nutrients in a water body due to run-off from land, which results in excessive plant and algal growth in the water. An excessive concentration of nutrients in water and eutrophication are directly related because richness of nutrients in river water promotes excessive growth of aquatic vegetation and algae leading towards eutrophication and deteriorating quality of the water bodies.
Flood volume [F season]	The concentration of nutrients in the river decrease as the flood volume increases because flooding causes dilution in the river water, resulting in lower concentration of nutrients.

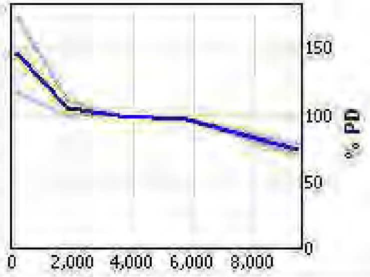
Eutrophication [D season]

Desc	%2013	Y
Min	0.00	0.000
MinPD	25.00	0.500
	50.00	1.000
Median	100.00	1.700
	150.00	2.200
Max PD	200.00	2.700
Max	250.00	2.700



Flood volume [F season]

Desc	Mm3	Y
Min	0.00	2.000
MinPD	105.67	2.000
	1781.81	0.200
Median	3457.95	0.000
	5775.57	-0.200
Max PD	8093.19	-1.000
Max	9472.19	-1.500



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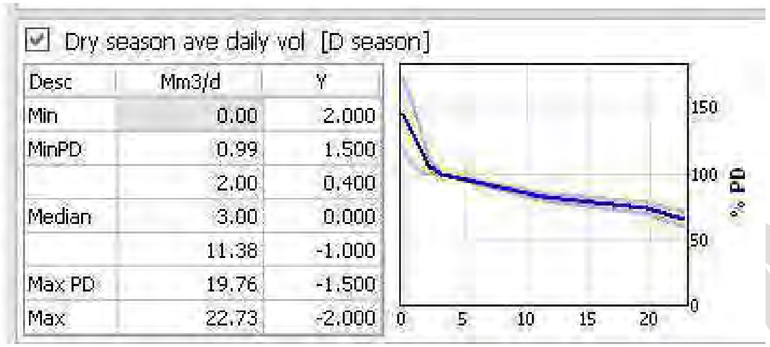
Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

Jafari, N. and Alavi. S.S. 2010. *Phytoplankton community in relation to physico-chemical characteristics of the Talar River, Iran*.Journal of Applied Sciences and Environmental Management.14 (2) 51 - 56. (ISI).

Concentration of nutrients the river

Response curve	*Explanation*



Desc	Mm3/d	Y
Min	0.00	2.000
MinPD	0.99	1.500
	2.00	0.400
Median	3.00	0.000
	11.38	-1.000
Max PD	19.76	-1.500
Max	22.73	-2.000

With an increase in average daily volume of the river, the nutrient concentration decreases due to dilution of the river water.

References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

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B.2 Temperature Response-curve Explanations

The explanations of the Response Curves are tabulated as **Exhibit B.2** Temperature

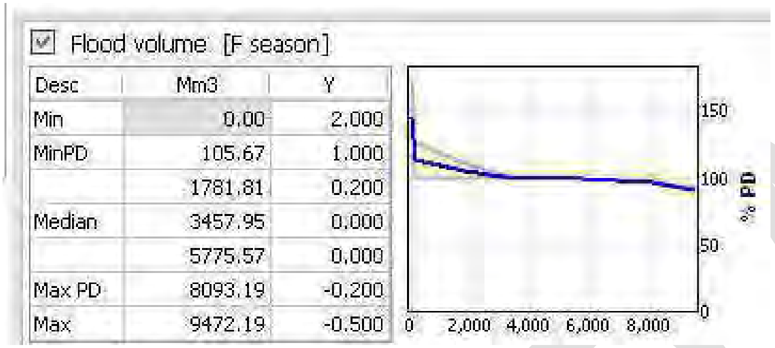
NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

Exhibit B.2: Temperature

Temperature

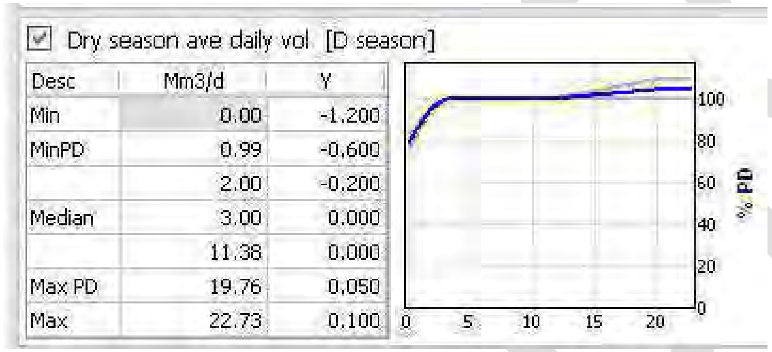
Response curve	*Explanation*



Flood volume [F season]

Desc	Mm3	Y
Min	0.00	2.000
MinPD	105.67	1.000
	1781.81	0.200
Median	3457.95	0.000
	5775.57	0.000
Max PD	8093.19	-0.200
Max	9472.19	-0.500

Temperature follows an almost constant trend with respect to flood volume. However, when the river experiences scant water conditions, the surface heats up faster and temperature rises sharply due to thermodynamic effects.



Dry season ave daily vol [D season]

Desc	Mm3/d	Y
Min	0.00	-1.200
MinPD	0.99	-0.600
	2.00	-0.200
Median	3.00	0.000
	11.38	0.000
Max PD	19.76	0.050
Max	22.73	0.100

Temperature remains constant as the average daily volume of the river in dry season, increases. The temperature drops in low flow conditions because the lower ambient temperatures in winter dominate.

References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

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B.3 Algae Response-curve Explanations

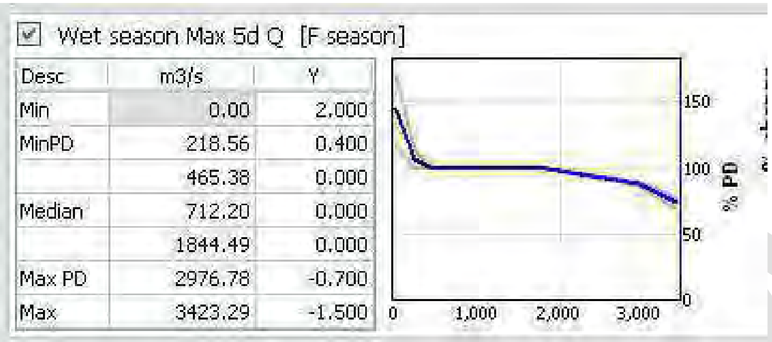
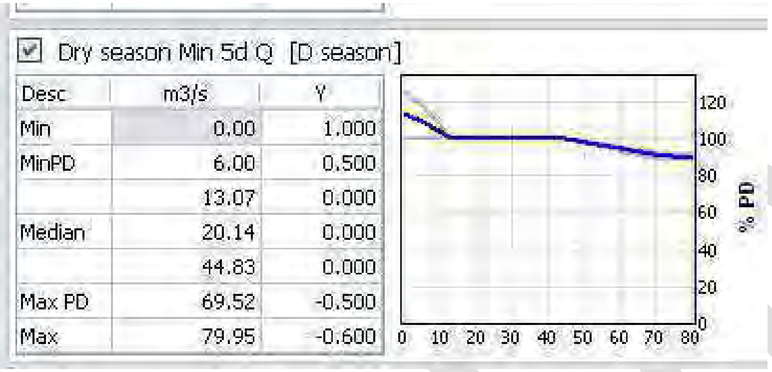
The explanations of the Response Curves are tabulated as **Exhibit B.3** Periphyton Biomass.

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

Exhibit B.3: Periphyton Biomass

Periphyton biomass

Response curve	*Explanation*
	The periphyton biomass in the river is high when flow rate is low. As the flow rate increases, periphyton is destroyed and washed off of rocks, where it grows naturally.
	In the dry season, the trend is similar to the wet season with periphyton biomass decreasing as flow rate increases. Periphyton is destroyed by higher flow rates. With low flows, shearing pressure of water decreases and more and more periphyton is attached to these stones. Moreover, the light penetrates throughout the depth of water column and the photosynthetic process is enhanced leading to an excessive growth of attached algae.

Wet season Max 5d Q [F season]

Desc	m3/s	Y
Min	0.00	2.000
MinPD	218.56	0.400
	465.38	0.000
Median	712.20	0.000
	1844.49	0.000
Max PD	2976.78	-0.700
Max	3423.29	-1.500

Dry season Min 5d Q [D season]

Desc	m3/s	Y
Min	0.00	1.000
MinPD	6.00	0.500
	13.07	0.000
Median	20.14	0.000
	44.83	0.000
Max PD	69.52	-0.500
Max	79.95	-0.600

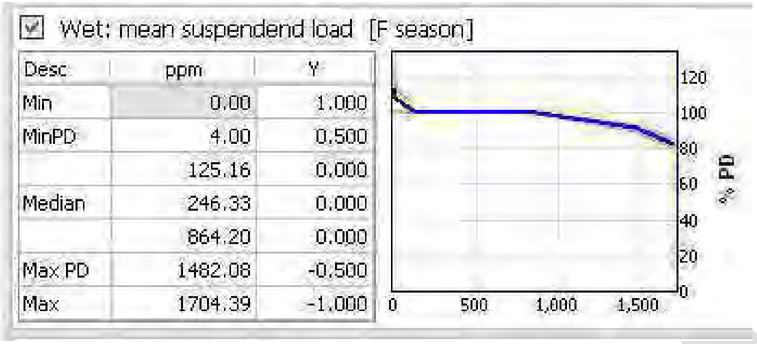
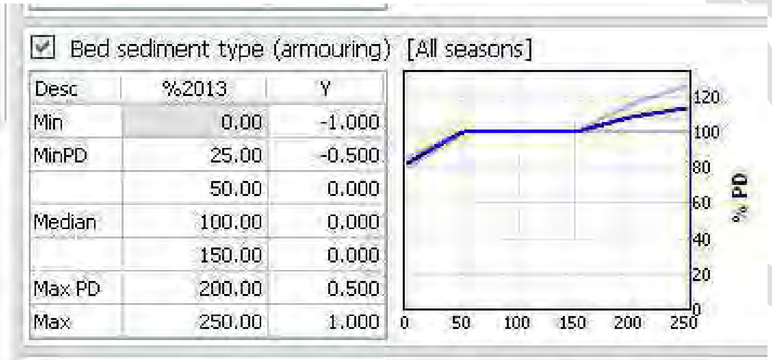
References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

Jafari, N. and Alavi. S.S. 2010. *Phytoplankton community in relation to physico-chemical characteristics of the Talar River, Iran*.Journal of Applied Sciences and Environmental Management.14 (2) 51 - 56. (ISI).

Periphyton biomass

Response curve	*Explanation*
	As the mean suspended load increases, light penetration in the river is almost zero and photosynthetic activity comes to an end resulting in a decrease in the periphyton productivity. As the suspended load decreases more and more light penetrates in the water column enhancing the production of attached algae adding into periphyton productivity.
	River bed armouring refers to large sediments on the river bed. This layer of rocks provide habitat for the growth of periphyton. As a result, Periphyton biomass increases with an increase in armouring of the bed sediment.

Desc	ppm	Y
Min	0.00	1.000
MinPD	4.00	0.500
	125.16	0.000
Median	246.33	0.000
	864.20	0.000
Max PD	1482.08	-0.500
Max	1704.39	-1.000

Desc	%2013	Y
Min	0.00	-1.000
MinPD	25.00	-0.500
	50.00	0.000
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	0.500
Max	250.00	1.000

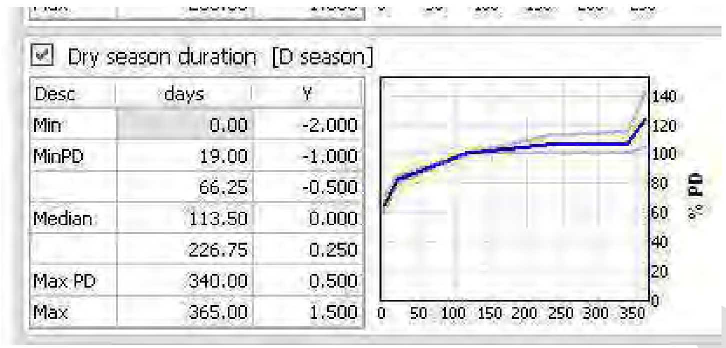
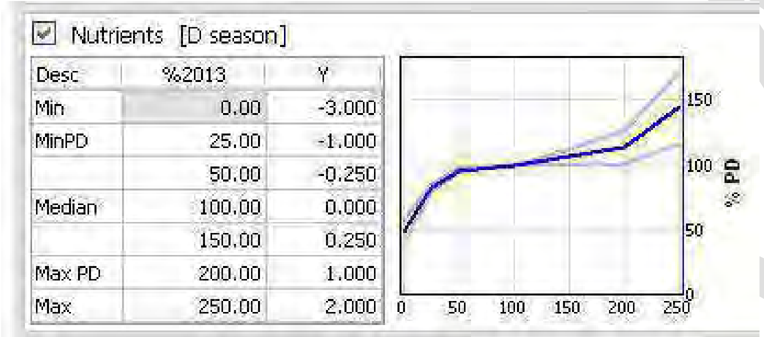
References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

Jafari, N. and Alavi. S.S. 2010. *Phytoplankton community in relation to physico-chemical characteristics of the Talar River, Iran*.Journal of Applied Sciences and Environmental Management.14 (2) 51 - 56. (ISI).

Periphyton biomass

Response curve	*Explanation*
	The flow is relatively lower in the dry season, shearing pressure of the flow is reduces and stones and cobbles in the river bed are exposed to sunlight, all resulting into an increase in the periphyton productivity. Longer dry season will favour more productivity of the periphyton and vice versa.
	Nutrients are higher in concentration in the dry season and act as one of the raw material for growth of Periphyton. Increase in concentration of nutrients means greater Periphyton biomass in the river.

References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

Jafari, N. and Alavi. S.S. 2010. *Phytoplankton community in relation to physico-chemical characteristics of the Talar River, Iran*.Journal of Applied Sciences and Environmental Management.14 (2) 51 - 56. (ISI).

B.4 Riparian Vegetation Response-curve Explanations

The explanations of the Response Curves are tabulated as follows **Exhibit B.4** Dry Bank Trees and Shrubs.

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

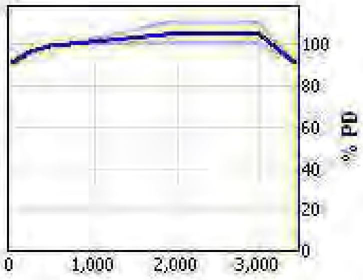
Exhibit B.4: Dry Bank Trees and Shrubs

Periphyton biomass

Response curve	*Explanation*

☑ Wet season Max 5d Q [F season]

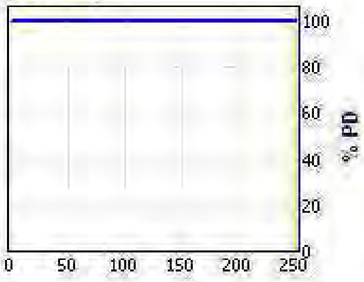
Desc	m3/s	Y
Min	0.00	-0.500
MinPD	218.56	-0.200
	465.38	-0.005
Median	712.20	0.000
	1844.49	0.100
Max PD	2976.78	0.200
Max	3423.29	-0.500



Dry bank trees and shrubs require some high flows to sustain them and to prevent terrestrialisation of the ripatian area. However, very high flow uproot trees and shrubs.

☑ Mining - cobble and boulder [All seasons]

Desc	%2013	Y
Min	0.00	0.000
MinPD	25.00	-0.001
	50.00	-0.003
Median	100.00	-0.005
	150.00	-0.008
Max PD	200.00	-0.012
Max	250.00	-0.012



Damage associated with clearance of the bank for mining and making roads for the tractors. This is not expected to be major as mining is localised in the reach.

References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

Jafari, N. and Alavi. S.S. 2010. *Phytoplankton community in relation to physico-chemical characteristics of the Talar River, Iran*.Journal of Applied Sciences and Environmental Management.14 (2) 51 - 56. (ISI).

Periphyton biomass

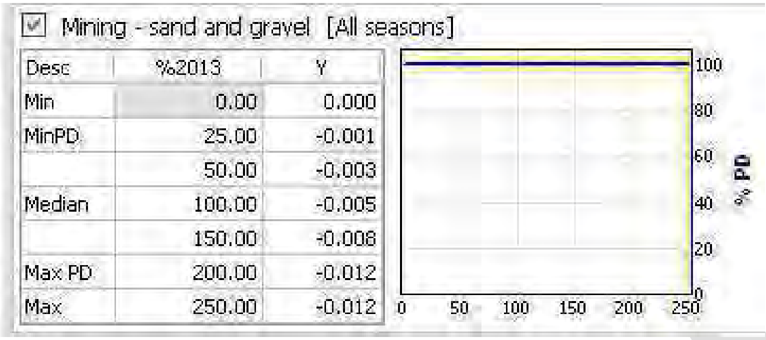
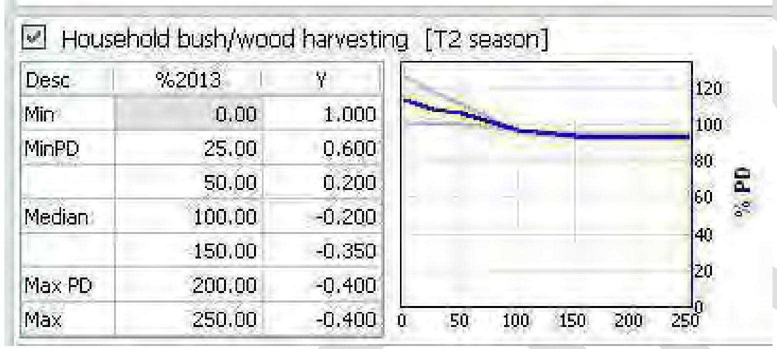
Response curve	*Explanation*
	Damage associated with clearance of the bank for mining and making roads for the tractors. This is not expected to be major as mining is localised in the reach.
	Due to harvesting of wood and vegetation along the river bank for domestic and commercial purposes, the dry bank trees and shrubs reduce in numbers.

Image 1: Mining - sand and gravel [All seasons]

Desc	%2013	Y
Min	0.00	0.000
MinPD	25.00	-0.001
	50.00	-0.003
Median	100.00	-0.005
	150.00	-0.008
Max PD	200.00	-0.012
Max	250.00	-0.012

Image 2: Household bush/wood harvesting [T2 season]

Desc	%2013	Y
Min	0.00	1.000
MinPD	25.00	0.600
	50.00	0.200
Median	100.00	-0.200
	150.00	-0.350
Max PD	200.00	-0.400
Max	250.00	-0.400

References

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Jafari ,A. and Hosseinzadeh Colagar, A.. 2010. *Ecological investigation of phytoplankton and their correlated to environmental variables*. International Journal on Algae. 12 (2):169-184.(ISI).

Jafari, N. and Alavi. S.S. 2010. *Phytoplankton community in relation to physico-chemical characteristics of the Talar River, Iran*.Journal of Applied Sciences and Environmental Management.14 (2) 51 - 56. (ISI).

B.5 Macroinvertebrate Response-curve Explanations

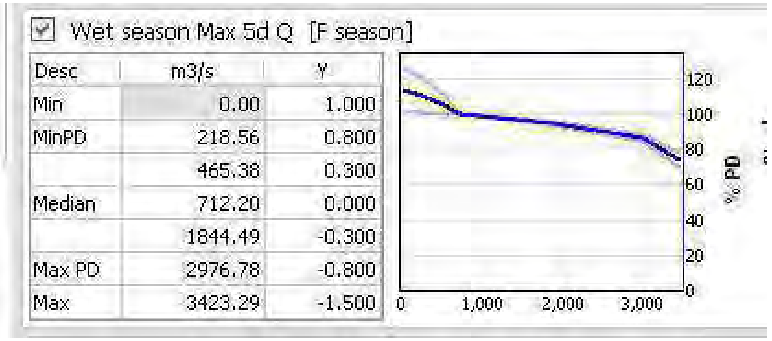
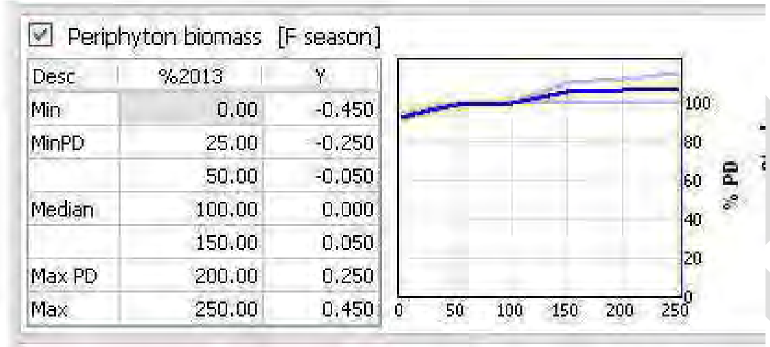
The explanations of the Response Curves are tabulated as **Exhibit B.5** Simuliidae and **Exhibit B.6** EPT abundance.

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

Exhibit B.5: Simuliidae

Simuliidae

Response curve	*Explanation*
	Prefer areas of moderate currents and attach to hard substrata. Simuliidae larvae feed on suspended food particles, These food resources are washed away under heavy flow conditions causing a decline in the population of Simuliidae. Moreover, simulidae larvae are attached to the hard substratum, heavy floods wash away the attached larvae resulting in a decrease of the simulidae during high flows.
	Larvae are filtering collectors, extracting fine particulate detritus from the water as it flows past. Simuliid larvae ingest particles such as bacteria, diatoms and silt from Periphyton. An increase in the concentration of periphton will result in and enhancement of the Simulidae.

Response curve 1: Wet season Max 5d Q [F season]

Desc	m3/s	Y
Min	0.00	1.000
MinPD	218.56	0.800
	465.38	0.300
Median	712.20	0.000
	1844.49	-0.300
Max PD	2976.78	-0.800
Max	3423.29	-1.500

Response curve 2: Periphyton biomass [F season]

Desc	%2013	Y
Min	0.00	-0.450
MinPD	25.00	-0.250
	50.00	-0.050
Median	100.00	0.000
	150.00	0.050
Max PD	200.00	0.250
Max	250.00	0.450

References

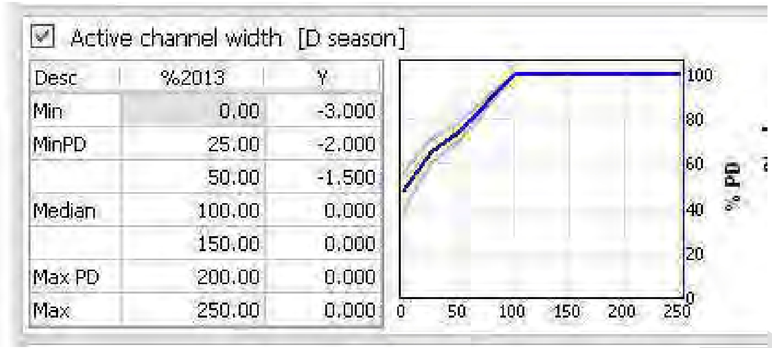
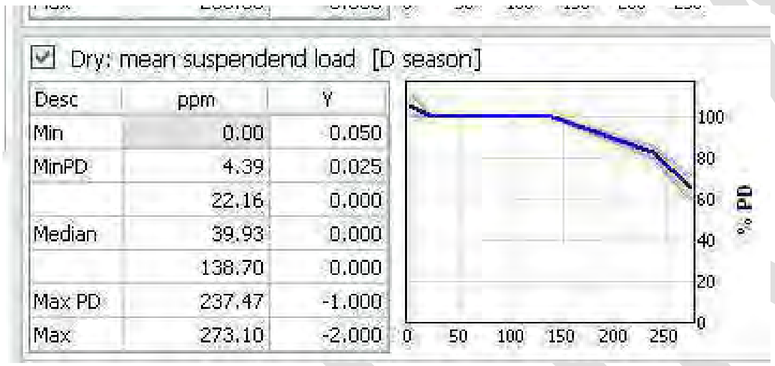
Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Simuliidae

Response curve	*Explanation*
	Reduction in the active channel width of the river causes less habitat available for breeding. Therefore the population of Simuliidae declines. However, an increase in active channel width does not have an effect on the Sumuliidae population once requirements for breeding habitat have been fulfilled.
	Simuliidae larvae attach themselves to underwater rocks. If mean suspended load in the river increases, Simuliidae larvae will have no space left for their attachment on the coarser substratum and its population will be badly affected.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

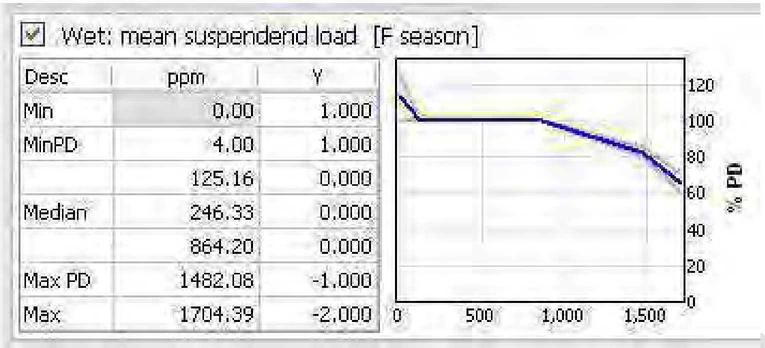
Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

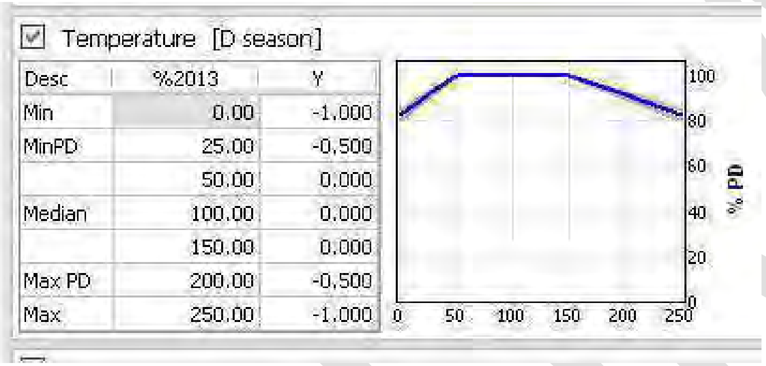
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Simuliidae

Response curve	*Explanation*
(see response curve below)	Trend for the wet season mean suspended load is similar to the dry season and the Simuliidae larvae attach themselves to underwater rocks. If mean suspended load in the river increases, Simuliidae larvae will have no space left for their attachment on the coarser substratum and its population will be badly affected.
	Most Simuliidae species flourish in the optimum temperature range from 10 °C to 15 °C. Simuliidae are temperature sensitive and growth rates decline above and below the optimum temperature range.





References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

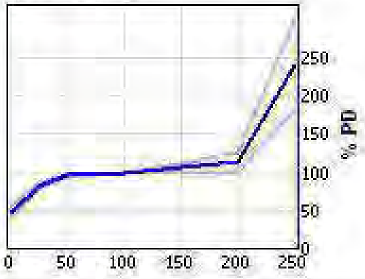
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Simuliidae

Response curve	*Explanation*
☑ Bed sediment type (armouring) [All seasons]	The preferred breeding habitat of the Simuliidae is underwater rocks and other objects to which they can attach themselves. An increase in sediment bed size provides more surfaces for attchment to substratee and so results in an increase in their population.
☑ Dry season duration [D season]	In the lifecycle of Simuliidae, it overwinter as egg or full grown larvae during dry season. Increase in duration of dry season corresponds to increase in Simuliidae population because habitat & substrate remain stable.

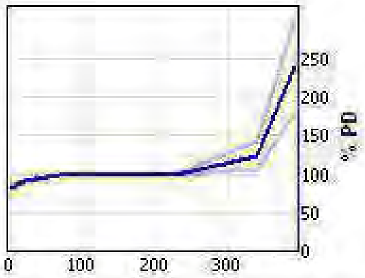
☑ Bed sediment type (armouring) [All seasons]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-1.000
	50.00	-0.250
Median	100.00	0.000
	150.00	0.250
Max PD	200.00	1.000
Max	250.00	3.000



☑ Dry season duration [D season]

Desc	days	Y
Min	0.00	-1.000
MinPD	19.00	-0.500
	66.25	0.000
Median	113.50	0.000
	226.75	0.000
Max PD	340.00	1.500
Max	391.00	3.000



References

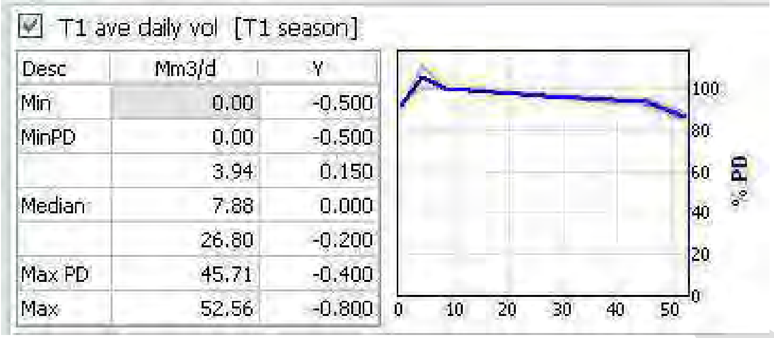
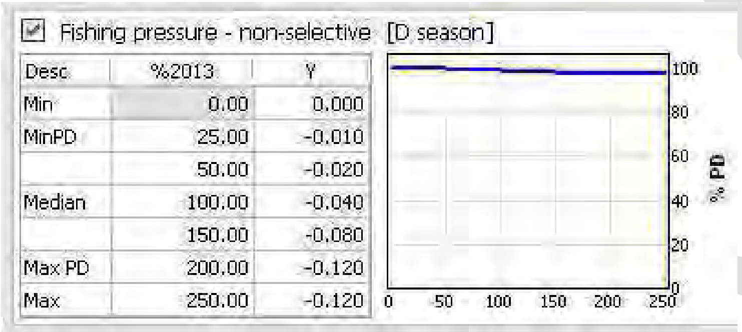
Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Simuliidae

Response curve	*Explanation*
	Simulidae prefers moderate water volumes for its proper growth. Very low and very high water volumes in the river affects the population of the simulidae.
	Non selective fishing such as blasting and poisoning negatively affects abundance of the Simuliidae. The abundance will not increase relative to the present level because non-selective fishing pressure will not promote breeding or feeding in any way.

T1 ave daily vol [T1 season]

Desc	Mm3/d	Y
Min	0.00	-0.500
MinPD	0.00	-0.500
	3.94	0.150
Median	7.88	0.000
	26.80	-0.200
Max PD	45.71	-0.400
Max	52.56	-0.800

Fishing pressure - non-selective [D season]

Desc	%2013	Y
Min	0.00	0.000
MinPD	25.00	-0.010
	50.00	-0.020
Median	100.00	-0.040
	150.00	-0.080
Max PD	200.00	-0.120
Max	250.00	-0.120

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

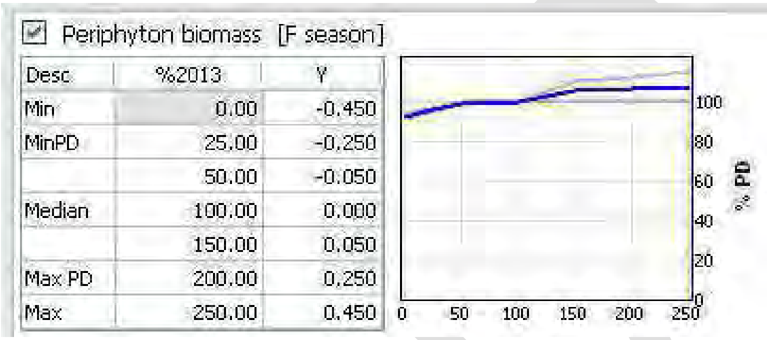
Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Exhibit B.6: EPT Abundance

EPT abundance

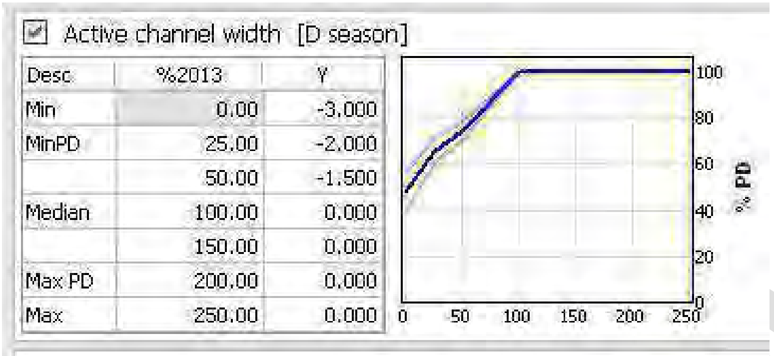
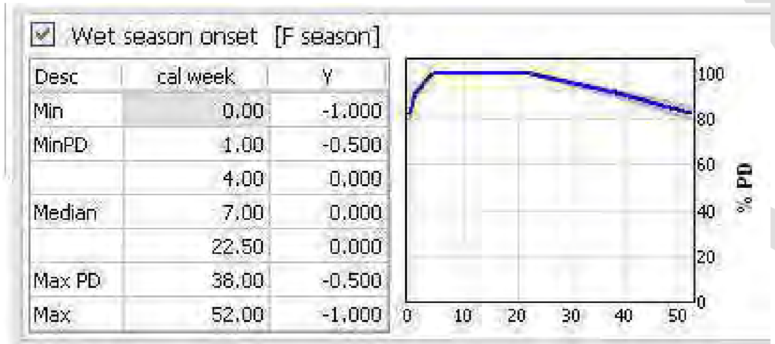
Response curve	*Explanation*
	The EPT are sensitive to flow regimes. While the EPT thrive in fast flowing waters, very high flows can result in decrease of EPT in the river as the population can be washed out. It receives a slight benefit in its preferred range at low flows.
	EPT nymphs feed on particles of organic matter, such as plant material, algae, diatoms, mosses; immature aquatic invertebrates; debris that accumulate on rocks or other substrata in flowing water. Increase in periphyton biomass represents more availability of food therefore the EPT population increases.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

EPT abundance	
Response curve	*Explanation*
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.	
	Reduction in active channel width leads to less habitat available for breeding therefore the population declines. However, availability of the extra channel width does not increase the population because, once the breeding room requirements have been fulfilled, the extra width available does not matter.
	Onset of the wet season provides breeding cues for the EPT. If, however, the onset of the wet season is either too early or too late, both will have a negative impact on the EPT population.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

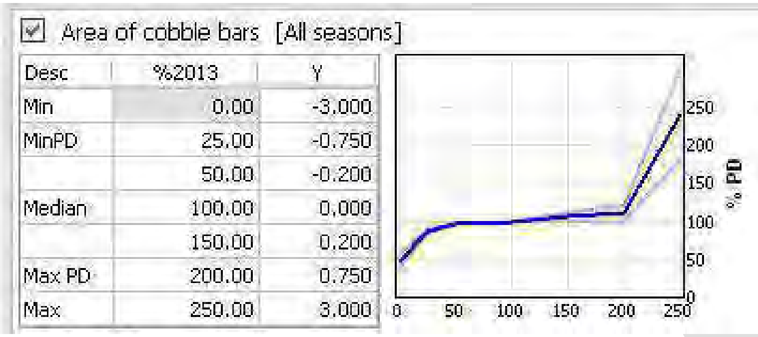
Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

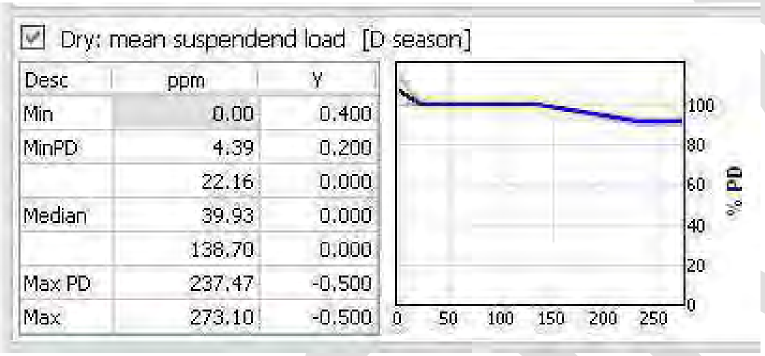
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

EPT abundance

Response curve	*Explanation*



EPT larvae attach themselves to the cobble bars on the river bed. If the area available increases, the populations is not affected up to a threshold limit, but after that the population increases rapidly.



As the dry mean suspended load in the river increases, the EPT population decreases because increased suspended load result in an increase in water turbidity causing a decrease in available food and habitat. The low suspended load will favour the availability of quality habitat and food for EPT growth.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

EPT abundance

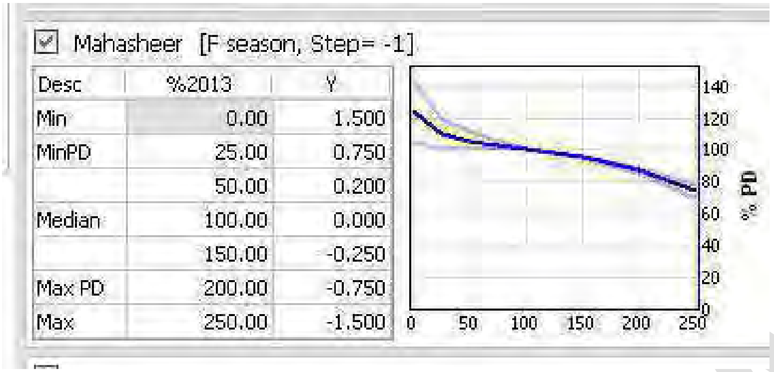
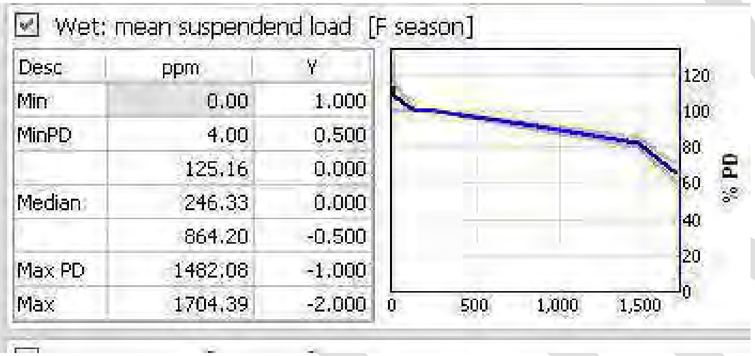
Response curve	*Explanation*
	The Mahasheer fish feeds on EPT fauna. Therefore an increase in the fish population decreases the EPT abundance in the river whereas a decrease in Mahasheer population allows the EPT abundance to increase.
	An increase in the mean suspended load in the wet season causes a decline in the EPT population since EPT are sensitive to increases in turbidity. Similarly a decline in the suspended load increases the population of EPT.

Image 1: Mahasheer [F season, Step= -1]

Desc	%2013	Y
Min	0.00	1.500
MinPD	25.00	0.750
	50.00	0.200
Median	100.00	0.000
	150.00	-0.250
Max PD	200.00	-0.750
Max	250.00	-1.500

Image 2: Wet: mean suspendend load [F season]

Desc	ppm	Y
Min	0.00	1.000
MinPD	4.00	0.500
	125.16	0.000
Median	246.33	0.000
	864.20	-0.500
Max PD	1482.08	-1.000
Max	1704.39	-2.000

References

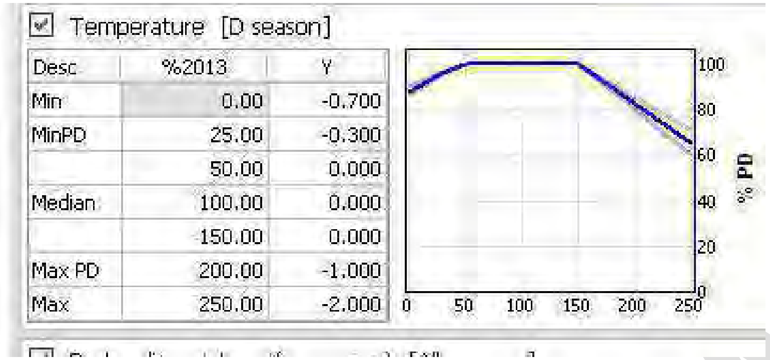
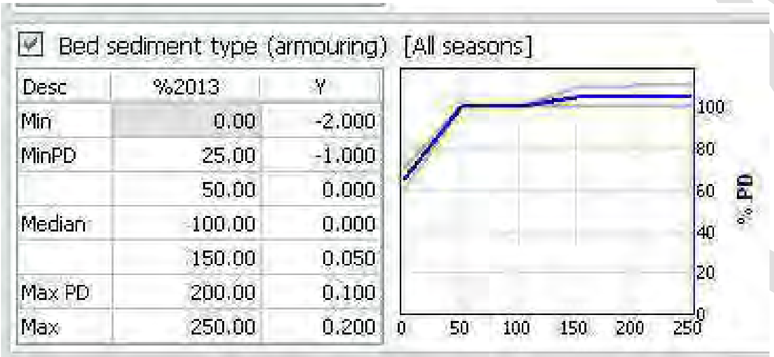
Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

EPT abundance

Response curve	*Explanation*
	Most of the EPT fauna flourish at water temperatures ranging from 5 °C to 15 °C. They have a high oxygen demand, ranging from 8 mg/l to 10 mg/l. Very high and very low temperature will cause deletion of oxygen in water rendering the water unfit for growth of most of the EPT species and very low temperature will affect the breeding and feeding activities of EPT affecting their population.
	An increase in bed sediment size provides more surface available for growth, feeding and attachment of the EPT and so promotes an increase in their population. Increase in fine particles will cause silting of the habitat, low productivity of food and deteriorating the breeding habitat resulting in a decline of their population.

Temperature [D season]

Desc	%2013	Y
Min	0.00	-0.700
MinPD	25.00	-0.300
	50.00	0.000
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	-1.000
Max	250.00	-2.000

Bed sediment type (armouring) [All seasons]

Desc	%2013	Y
Min	0.00	-2.000
MinPD	25.00	-1.000
	50.00	0.000
Median	100.00	0.000
	150.00	0.050
Max PD	200.00	0.100
Max	250.00	0.200

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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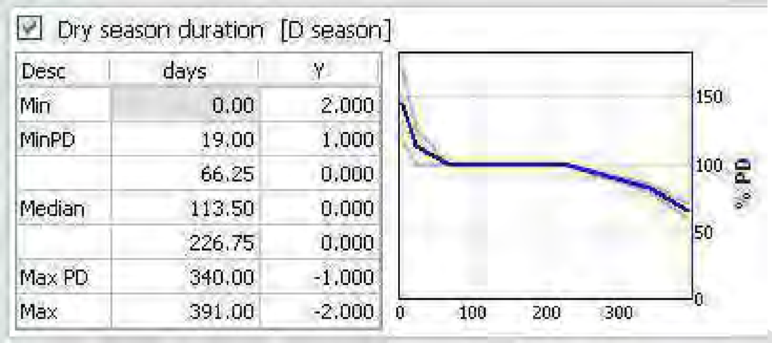
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

EPT abundance

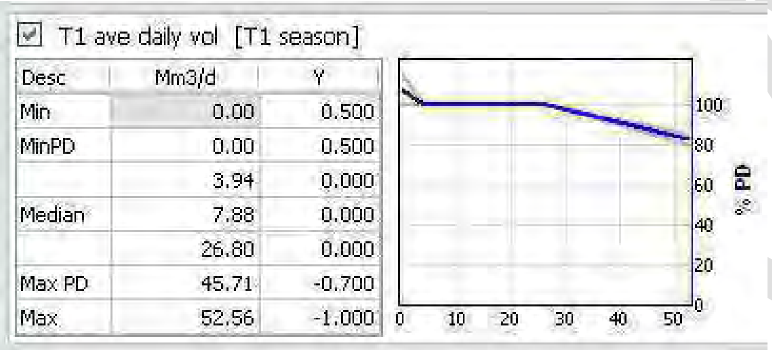
Response curve | *Explanation*



Dry season duration [D season]

Desc	days	Y
Min	0.00	2.000
MinPD	19.00	1.000
	66.25	0.000
Median	113.50	0.000
	226.75	0.000
Max PD	340.00	-1.000
Max	391.00	-2.000

EPT breed and grow actively in the wet season therefore they prefer shorter dry seasons. Their populations increases significantly when the dry season durations are shorter.



T1 ave daily vol [T1 season]

Desc	Mm3/d	Y
Min	0.00	0.500
MinPD	0.00	0.500
	3.94	0.000
Median	7.88	0.000
	26.80	0.000
Max PD	45.71	-0.700
Max	52.56	-1.000

EPT prefer moderate water volumes for their proper growth. Very low and very high water volumes in the river affect the population of EPT.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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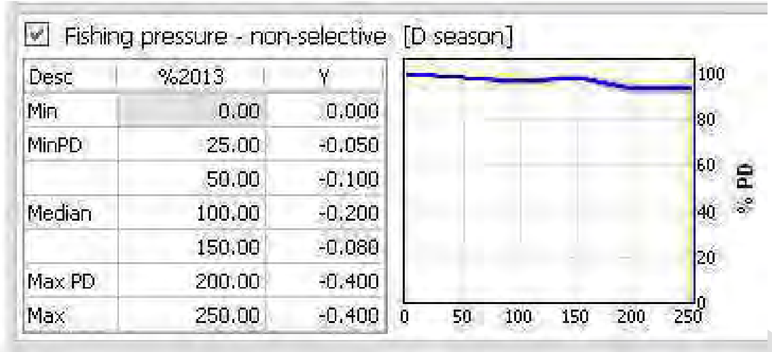
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

EPT abundance

Response curve	*Explanation*
	Non-selective fishing pressures involves poisoning and blasting which affect EPT abundance in addition to killing the fish. Therefore an increase in the non-selective fishing pressure leads to a slight decline in the EPT abundance.

Fishing pressure - non-selective [D season]

Desc	%2013	Y
Min	0.00	0.000
MinPD	25.00	-0.050
	50.00	-0.100
Median	100.00	-0.200
	150.00	-0.080
Max PD	200.00	-0.400
Max	250.00	-0.400

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

B.6 Fish Response-curve Explanations

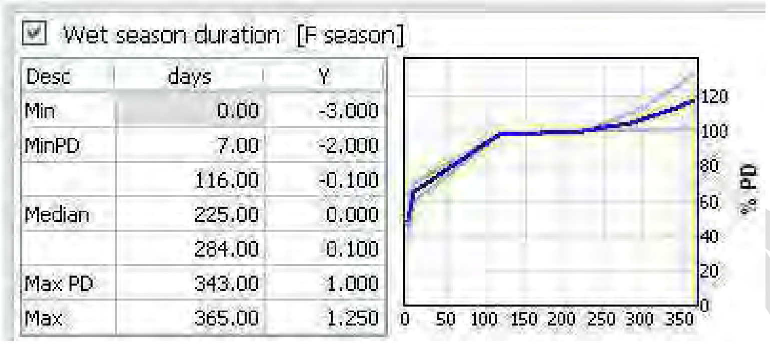
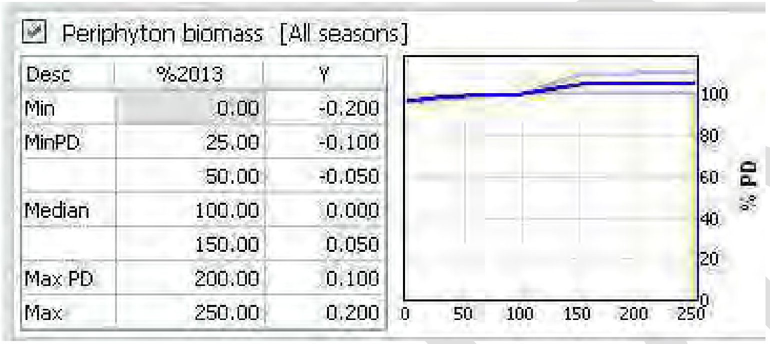
The explanations of the Response Curves are tabulated as **Exhibit B.7** Pakistani Labeo, **Exhibit B.8** Mahaseer, **Exhibit B.9** Twin-banded loach**, Exhibit B.10** Kashmir Catfish and **Exhibit B.11** Garua bachwaa.

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

Exhibit B.7: Pakistani labeo

Pakistani Labeo

Response curve	*Explanation*
	Pakistani Labeo fish population rises with increase in wet season duration and decreases with decrease in wet season duration. It is because longer wet seasons ensure more food productivity, longer reproductive season for early and late spawners, lower winter season when fish remains inactive and feeds none. The shorter the wet season, the lower food productivity, shorter breeding season, and longer inactive period as a result of longer dray season.
	Pakistan labeo utilizes periphyton as a food resource and therefore an increase in periphyton results in increased fish food and hence an increase in population of the fish.

Wet season duration [F season]

Desc	days	Y
Min	0.00	-3.000
MinPD	7.00	-2.000
	116.00	-0.100
Median	225.00	0.000
	284.00	0.100
Max PD	343.00	1.000
Max	365.00	1.250

Periphyton biomass [All seasons]

Desc	%2013	Y
Min	0.00	-0.200
MinPD	25.00	-0.100
	50.00	-0.050
Median	100.00	0.000
	150.00	0.050
Max PD	200.00	0.100
Max	250.00	0.200

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

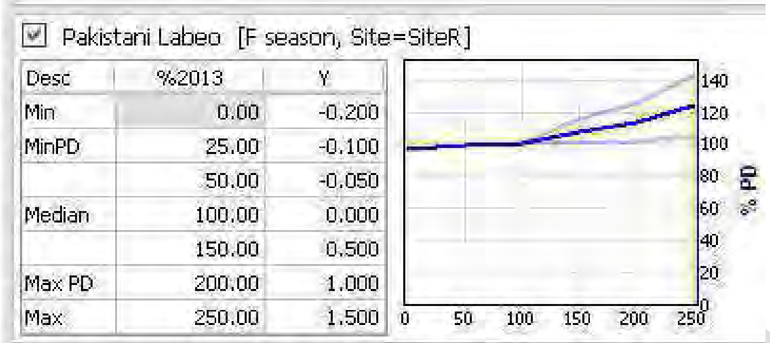
Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

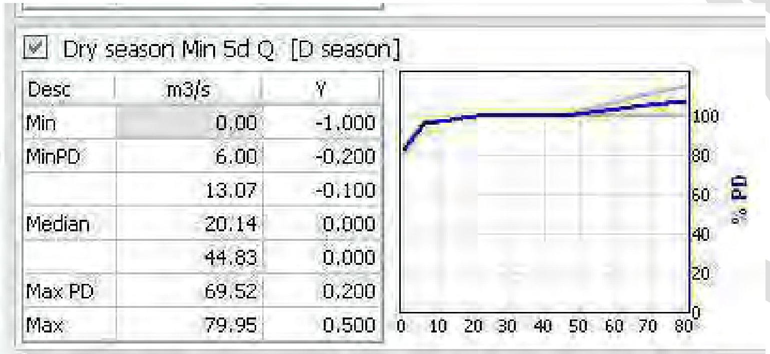
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Pakistani Labeo

Response curve | *Explanation*



This curve relates the effect on population of fish at EF Site 2 with respect to the population of fish able to go upstream to breed. When more fishes can cross for breeding, the fish population at Site 2 increases. When small number of fishes cross, the population at Site 2 flattens out at 100.



Increase in minimum five day dry season discharge benefits the fish due to more habitats available during the dry season for overwintering and vice versa.

References

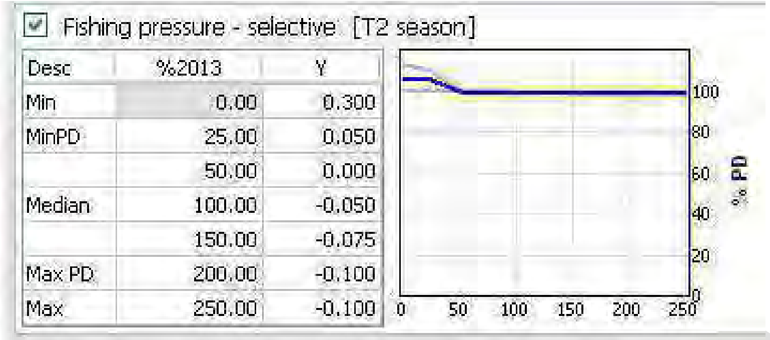
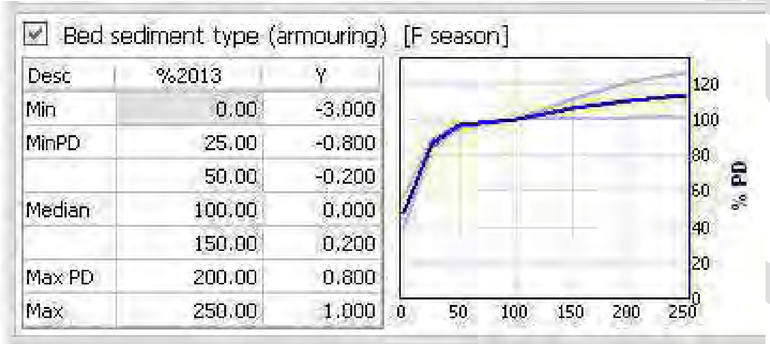
Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Pakistani Labeo

Response curve	*Explanation*
	Increase in selective fishing pressures leads to very small decrease in Pakistani labeo fish population. This is because this is widely caught using gill nets and other non-selective fishing means. Only very low selective fishing pressures benefit this fish.
	Pakistani Labeo spawns in slow running water with small and medium size stones in the confluence of the small tributaries in the side of the river bank. The armoring of the bed sediment therefore provides them a suitable habitat for breeding. Decrease in sediment size result in accumulation of fine particles in the river bed rendering it unfit for breeding.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

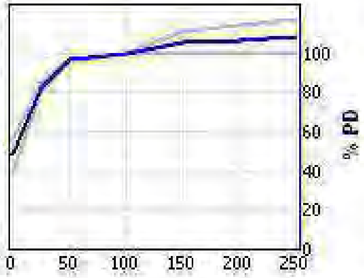
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Pakistani Labeo

Response curve	*Explanation*
Depth of pools [D season]	Increasing depth of pools during dry season will provide more room to the fish for overwintering and survival so the population will increase. However, if the depth of pools reduces below the required level, the fish survival is expected to become difficult and the population will decline.
Fishing pressure - non-selective [T2 season]	Pakistani Labeo is mainly caught using non-selective fishing pressure such as gill nets, dynamites and poisoning. These fishing practices have a major role in the decline of the population of this fish. when non-selective fishing pressure is less, fish population increases and if the non selective fishing pressure increases from the present day level, fish population will decline.

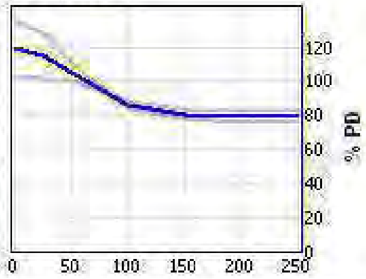
Depth of pools [D season]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-1.000
	50.00	-0.200
Median	100.00	0.000
	150.00	0.200
Max PD	200.00	0.400
Max	250.00	0.600



Fishing pressure - non-selective [T2 season]

Desc	%2013	Y
Min	0.00	1.300
MinPD	25.00	1.100
	50.00	0.150
Median	100.00	-0.800
	150.00	-1.100
Max PD	200.00	-1.200
Max	250.00	-1.200



References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

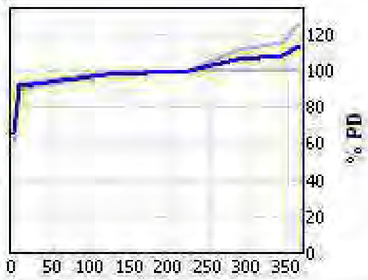
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Exhibit B.8: Mahaseer

Mahaseer

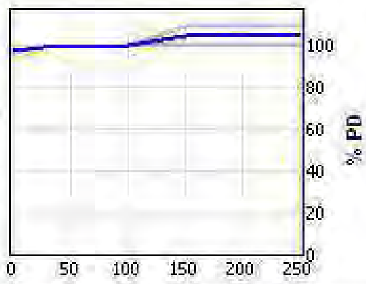
Response curve	*Explanation*
Wet season duration [F season]	Mahaseer fish population increases with increase in duration of flood season because breeding Season is prolonged and both early and late breeders find a chance to breed. If the wet season duration is decreased, fish will find less chance for fattening and gonadal growth and breeding success will be compromised to certain level resulting in decrease of in fish population.

Desc	days	Y
Min	0.00	-2.000
MinPD	7.00	-0.500
	116.00	-0.100
Median	225.00	0.000
	284.00	0.200
Max PD	343.00	0.500
Max	365.00	1.000



Response curve	*Explanation*
Periphyton biomass [F season]	The Mahaseer fish feeds on macroinvertebrates, dipteran larvae and plant matter. Therefore an increase in the periphyton biomass results in an increase in the population of Mahaseer fish in the river.

Desc	%2013	Y
Min	0.00	-0.150
MinPD	25.00	-0.050
	50.00	-0.010
Median	100.00	0.000
	150.00	0.020
Max PD	200.00	0.050
Max	250.00	0.100



References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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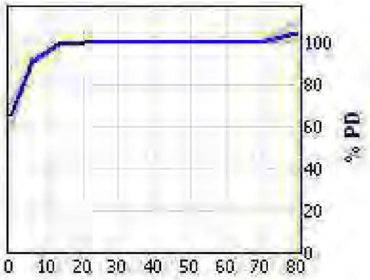
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Mahaseer	
Response curve	*Explanation*

☑ Dry season Min 5d Q [D season]

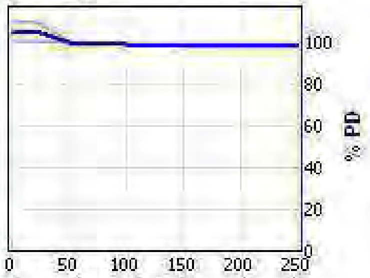
Desc	m3/s	Y
Min	0.00	-2.000
MinPD	6.00	-0.500
	13.07	-0.050
Median	20.14	0.000
	44.83	0.000
Max PD	69.52	0.000
Max	79.95	0.100



Mahaseer fish is inactive in the dry season and is restricted in deep pools for survival, Reduction in flow during winter season results in shrinkage and shallowness of the pools and increasing crowding and competition of fish in limited available habitat compromising winter survival and hence an overall decrease in fish population. A better flow will result in better survival and hence an increase in population.

☑ Fishing pressure - selective [T2 season]

Desc	%2013	Y
Min	0.00	0.100
MinPD	25.00	0.050
	50.00	0.000
Median	100.00	-0.050
	150.00	-0.075
Max PD	200.00	-0.100
Max	250.00	-0.100



Increase in selective fishing pressures leads to very small decrease in Mahaseer fish population. This is because this is widely caught using gill nets and other non-selective fishing means. Only very low selective fishing pressures benefit this fish.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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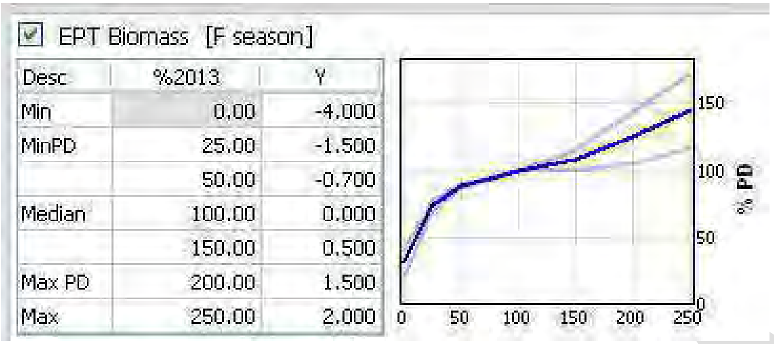
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Mahaseer

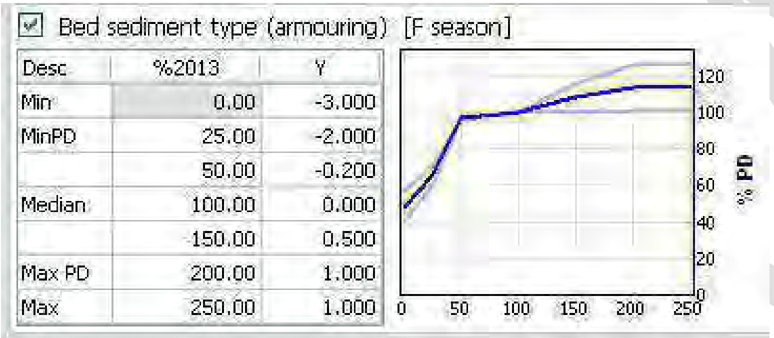
Response curve	*Explanation*



☑ EPT Biomass [F season]

Desc	%2013	Y
Min	0.00	-4.000
MinPD	25.00	-1.500
	50.00	-0.700
Median	100.00	0.000
	150.00	0.500
Max PD	200.00	1.500
Max	250.00	2.000

Mahaseer utilizes EPT as a source of food, therefore an increase in the EPT abundance results in better growth, production of more eggs and better winter survival due to more reserve food in the form of accumulated fat, all leading to an increase in fish population more eggs, more and quicker breeding, leading to more fish in the wet season. In case of low EPT productivity, fish growth, fecundity and winter survival will be affected causing a decline in its population.



☑ Bed sediment type (armouring) [F season]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-2.000
	50.00	-0.200
Median	100.00	0.000
	150.00	0.500
Max PD	200.00	1.000
Max	250.00	1.000

Armouring of the sediment bed provides a preferable habitat for fish breeding and food productivity. When armouring is less, the fish breeding sites, food productivity are adversely affected leading to reduced population.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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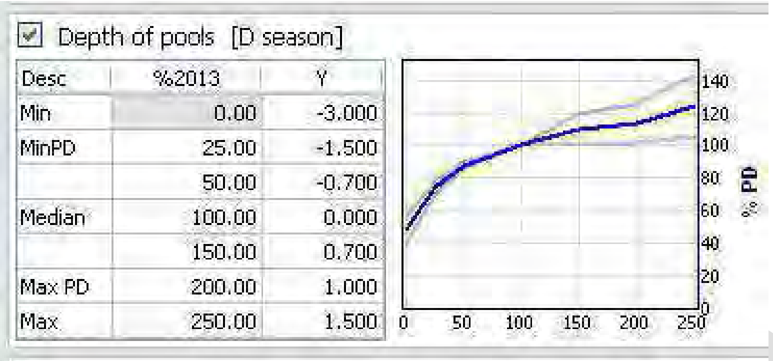
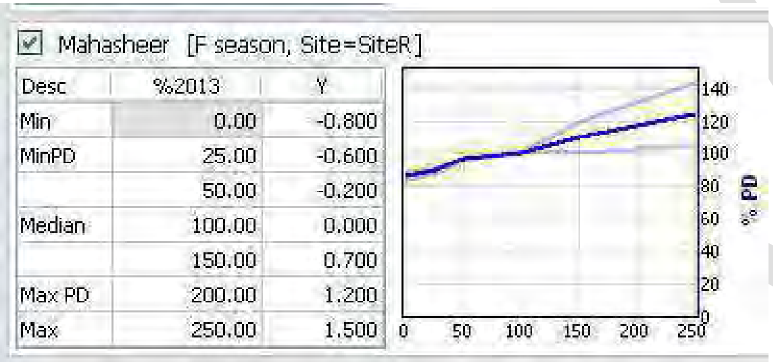
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Mahaseer

Response curve	*Explanation*
	Mahaseer becomes inactive in the dry season and takes refuge in deep stagnant pools during this time. When the deeper pools are in abundance, the fish has better survival chances during winter season while reduction in depth of pools will limit the available wintering space.
	This curve relates the effect on population of Mahaseer at EF Site 2 with respect to the population of Mahaseer able to go upstream to breed. When more fishes can cross for breeding, the fish population at Site 2 increases. When less fish will cross, it means they cannot access tributaries for breeding therefore their population declines.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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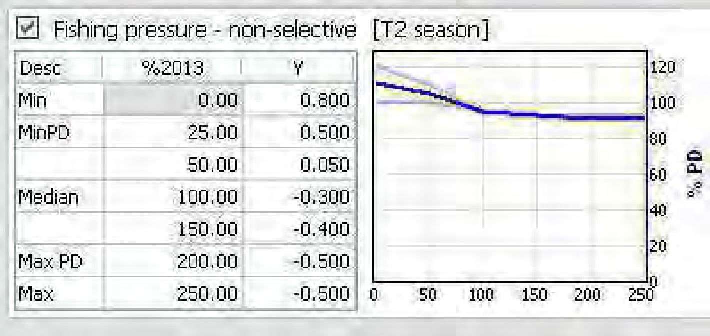
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Mahaseer

Response curve	*Explanation*
	Mahaseer is mainly caught using non-selective fishing pressure means such as gill nets, dynamites and poisoning. These fishing practices have a major role in the decline of the population of this fish. The fish population will increases when non-selective fishing pressure is less.

Fishing pressure - non-selective [T2 season]

Desc	%2013	Y
Min	0.00	0.800
MinPD	25.00	0.500
	50.00	0.050
Median	100.00	-0.300
	150.00	-0.400
Max PD	200.00	-0.500
Max	250.00	-0.500

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

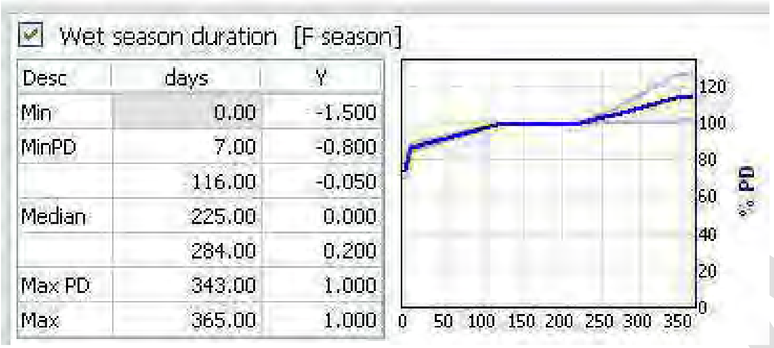
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Exhibit B.9: Twin-banded loach

Twin-banded loach

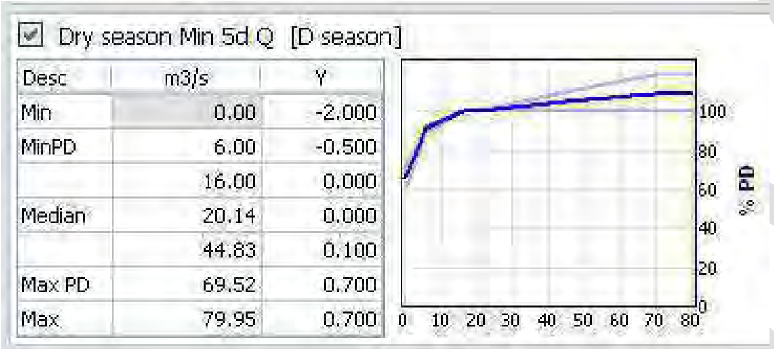
Response curve	*Explanation*



Wet season duration [F season]

Desc	days	Y
Min	0.00	-1.500
MinPD	7.00	-0.800
	116.00	-0.050
Median	225.00	0.000
	284.00	0.200
Max PD	343.00	1.000
Max	365.00	1.000

Flood season is the breeding season of the twin-banded loach, therefore the fish population increases with increased duration of the wet seasonDuring longer wet season, fish comes out of dormancy period earlier and gets more chance for feeding and ovarian development. The early and late spawners fishes get more chances of successful breeding. All these factors impart in an increase of fish population.



Dry season Min 5d Q [D season]

Desc	m3/s	Y
Min	0.00	-2.000
MinPD	6.00	-0.500
	16.00	0.000
Median	20.14	0.000
	44.83	0.100
Max PD	69.52	0.700
Max	79.95	0.700

During minimum five days flow, the river continuity is compromised; the fish taking refuge under stones, crevices, and boulders has to be dislodged from their wintering habitat and becomes vulnerable to prey of the predators resulting in a loss of population. An increase in five day minimum flow keeps the wintering habitats intact resulting in more survival rate and hence an increase in its population.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

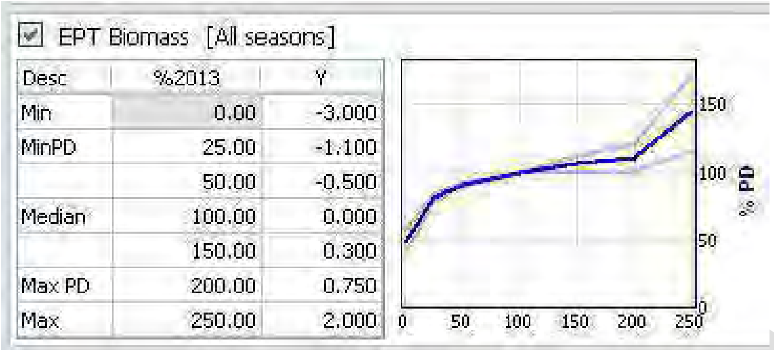
Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

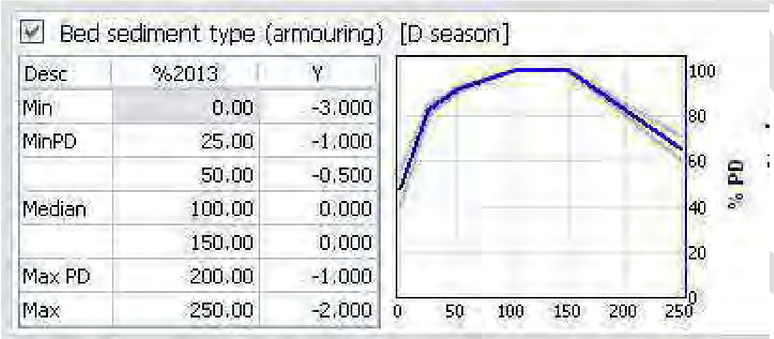
Twin-banded loach

Response curve	*Explanation*



Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-1.100
	50.00	-0.500
Median	100.00	0.000
	150.00	0.300
Max PD	200.00	0.750
Max	250.00	2.000

Twin-banded loach utilizes the EPT biomass as a food source. Hence, an increase in the abundance of biomass increases the population of the fish and similarly a decrease in EPT biomass will result in decline of population of the fish. .



Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-1.000
	50.00	-0.500
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	-1.000
Max	250.00	-2.000

An increase in armouring of river bed to certain extant will produce more habitat for production of fish food in the form of invertebrates, and enhancing the breeding and overwintering habitat. An access of boulders will change the river bed morphology and fish habitat not coinciding with the biological requirements of the fish and will result in a decline of its population. Decrease in size of river bed sediment from a certain level will transform the river bed in a way which will be rendered unfit for food productivity, breeding and overwintering of fish.

References

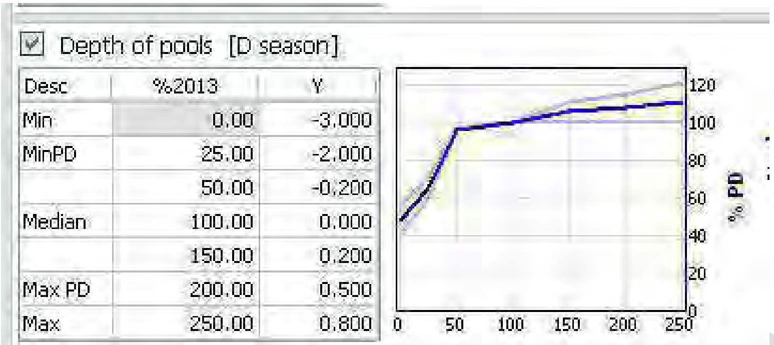
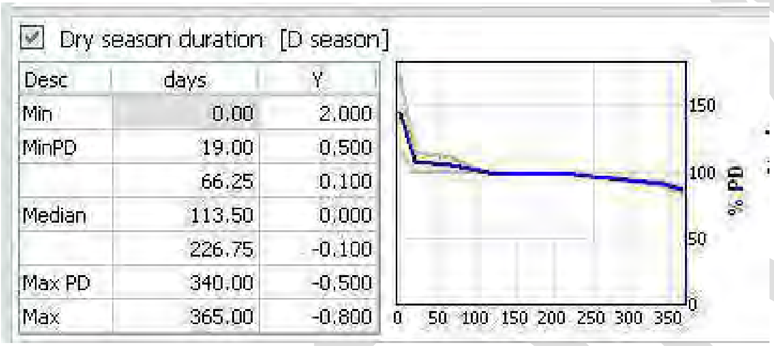
Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Twin-banded loach

Response curve	*Explanation*
	The fish becomes inactive in the dry season and takes refuge in pools and crevices along deep side pools during this time. When the deeper pools are in abundance, the fish has better survival chances during winter season while reduction in depth of pools will limit the available wintering space and winter mortalities may occur resulting in a reduction in fish population. .
	Fish become inactive during dry season. It does not feed and grow and depends mainly on fat reserves for survival. Very short dry seasons will ensure less inactive period, more food productivity and more growth and development of fish reproductive system ensuring an increase in fish population. Very long dry seasons will result in cool environment, less active period, less food productivity, less growth, small reproductive season . All these factors will result in loss of fish population.

Depth of pools [D season]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-2.000
	50.00	-0.200
Median	100.00	0.000
	150.00	0.200
Max PD	200.00	0.500
Max	250.00	0.800

Dry season duration [D season]

Desc	days	Y
Min	0.00	2.000
MinPD	19.00	0.500
	66.25	0.100
Median	113.50	0.000
	226.75	-0.100
Max PD	340.00	-0.500
Max	365.00	-0.800

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

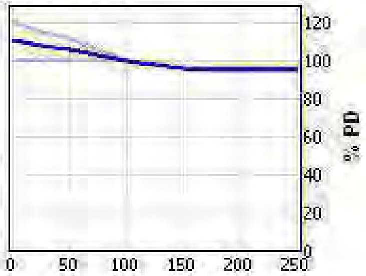
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Twin-banded loach

Response curve	*Explanation*
See below	Non selective fishing pressure such as dynamite and poisoning kills all life classes of this fish resulting in a decline of population of this fish. In conditions when non selective fishing pressure is reduced, the fries, fingerlings and breeding fish stays safe and and results in an increased population.

☑ Fishing pressure - non-selective [T2 season]

Desc	%2013	Y
Min	0.00	0.800
MinPD	25.00	0.500
	50.00	0.250
Median	100.00	0.000
	150.00	-0.200
Max PD	200.00	-0.300
Max	250.00	-0.300



References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. The Simuliidae of Pakistan. Bulletin of Entomological Research, 62:453-470.

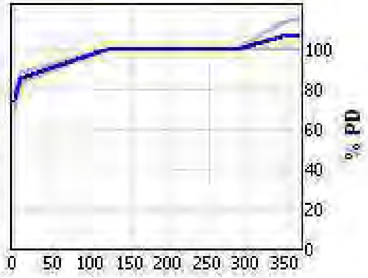
Exhibit B.10: Kashmir catfish

Kashmir catfish

Response curve	*Explanation*
Wet season duration [F season] (table and chart below)	Wet season is the active season for feeding and breeding of the Kashmir cat fish , therefore the fish population increases with increased duration of the wet season. During longer wet season, fish comes out of dormancy period earlier and gets more chance for feeding and ovarian development. The early and late spawning fishes get more chances of successful breeding. All these factors impart in an increase of fish population. During very small wet season, the active period is small, fish has less time for active breeding and growth and development which affects its breeding success resuting in decrease of fish population.
Dry season Min 5d Q [D season] (table and chart below)	During minimum five days flow, the river continuity is compromised; the fish taking refuge under stones, crevices, and boulders has to be dislodged from their wintering habitat and becomes vulnerable to prey of the predators resulting in a loss of population. An increase in five day minimum flow keeps the wintering habitats intact resulting in more survival rate and hence an increase in its population.

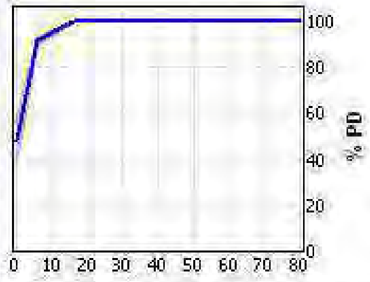
☑ Wet season duration [F season]

Desc	days	Y
Min	0.00	-1.500
MinPD	7.00	-0.800
	116.00	0.000
Median	225.00	0.000
	284.00	0.000
Max PD	343.00	0.400
Max	365.00	0.500



☑ Dry season Min 5d Q [D season]

Desc	m3/s	Y
Min	0.00	-3.000
MinPD	6.00	-0.500
	16.00	0.000
Median	20.14	0.000
	44.83	0.000
Max PD	69.52	0.000
Max	79.95	0.000



References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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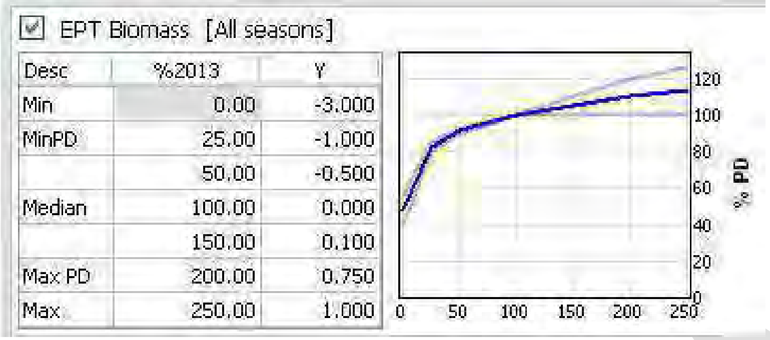
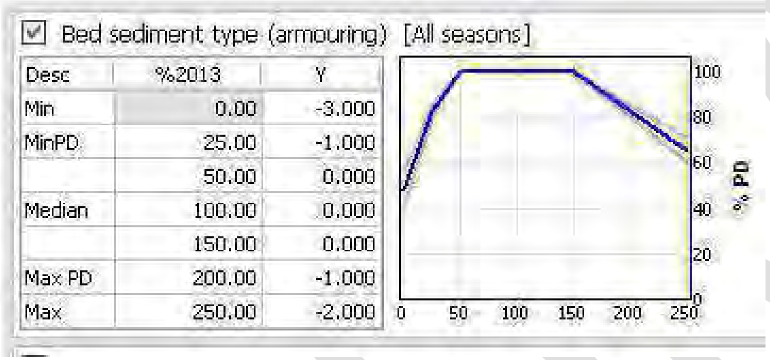
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Kashmir catfish

Response curve	*Explanation*
	Kashmir Cat fish utilizes the EPT biomass as a food source. Hence, an increase in the abundance of biomass increases the population of the fish and similarly a decrease in EPT biomass will result in decline of population of the fish. .
	An increase in armouring of river bed to certain extant will produce more habitat for production of fish food in the form of invertebrates, and enhancing the breeding and overwintering habitat. An access of boulders will change the river bed morphology and fish habitat not coinciding with the biological requirements of the fish and will result in a decline of its population. Decrease in size of river bed sediment from a certain level will transform the river bed in a way which will be rendered unfit for food productivity, breeding and overwintering of fish.

EPT Biomass [All seasons]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-1.000
	50.00	-0.500
Median	100.00	0.000
	150.00	0.100
Max PD	200.00	0.750
Max	250.00	1.000

Bed sediment type (armouring) [All seasons]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-1.000
	50.00	0.000
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	-1.000
Max	250.00	-2.000

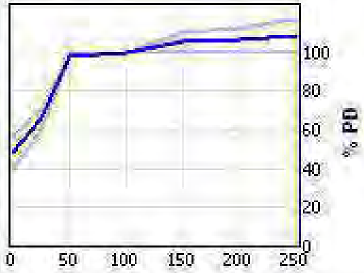
References

Kashmir catfish

Response curve	*Explanation*
Depth of pools [D season] (see table and chart below)	The fish becomes inactive in the dry season and takes refuge in pools and crevices along deep side pools during this time. When the deeper pools are in abundance, the fish has better survival chances during winter season while reduction in depth of pools will limit the available wintering space and winter mortalities may occur resulting in a reduction in fish population. .
Dry season duration [D season] (see table and chart below)	Fish become inactive during dry season. It does not feed and grow and depends mainly on fat reserves for survival. Very short dry seasons will ensure less inactive period, more food productivity and more growth and development of fish reproductive system ensuring an increase in fish population. Very long dry seasons will result in cool environment, less active period, less food productivity, less growth, small reproductive season. All these factors will result in loss of fish population.

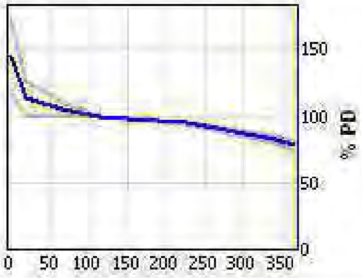
☑ Depth of pools [D season]

Desc	%2013	Y
Min	0.00	-3.000
MinPD	25.00	-2.000
	50.00	-0.100
Median	100.00	0.000
	150.00	0.100
Max PD	200.00	0.300
Max	250.00	0.600



☑ Dry season duration [D season]

Desc	days	Y
Min	0.00	2.000
MinPD	19.00	1.000
	66.25	0.100
Median	113.50	0.000
	226.75	-0.300
Max PD	340.00	-1.000
Max	365.00	-1.300



References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

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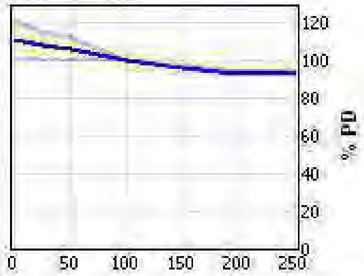
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Kashmir catfish

Response curve	*Explanation*
☑ Fishing pressure - non-selective [T2 season]	Non selective fishing pressure such as dynamite and poisoning kills all life classes of this fish resulting in a decline of population of this fish. In conditions when non selective fishing pressure is reduced, the fries, fingerlings and breeding fish stays safe and and results in an increased population.

Desc	%2013	Y
Min	0.00	0.800
MinPD	25.00	0.500
	50.00	0.250
Median	100.00	0.000
	150.00	-0.200
Max PD	200.00	-0.400
Max	250.00	-0.400



References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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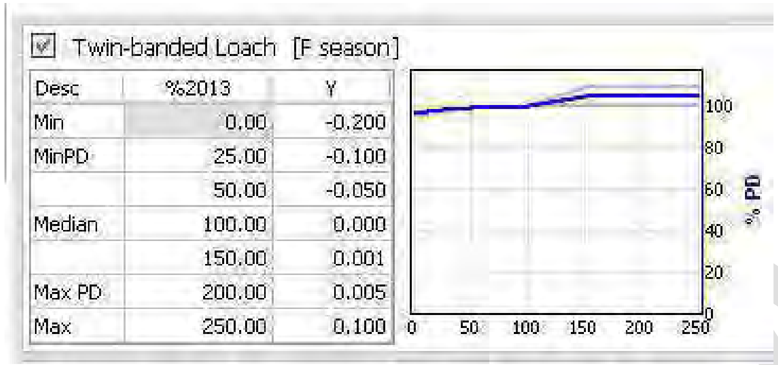
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Exhibit B.11: Garua bachwaa

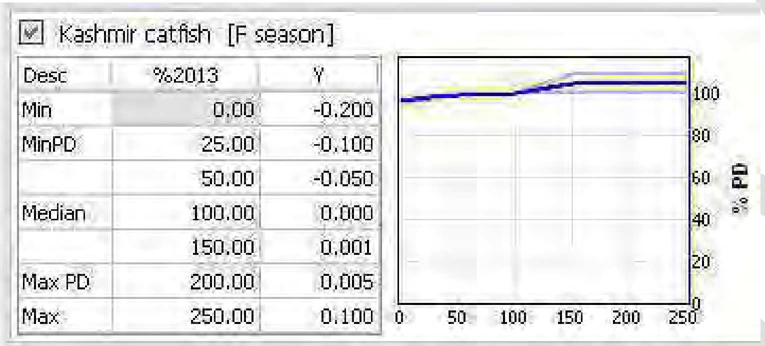
Garua bachwaa

Response curve | *Explanation*



Desc	%2013	Y
Min	0.00	-0.200
MinPD	25.00	-0.100
	50.00	-0.050
Median	100.00	0.000
	150.00	0.001
Max PD	200.00	0.005
Max	250.00	0.100

The garua bachwaa is a carnivorous fish that feeds on insects, shrimps, other crustaceans and small fish including the twin-banded loach among othres. Increase in population of twin-banded loach also increases the population of the garua bachwaa.



Desc	%2013	Y
Min	0.00	-0.200
MinPD	25.00	-0.100
	50.00	-0.050
Median	100.00	0.000
	150.00	0.001
Max PD	200.00	0.005
Max	250.00	0.100

The garua bachwaa is a carnivorous fish that feeds on insects, shrimps, other crustaceans and small fish including the Kashmir catfish. Increase in population of the Kashmir catfish therefore also increases the population of the garua bachwaa.

References

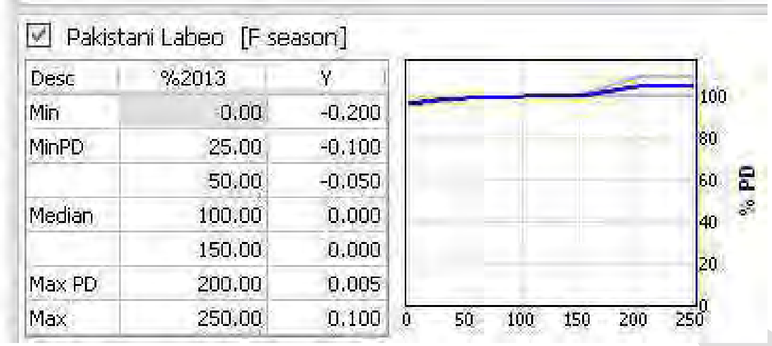
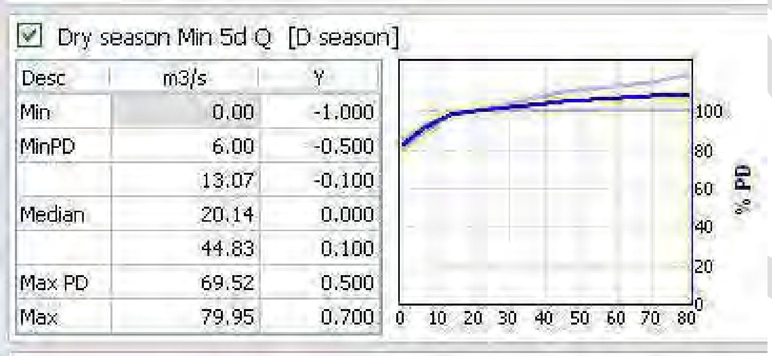
Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Garua bachwaa

Response curve	*Explanation*
	The garua bachwaa is a carnivorous fish that feeds on insects, shrimps, other crustaceans and small fish including the Pakistani labeo. Increase in population of the Pakistani labeo therefore also increases the population of the garua bachwaa.
	Reduction in flow during winter season results in shrinkage and shallowness of the pools and increasing crowding and competition of fish in limited available habitat compromising winter survival and hence an overall decrease in fish population. A better flow will result in better survival and hence an increase in population.

Pakistani Labeo [F season]

Desc	%2013	Y
Min	0.00	-0.200
MinPD	25.00	-0.100
	50.00	-0.050
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	0.005
Max	250.00	0.100

Dry season Min 5d Q [D season]

Desc	m3/s	Y
Min	0.00	-1.000
MinPD	6.00	-0.500
	13.07	-0.100
Median	20.14	0.000
	44.83	0.100
Max PD	69.52	0.500
Max	79.95	0.700

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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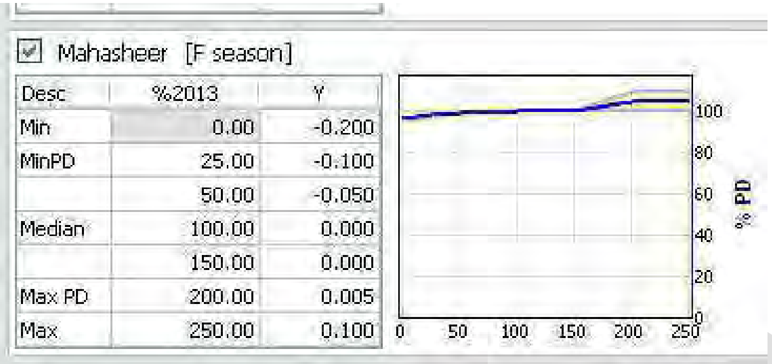
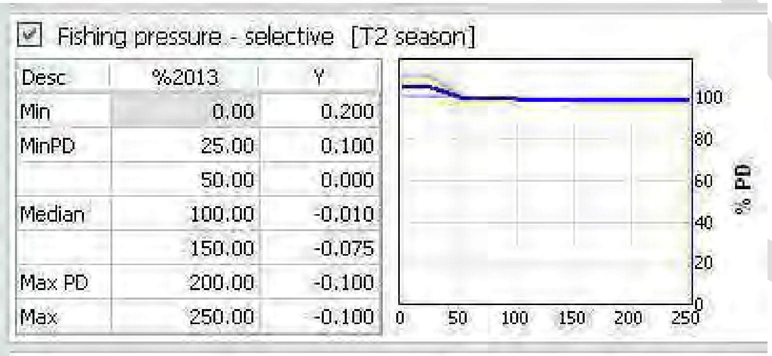
Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Garua bachwaa

Response curve	*Explanation*
	The garua bachwaa is a carnivorous fish that feeds on insects, shrimps, other crustaceans and small fish including the mahaseer. Increase in population of the mahaseer therefore also increases the population of the garua bachwaa.
	Garua bachwaa population is significantly affected by the non-selective fishing pressure (dynamites and poisoning). The selective fishing pressure does not have a major role in the decline of population of garua bachwaa. However in decrease in selective fishing pressure will ensure an increase in fish population.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

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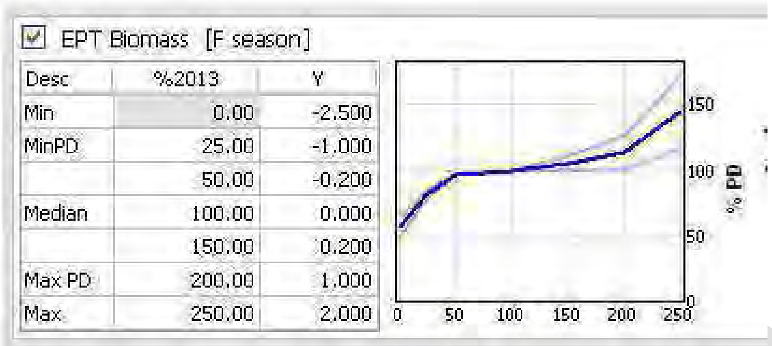
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Garua bachwaa

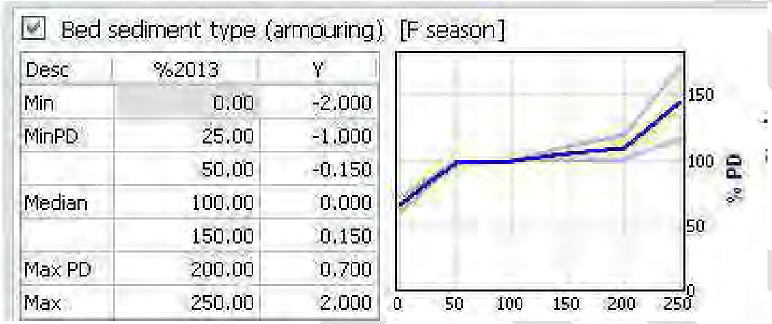
Response curve	*Explanation*



☑ EPT Biomass [F season]

Desc	%2013	Y
Min	0.00	-2.500
MinPD	25.00	-1.000
	50.00	-0.200
Median	100.00	0.000
	150.00	0.200
Max PD	200.00	1.000
Max	250.00	2.000

Garua bachwaa is a carnivorous fish that feeds on EPT, shrimps, other crustaceans and small fish. The population of small fish in the river are mainly dependent on the EPT biomass. Therefore increase in the EPT biomass will ensure an increase in the population of the garua bachwaa. Similarly a decrease in EPT biomass will result in less food for fish which will directly impact on the growth and reproductive vigor of the fish causing a decline in fish population.



☑ Bed sediment type (armouring) [F season]

Desc	%2013	Y
Min	0.00	-2.000
MinPD	25.00	-1.000
	50.00	-0.150
Median	100.00	0.000
	150.00	0.150
Max PD	200.00	0.700
Max	250.00	2.000

Garua bachwaa prefers rocky and co0bbly river beds as its natural habitat. It is also the habitat where maximum fish food in the form of EPT is produced. Armouring of the bed sediment , therefore, will provides a habitat to this fish for More food, more growth and a conducive habitat for reproduction. Decrease in armouring will result in non-availability of the preferred habitat for breeding and feeding resulting in a decrease in fish population.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

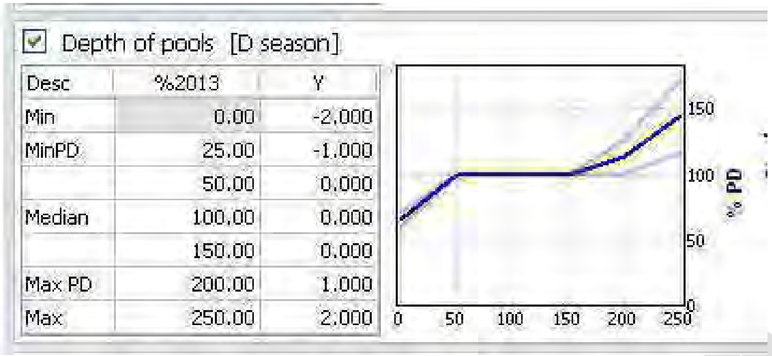
Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Garua bachwaa

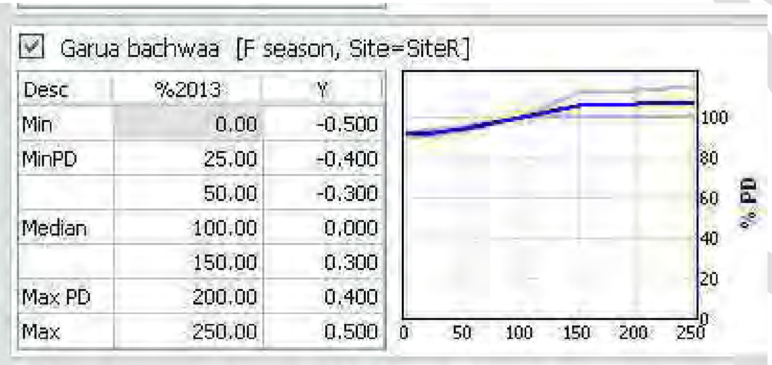
Response curve	*Explanation*



☑ Depth of pools [D season]

Desc	%2013	Y
Min	0.00	-2.000
MinPD	25.00	-1.000
	50.00	0.000
Median	100.00	0.000
	150.00	0.000
Max PD	200.00	1.000
Max	250.00	2.000

The fish becomes inactive in the dry season and takes refuge in pools and crevices along deep side pools during this time. When the deeper pools are in abundance, the fish has better survival chances during winter season while reduction in depth of pools will limit the available wintering space and winter mortalities may occur resulting in a reduction in fish population. .



☑ Garua bachwaa [F season, Site=SiteR]

Desc	%2013	Y
Min	0.00	-0.500
MinPD	25.00	-0.400
	50.00	-0.300
Median	100.00	0.000
	150.00	0.300
Max PD	200.00	0.400
Max	250.00	0.500

This curve relates the effect on population of fish at EF Site 2 with respect to the population of fish able to migrate upstream to breed. When more fish can cross for breeding, the fish population at Site 2 increases. When small number of fish cross, this results in lesser breeding resulting in a decline in population.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

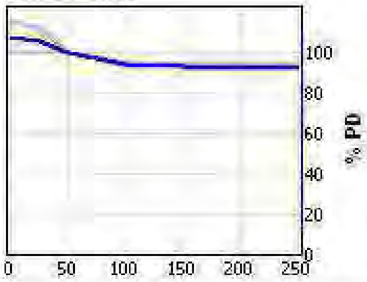
Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

Garua bachwaa

Response curve

☑ Fishing pressure - non-selective [T2 season]

Desc	%2013	Y
Min	0.00	0.500
MinPD	25.00	0.300
	50.00	0.000
Median	100.00	-0.300
	150.00	-0.350
Max PD	200.00	-0.400
Max	250.00	-0.400



Explanation

Garua bachwaa is mainly caught using non-selective fishing pressure means such as gill nets, dynamites and poisoning. The fish population increases when non-selective fishing pressure is less, while decreases with increase in non-selective fishing pressure.

References

Berry, W., Hill, B., Melzian, B. & Rubinstein, N., 2003. *The Biological Effects of Suspended and Bedded Sediments (SABS) in Aquatic Systems: a Review*, Internal report prepared by the U.S. Environmental Protection Agency, Offi ce of Research and Development.

Hagler-Bailly-Mira Power, *Baseline Biodiversity Impact Assessment: Gulpur Hydropower Project*.November 2013. Pakistan.

Huggins, D.G., R. Everhart, A. Dzialowski, J. Kriz, and D. Baker. 2007. *Impact of sedimentationon biological resources: A sediment issue white paper report prepared for the State of Kansas*. Open-file Report No. 146, Kansas Biological Survey, Lawrence, KS. 24 pp.

Lewis, D.J. 1973. *The Simuliidae of Pakistan*. Bulletin of Entomological Research, 62:453-470.

B.7 Wild Life Response-curve Explanations

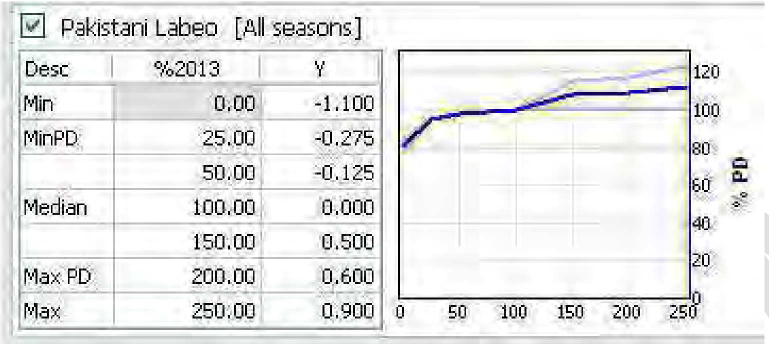
The explanations of the Response Curves are tabulated as **Exhibit B.12** Fish Eating Wildlife, **Exhibit B.13** Wildlife water needs, **Exhibit B.14** Riverine Insectivores.

NB: The Response Curves do not address any of the scenarios directly. The curves are drawn for a range of possible changes in each linked indicator, regardless of what is expected to occur in any of the scenarios. For this reason, some of the explanations refer to conditions that are unlikely to occur under any of the Gulpur HPP scenarios but are needed for completion of the Response Curves. In addition, each response curve assumes that all other conditions are at baseline.

The curves provided below are site specific, although the relationships are similar across all sites. The curves shown below are taken from Gulpur EF Site 2 unless otherwise indicated.

Exhibit B.12: Fish Eating Wildlife

EPT abundance

Response curve	*Explanation*
	This relationship refers to the population of otter which mainly depends on Pakistani labeo for feeding. Abundant population of Pakistani labeo means more food availability for otter resulting in an increase in otter population. A decrease in fish population will result in less food for fish impacting its population.

Pakistani Labeo [All seasons]

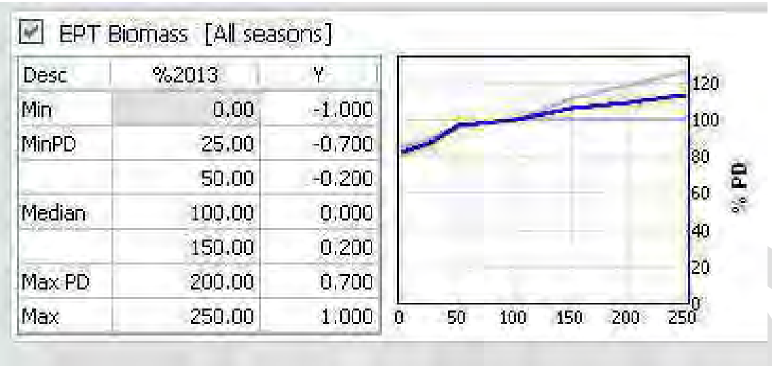
Desc	%2013	Y
Min	0.00	-1.100
MinPD	25.00	-0.275
	50.00	-0.125
Median	100.00	0.000
	150.00	0.500
Max PD	200.00	0.600
Max	250.00	0.900

References

Exhibit B.13: Wildlife water needs

EPT abundance	
Response curve	*Explanation*
	Increasing availability of drinking water will not increase the population of wildlife. However, if the availability of water decreases from the resilience level, the wildlife population will decline.
References	

Exhibit B.14: Riverine Insectivores

<table>
<tr><th colspan="2">EPT abundance</th></tr>
<tr><th>Response curve</th><th>Explanation</th></tr>
<tr><td>
</td><td>Riverine insectivores refer to species that depend upon insects for feeding. An increase in EPT biomass abundance will lead to an increase in the population of riverine insectivores.</td></tr>
<tr><td colspan="2">References</td></tr>
</table>

Appendix C: Evaluation of Additional Scenarios

C.1 Introduction

The preparation for the initial EF scenarios raised concerns as to whether or not constant EF releases were realistic given the design of Gulpur HPP as they would result in sub-optimal efficiencies that would put a strain on the turbines (see Section 4.2). This concern was prompted by the fact that the three Francis 33.33-MW turbines that were planned for use (design report), each had an operational discharge range of 33-66 m^3s^{-1} (where 66 m^3s^{-1} was the installed capacity), but that the daily hydrological record showed that at times inflows to Gulpur reservoir flows dropped below 33 m^3s^{-1}.

Subsequent analysis of the operation of the HPP using daily hydrology confirmed that this was the case, and led to a change in turbine selection to two 50-MW Kaplan units each with a 20 m^3s^{-1} minimum operating discharge (V. Zakaria; HBP, pers. comm.). However, at times inflows to Gulpur reservoir flows drop below 20 m^3s^{-1}. Thus, the turbines would have to be switched off until sufficient water was available to turn them back on. This led to a decision to explore additional scenarios that included this possibility when river flows drop below minimum turbine capacity.

A suite of ten additional scenarios was compiled (Section C.2). These were all evaluated using the design criteria for Option 3 (see Sections 1.1.2 and C.2.1). To facilitate comparison with the original scenarios, NDBAU, NDPro1 and NDPro2 were rerun (Section C.2).

C.2 Additional scenarios evaluated

The ten additional scenarios were evaluated for Option 3 using the DRIFT DSS set up as described in Section 5 and Appendix B. The scenarios differed from one another in terms of the minimum EF release from the Gulpur weir, but were identical in terms of the HPP operating rules (OR) applied and/or protection level. ALL of the scenarios incorporate the design sediment control operating rules (Section 5.5.1).

The HPP operating rules applied were as follows:

Where:
F = river flow in m^3s^{-1}.
C= powerhouse capacity = 198 m^3s^{-1}.
M = minimum turbine capacity = 20 m^3s^{-1}.
E = minimum EF release in m^3s^{-1}.
NOL = normal operating level of the reservoir.

If F >C+E m^3s^{-1}:

- E released from weir;
- C diverted to turbines and released down tailrace;
- remainder spills over weir.

If F between C+E and M+E:

- E released from weir;
- F diverted to turbines and released down tailrace.

If F < M+E:

- NOL maintained;
- turbines switched off;
- F released from weir.

For Protection Levels, each of the additional scenarios was run with:

- Business as usual (BAU) = - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years (Section 5.2).
- Protection Level 2 (Pro 2) = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013; Section 5.2).

The ten additional scenarios were:

G4ORBAU: A 4 m^3s^{-1} minimum release from the Gulpur weir. Protection level BAU.
G4ORPro2: A 4 m^3s^{-1} minimum release from the Gulpur weir. Protection Level 2.
G6ORBAU: A 6 m^3s^{-1} minimum release from the Gulpur weir. Protection level BAU.
G6ORPro2: A 6 m^3s^{-1} minimum release from the Gulpur weir. Protection Level 2.
G8ORBAU: An 8 m^3s^{-1} minimum release from the Gulpur weir. Protection level BAU.
G8ORPro2: An 8 m^3s^{-1} minimum release from the Gulpur weir. Protection Level 2.
G12ORBAU: A 12 m^3s^{-1} minimum release from the Gulpur weir. Protection level BAU.
G12ORPro2: A 12 m^3s^{-1} minimum release from the Gulpur weir. Protection Level 2.
G16ORBAU: A 4 m^3s^{-1} minimum release from the Gulpur weir. Protection level BAU.
G16ORPro2: A 16 m^3s^{-1} minimum release from the Gulpur weir. Protection Level 2.

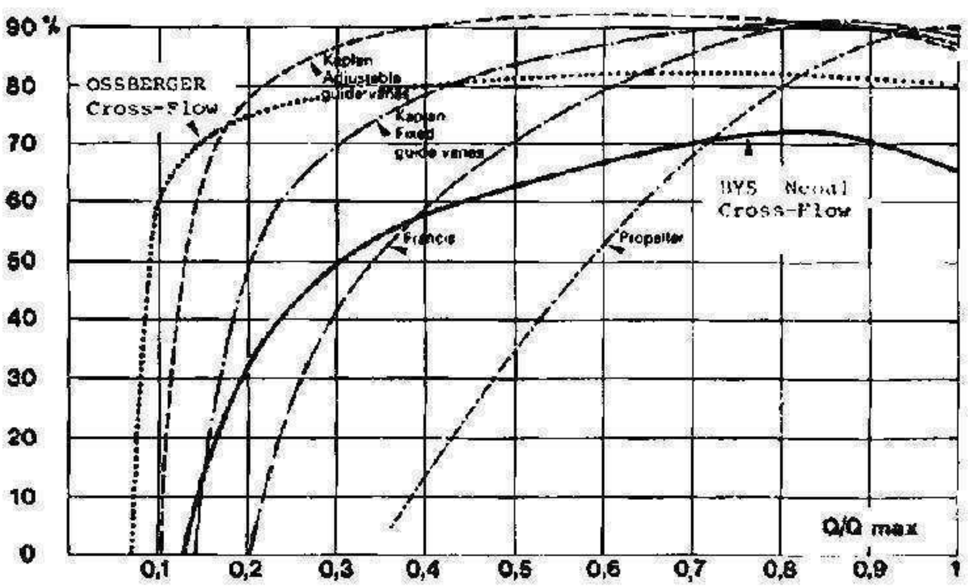
NDPro1: No Gulpur HPP in place; flow and sediment regimes the same as 2013 and Protection Level 1 (Section 5.2).
NDBAU: No Gulpur HPP in place; flow and sediment regimes the same as 2013 and Protection Level BAU.
NDPro2: No Gulpur HPP in place; flow and sediment regimes the same as 2013 and Protection Level 2.

Note: The baseline time-series used for an hypothetical location for Option 3: Site 2, which is situated slightly downstream of Option 1: EF Site 2, would be differ slightly from that in the main report. For ease of comparison, the baseline sequences used here are the same as those in the main report.

C.2.1 Modeling underlying the generation of the scenarios

The following considerations were applied in the modelling of the additional scenarios (detail is provided in the EF Hydraulics Specialist Report; Streamflow Solutions 2014):

- Head losses in the headrace and tailrace were excluded on instruction from HBP.
- The tailwater rating curve from the layout for Option 1 was used, and the stages were reduced by 1 m as the new tailwater for Option 3 is 600 m further downstream than that for Option 1. This may be a conservative adjustment in terms of power generation as the valley slope is c. 0.004, which gives a fall of closer to 2.4 m. However, since head losses in the headrace and tailrace were excluded, the more conservative approach seems fitting.
- The efficiency curve for the Kaplan turbines were taken from the literature (Appendix Figure 1), assuming the most efficient design, which has adjustable vanes.
- No flow was allowed through the turbines when the river flow > 830 m^3s^{-1}. This is to prevent damage to the blades from high sediment loads.
- The minimum discharge through a 50-MW Kaplan turbine is c. 20 m^3s^{-1} (discharge ratio of c. 0.2 and efficiency of c. 78%; Appendix Figure 1), however, the second turbine was allowed to switch on at a (higher) minimum discharge of c. 40 m^3s^{-1} (discharge ratio of c. 0.4 and efficiency of c. 90%). This meant that both turbines could operate more efficiently when the second turbine was switched on, which increased the modelled power generation by c. 2.5 GWa^{-1}. In practice, however, when the second turbine is switched on, depending on the inflow, the flow through the first turbine will be reduced from maximum capacity to compensate for the higher minimum flow through the second turbine.
- Dam evaporation, although small, was included.



Appendix Figure 1 Efficiency curves for various makes and design of turbines (after SKAT 1985; adapted from James Leffel Co).

C.3 Power generation results for the scenarios

The average annual power generation ($GWha^{-1}$) at variable turbine efficiency (as per modelling described in Section C.2.1) for each of EF release levels (where E = minimum EF release in m^3s^{-1}; Section C.2) is given in Appendix Table 1.

Appendix Table 1 Average annual power generation ($GWha^{-1}$) at variable turbine efficiency for each of EF release levels (as per modelling described in Section C.2.1).

Normal Operating Level = 532 m						
MAR = 3989.0 Mm^3a^{-1}						
E	**E**	**Spill**	**E/MAR**	**E+Spill/MAR**	**Average annual power generation ($GWha^{-1}$)**	**Average annual reduction in power generation (%)**
m^3s^{-1}	Mm^3a^{-1}	Mm^3a^{-1}	%	%		
0.0	0.0	1028.3	0.0%	25.8%	395.1	0.0%
4.0	126.2	1025.5	3.2%	28.9%	378.3	4.3%
6.0	189.3	1020.8	4.7%	30.3%	370.4	6.3%
8.0	252.4	1017.1	6.3%	31.8%	362.4	8.3%
12.0	378.4	1001.7	9.5%	34.6%	347.6	12.0%
16.0	503.4	981.5	12.6%	37.2%	333.2	15.7%

C.4 Biophysical results for the scenarios

For each scenario, the predicted changes in the study rivers are evaluated per site as:

- estimated mean percentage change from baseline[1] in the abundance, area or concentration of key indicators;
- time-series of abundance, area or concentration of key indicators under the flow regime resulting from each scenario.

The predicted changes in Overall Ecosystem Integrity, relative to baseline, associated with each scenario at each site are provided in Sections C.4.1 to C.4.4, and the combined integrity is provided in Section C.4.5.

C.4.1 Gulpur EF Site 1 (Kallar Bridge)

There are no flow changes at EF Site 1 associated with Gulpur HPP as the site is upstream of the reservoir. EF Site 1 will be affected by Gulpur weir and reservoir as described in Section 6.1. The additional BAU scenarios are equivalent to the original GXBAU, and the additional Pro 2 scenarios are equivalent to the original GXPro2 (see Section 6.1).

[1] Baseline ecological conditions are those measured in 2013.

C.4.2 Gulpur EF Site 2 (Borali Bridge)

EF Site 2 is located between the weir and the tailrace. As such it represents the potentially 'dewatered' zone and is directly affected by EF releases made at the weir. It is also affected by the barrier that Gulpur weir poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir, such as an increase in zooplankton, a decrease in oxygen or a change in water temperature.

C.4.2.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 2

The main characteristics of the flow regimes at Gulpur EF Site 2 associated with each of the additional scenarios are summarised in Appendix Table 2.

Appendix Table 2 Characteristics of the flow regime of the additional scenarios at Gulpur EF Site 2 (Borali Bridge). Median values are given for the flow indicators. Italicised scenarios are repeats (see Section 6.2 and C.2).

Scenario/EF indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	m^3s^{-1}	weeks[2]	m^3s^{-1}	days	weeks	m^3s^{-1}	days
NDPro1	*126.38*	*40*	*20.14*	*114*	*7.0*	*712.20*	*225.0*
NDBAU	*126.38*	*40*	*20.14*	*114*	*7.0*	*712.20*	*225.0*
NDPro2	*126.38*	*40*	*20.14*	*114*	*7.0*	*712.20*	*225.0*
G4ORBAU	32.62	34	4.02	201	12.5	594.52	142.5
G4ORPro2	32.62	34	4.02	201	12.5	594.52	142.5
G6ORBAU	34.50	34	6.03	201	12.5	594.72	142.5
G6ORPro2	34.50	34	6.03	201	12.5	594.72	142.5
G8ORBAU	36.51	34	8.03	201	12.5	594.92	142.5
G8ORPro2	36.51	34	8.03	201	12.5	594.92	142.5
G12ORBAU	40.10	34	12.03	201	12.5	595.32	142.5
G12ORPro2	40.10	34	12.03	201	12.5	595.32	142.5
G16ORBAU	42.90	34	16.04	199	12.5	595.32	142.5
G16ORPro2	42.90	34	16.04	199	12.5	595.32	142.5

C.4.2.2 Mean percentage changes

The mean percentage changes (relative to Baseline) for the indicators for the additional scenarios at Gulpur EF Site 2 (Borali Bridge) are given in Appendix Table 3.

The values provided in Appendix Table 3 are averages for the last 30 years of the record (1982-2012).

2 Weeks = calendar weeks

Appendix Table 3 Gulpur EF Site 2: The mean percentage changes in abundance (relative to Baseline) for the indicators under the additional scenarios. Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%. Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%. Italicised scenarios are repeats (see Sections 6.2 and C.2).

Indicators		*NDPro1*	*NDBAU*	*NDPro2*	G4ORBAU	G4ORPro2	G6ORBAU	G6ORPro2	G8ORBAU	G8ORPro2	G12ORBAU	G12ORPro2	G16ORBAU	G16ORPro2
Geomorphology	Active channel width	*-0.7*	*-0.7*	*-0.7*	-49.7	-49.7	-48.7	-48.7	-46.1	-46.1	-28.6	-28.6	-20.3	-20.3
	Area of silt/mixed deposits	*-3.2*	*-8.7*	*0.7*	-14.8	-9.7	-16.6	-10.8	-17.1	-11.0	-18.2	-11.5	-20.3	-12.6
	Area of cobble bars	*2.3*	*-15.7*	*1.0*	-45.9	-21.7	-45.9	-21.7	-45.9	-21.7	-45.9	-21.7	-45.9	-21.7
	Bed sediment type (armouring)	*-13.4*	*-21.1*	*-6.5*	20.6	35.2	21.6	36.2	22.2	36.8	22.6	37.2	23.9	38.5
	Depth of pools	*4.1*	*-7.6*	*3.1*	-49.7	-32.2	-36.5	-19.0	-31.7	-14.3	-22.2	-4.8	-19.9	-2.5
	Area of 2o channels and backwaters	*-9.6*	*-10.5*	*-0.1*	-41.8	-33.8	-41.8	-33.8	-41.8	-33.8	-41.8	-33.8	-41.7	-33.7
Water Quality	Nutrients	*26.8*	*105.7*	*10.7*	130.2	27.3	127.5	24.6	122.5	20.2	114.5	14.7	106.7	10.1
	Temperature	*0.3*	*0.3*	*0.3*	-0.7	-0.7	1.0	1.0	2.8	2.8	5.1	5.1	7.1	7.1
Algae	Periphyton biomass	*-1.1*	*9.8*	*-2.1*	5.7	1.4	5.1	1.2	4.3	0.8	3.2	0.2	2.5	0.0
Riparian vegetation	Dry bank trees and shrubs	*-19.6*	*-35.7*	*27.4*	-40.3	22.8	-40.3	22.8	-40.3	22.8	-40.3	22.8	-40.3	22.8
Macro-invertebrates	Simulidae	*-6.2*	*-10.7*	*-1.9*	7.5	19.3	9.5	21.4	12.3	24.4	24.7	37.0	30.9	43.3
	EPT biomass	*5.0*	*8.2*	*-5.7*	-16.4	8.7	-15.1	6.4	-12.8	3.6	-3.5	1.5	1.2	2.4
Fish	Pakistani labeo	*-58.8*	*-77.0*	*58.1*	-99.7	-26.0	-98.9	-4.5	-98.9	-1.5	-98.6	4.7	-98.0	10.5
	Mahaseer	*-55.1*	*-92.3*	*51.2*	-100.0	-92.9	-100.0	-90.8	-100.0	-87.1	-100.0	-60.5	-99.9	-41.5
	Twin-banded loach	*-1.4*	*-54.4*	*46.5*	-100.0	-90.2	-100.0	-82.8	-100.0	-78.4	-99.4	-50.1	-91.1	-13.5
	Kashmir catfish	*-8.0*	*-61.7*	*15.3*	-100.0	-91.0	-100.0	-88.7	-100.0	-85.9	-99.9	-70.7	-98.4	-45.2
	Garua bachwaa	*-59.5*	*-94.0*	*85.6*	-95.0	-88.8	-95.0	-88.8	-95.0	-88.2	-95.0	-53.4	-95.0	-9.5
Wildlife	Fish-eating wildlife	*-53.0*	*-84.2*	*37.8*	-100.0	-40.1	-100.0	-12.5	-100.0	-10.9	-100.0	-7.6	-100.0	-4.6
	Wildlife water needs	*0.0*	*0.0*	*0.0*	-100.0	-100.0	-83.6	-83.6	-59.9	-59.9	-13.5	-13.5	0.0	0.0
	Riverine insectivores	*-1.8*	*2.7*	*-5.2*	-42.1	-3.1	-39.1	-5.3	-33.5	-7.1	-13.2	-7.2	-4.6	-5.4

C.4.2.3 Time-series

The time-series for the scenarios for the biophysical indicators (Appendix Figure 2 to Appendix Figure 9) show the annual changes in abundance behind the mean values given in Appendix Table 3. The period simulated is 1960-2010. These show the year-on-year changes in each indicator in response to the prevailing conditions. These conditions, derived using the historical flow records (1960-2012), show the predicted response for each indicator, under the condition specified in each scenario, should the same flow conditions be replicated into the future. In the plots, some scenario lines are hidden underneath others. Where the visible scenarios are quite different, the location of the hidden scenario(s) is given in the text.

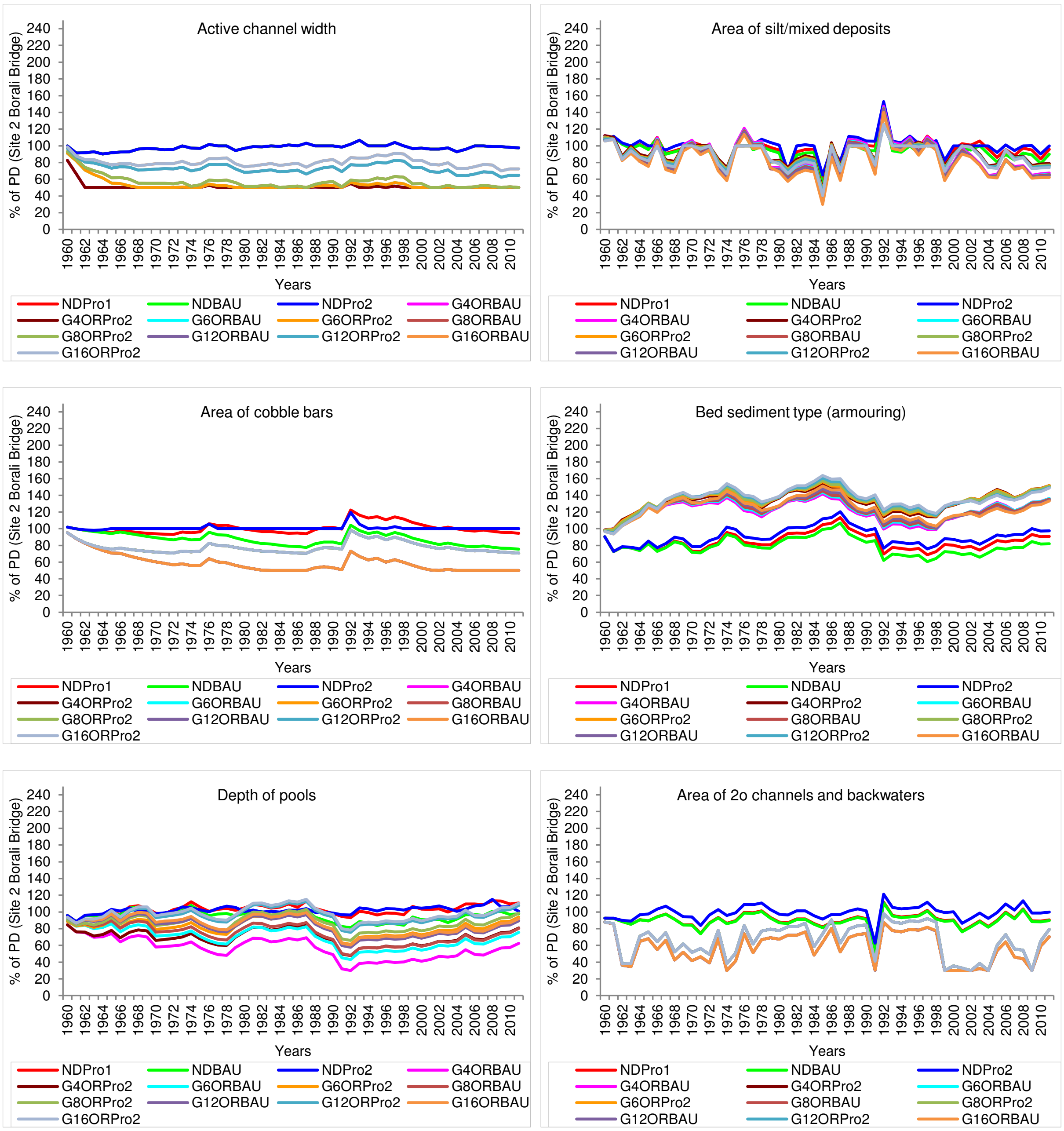
Geomorphology

The changes in geomorphology at EF Site 2 (Appendix Figure 2) are driven by:

- reduced bedload supply;
- reduced suspended sediment supply for much of the year as a result of trapping of sediments in the reservoir;
- higher peaks in suspended sediment during summer flushing, and,
- reduced flows in the dry, transitional and wet seasons, which would reduce sediment movement in the reach represented by EF Site 2.

The overall predictions, relative to the no dam (ND) scenarios, are that channel width would decrease, with a gradual armouring of the river bed and a reduction in secondary channels and backwaters.

The effects of the two management options (BAU and Pro 2) are overlaid on the effects of the weir, in that BAU is expected to result in a decrease in sediment size and pool depth.



Appendix Figure 2 Time-series of predicted changes in geomorphological indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

Water Quality

There are no water quality changes expected at EF Site 2 as a result of the presence of Gulpur weir (Appendix Figure 3). There may be some small temperature effects associated with the releases but, provided there is no stratification in the reservoir[3], these are expected to be minor. The differences between the scenarios are driven by the two management options. BAU is expected to result in an increase in the amount of nutrients entering the

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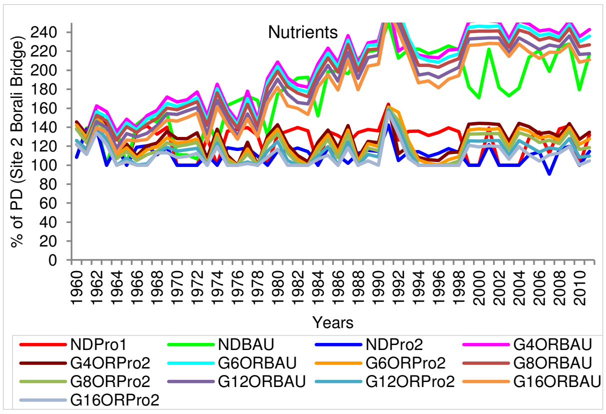
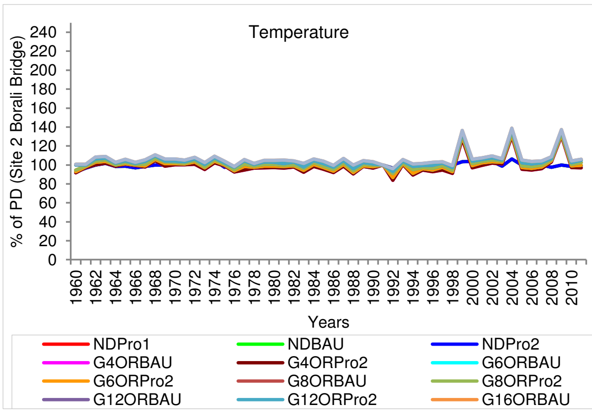
[3] Given the size of the reservoir relative to inflow, and the release schedules envisaged, stratification is unlikely (NESPAK pers. comm.).

river from towns and settlements in the upper catchment. The protection measures associated with Pro2 should result in decreased nutrient inflows into the system.

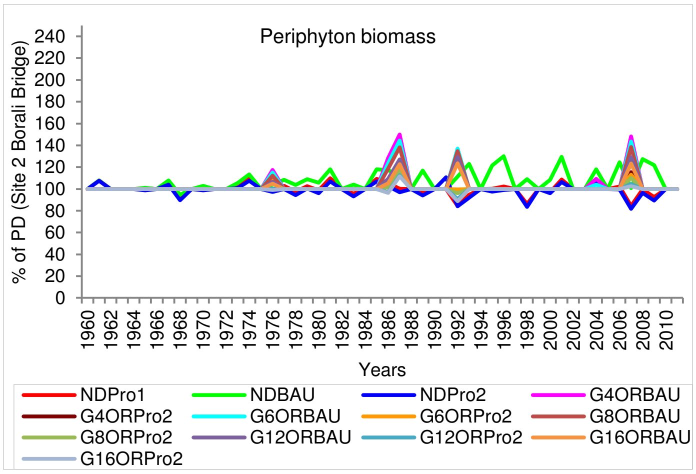




Appendix Figure 3 Time-series of predicted changes in water quality indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

Algae

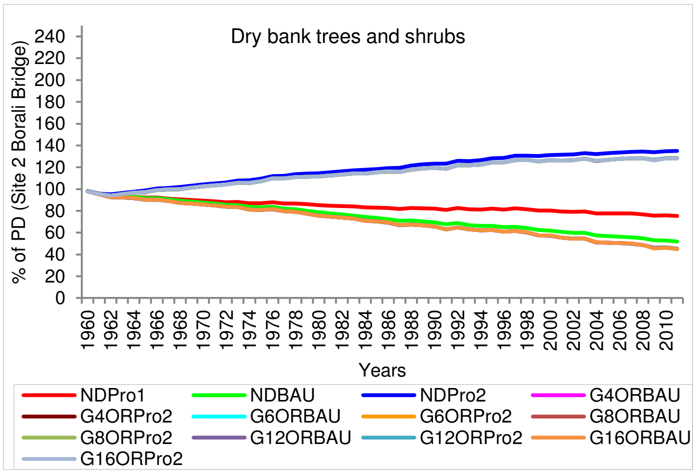
The periphyton changes predicted for EF Site 2 are likely to take the form of sporadic changes in periphyton densities in response to climatic and catchment conditions (such as inflows of nutrients; Appendix Figure 4). It is extremely difficult to predict where, when and over what area these will occur. However, the lower flows and clearer water at EF Site 2 will increase the chance of periphyton growth.



Appendix Figure 4 Time-series of predicted changes in algal indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

Riparian Vegetation

The reduced flows downstream of Gulpur weir, combined with the barrier to the downstream movement of seeds, are expected to result in a small decline in riparian vegetation at EF Site 2 (Appendix Figure 5). The main differences between the scenarios, however, are driven by the two management options. BAU is expected to result in an increase in the harvesting of shrubs and trees from the riparian area, whereas the protection measures associated with Pro2 should result in decreased harvesting and increased density of the riparian vegetation.

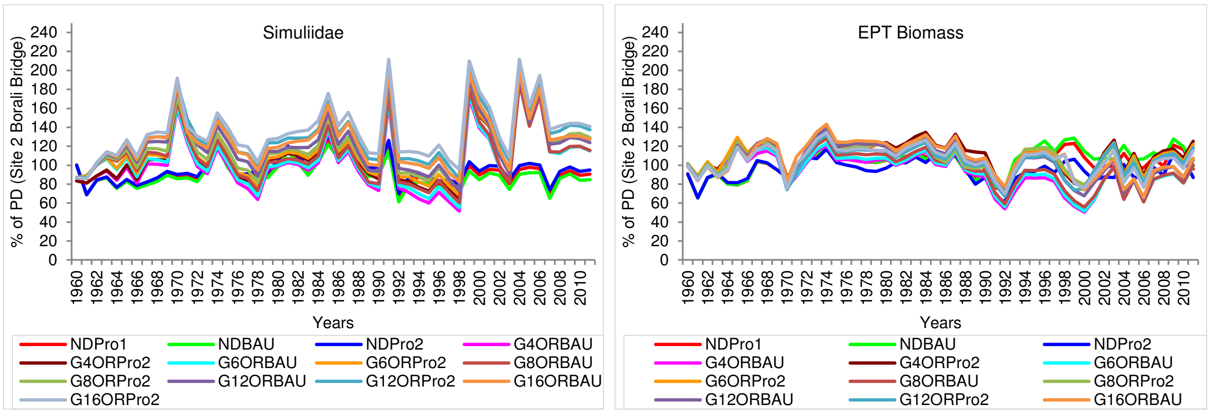


Appendix Figure 5 Time-series of predicted changes in vegetation indicators at EF Site 2. Scenario lines not visible are hidden by those showing. G4-, G6-, G8, G12- and G16ORPro overlie each other; and G4-, G6-, G8- and G16ORBAU overlie each other.

Macroinvertebrates

The lower constant flows at EF Site 2 under G4, G8 and G16 are likely to favour Simuliidae, many species of which favour stable low flows (Appendix Figure 6). Their food source is also likely to increase slightly, through conditions that favour plankton. Simuliids could also increase in abundance with the expected decline in fine sediments and armouring of the river bed (Berry et al 2003).

A drop in turbidity of the water column can increase primary and secondary production, which will provide more food for invertebrates (Huggins et al. 2007). The expected decline in suspended sediments will also reduce abrasion, and will favour higher populations of invertebrates. However, a slight decline in EPT is predicted related to reduction in available habitat (Appendix Figure 6), probably exacerbated by competition from other aquatic life such as Simuliidae.



Appendix Figure 6 Time-series of predicted changes in invertebrate indicators at EF Site 2. Scenario lines not visible are hidden by those showing.

Fish

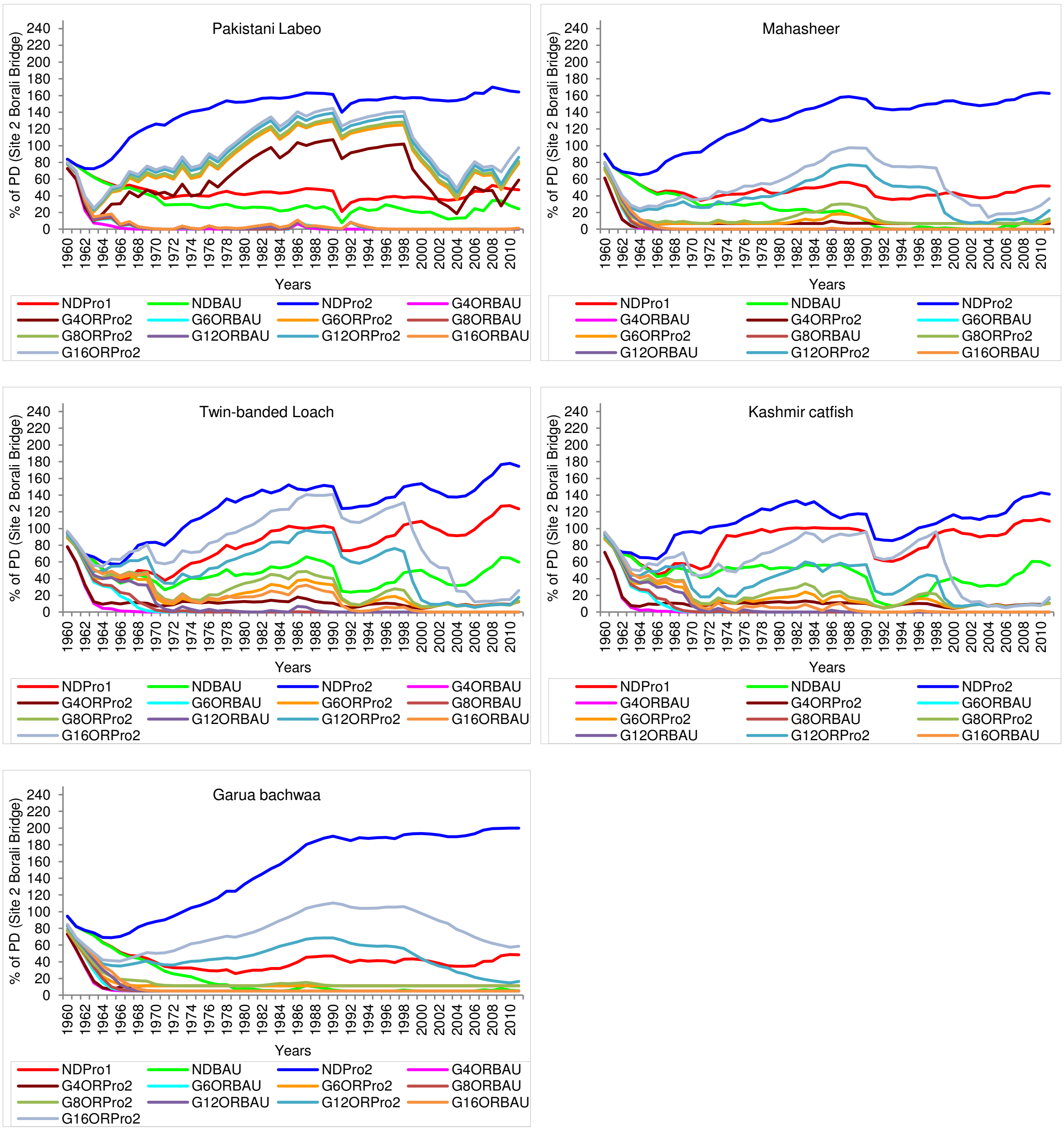
The effect of Gulpur weir is related to:

- reduced flows in the dry, transitional and wet seasons, which are expected to reduce available habitat;
- reduction in macroinvertebrates, which are a food source for some of the fish;
- increased periphyton, which is a food source for some of the fish;
- the barrier to longitudinal movement of Pakistani labeo, mahaseer and garua backwaa, but particularly mahaseer, because about 90% of its breeding habitat is located upstream of the weir, and it does not breed in the Jhelum River.

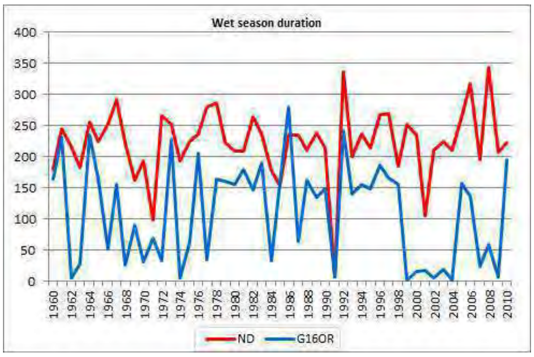
BAU scenarios are predicted to result in extremely low number of fish at EF Site 2, regardless of whether or not Gulpur weir is present.

G4-, G6-, G8-, G12- and G16ORPro 2 all result in better situations for the Pakistani labeo than the no dam situation with no increase in current pressures (NDPro 1).

For the remaining species, the release of 4 m^3s^{-1} is predicted to result in the elimination of these species from this reach or at least reduction to extremely low numbers. Releases of 6 and 8 m^3s^{-1} are predicted to result in very low numbers of fish in this reach, but probably no extinctions. Releases of 12 and 16 m^3s^{-1}, together with Protection Level 2 measures, are expected to maintain most of the fish community, albeit in reduced numbers for some. Both G12ORPro2 and G16ORPro 2 would result in better situations for the garua backwaa than the no dam situation with no increase in current pressures (NDPro1), although the populations appear to be more susceptible to droughts and floods, i.e., lower resilience, with the reduced flows. For instance, the Pakistani labeo population drops between 1999 and 2005 relative to the NDPro1 and NDPro2 options. The reason for this is that, with Gulpur in place, the wet season basically fails for this period (see blue line in Appendix Figure 8), which means less feeding time and little or no breeding for the labeo. A similar situation arises for mahaseer, the loach and the catfish.



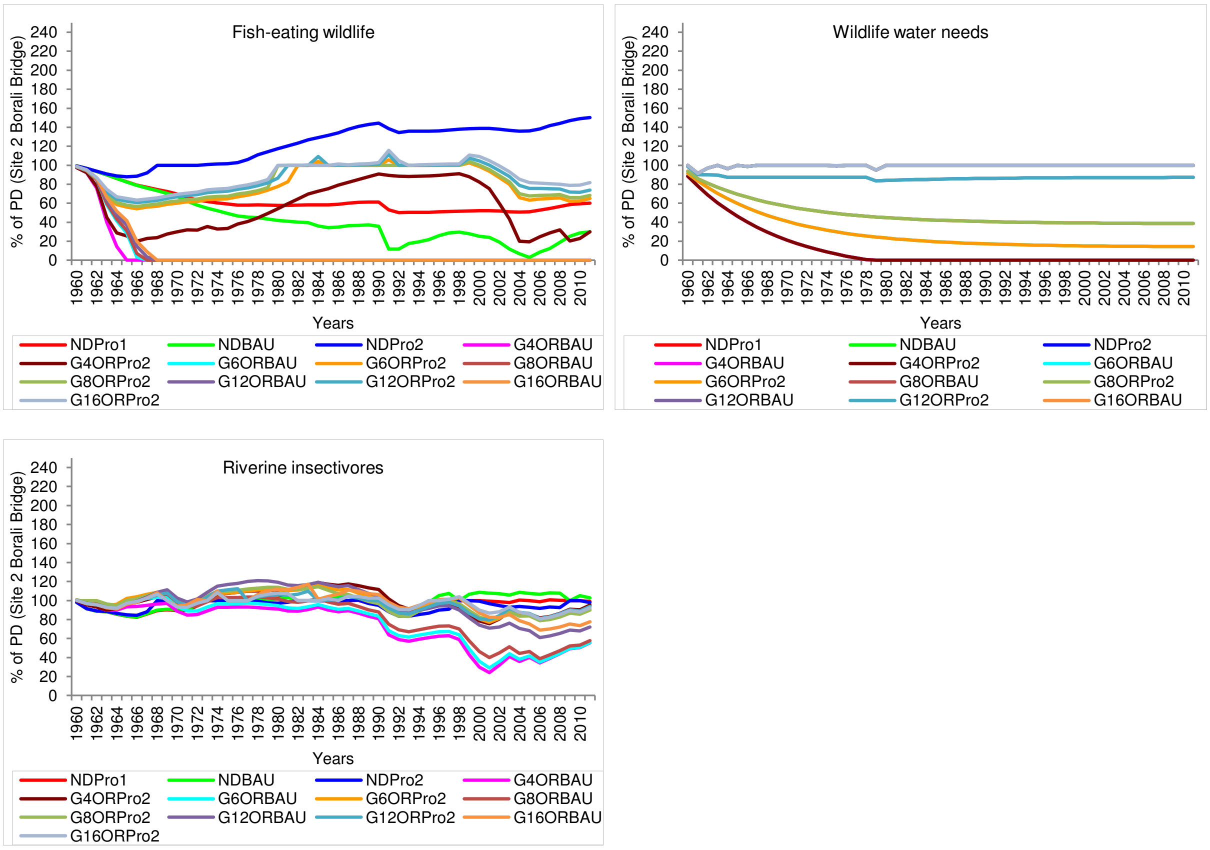
Appendix Figure 7 Time-series of predicted changes in fish indicators at EF Site 2. Scenario lines not visible are hidden by those showing.



Appendix Figure 8 Wet season durations for the ND and G16 scenarios.

Wildlife

It is expected that fish-eating wildlife, such as otter, would show very similar changes in abundance to their main food source, the fish. They would thrive under a scenario of no dam and level 2 protection measures but would likely disappear from the mainstem river in this area under the three BAU scenarios (Appendix Figure 9).



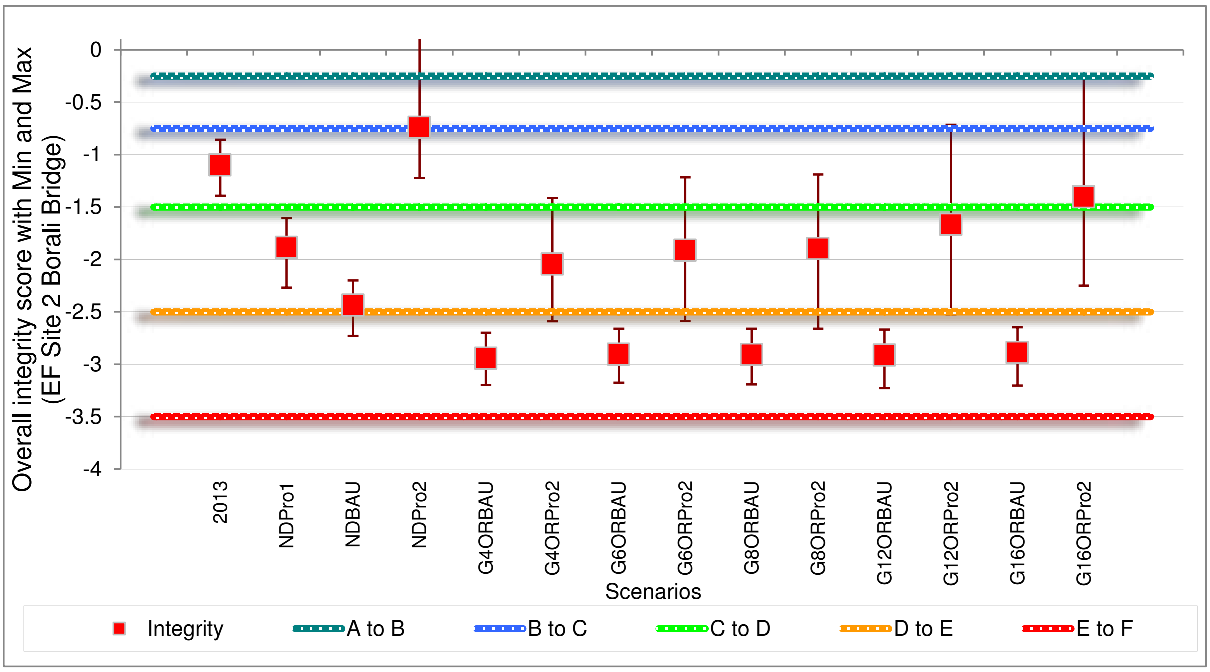
Appendix Figure 9 Time-series of predicted changes in wildlife indicators at EF Site 2. Scenario lines not visible are hidden by those showing. For wildlife water needs: NDPro1, NDBAU, NDPro2, G12ORPro2, G12ORBAU and G16ORBAU are all hidden beneath G16Pro2; G4BAU is under G4Pro2; G6BAU is under G6Pro2; G8BAU is under G8Pro2.

Wildlife that is dependent on the river for drinking water is likely to be deterred if flows are too low and they have to walk some distance across the exposed rocky channel. For this reason, it is predicted that G16OR and G12OR will have little or no impact on these wildlife, but G8OR and G6OR could result in a decline in their numbers, and G4OR could result in the animals seeking other water sources. The protection levels proposed do not affect these animals.

The small insect-eating birds that rely on the river for food would decline in numbers as their food source (EPT invertebrates: mayflies, stoneflies, caddisflies) also declines. Among the scenarios that include the dam, those incorporating level 2 protection would enhance their numbers most and those that follow BAU would cause the greatest decline.

C.4.2.4 Overall Ecological Integrity

The Overall Integrity for each the scenarios at Gulpur EF Site 2 are illustrated in Appendix Figure 10.



Appendix Figure 10 Overall ecosystem integrity scores for the additional scenarios at Gulpur EF Site 2 (Borali Bridge). Baseline (2013) integrity is shown on the extreme left.

In general, the additional scenarios result in slightly less impact on the downstream river ecosystem that the equivalent EF releases for the original scenarios. This is because, under the additional scenarios, the turbines are shutoff when flow drops below 20 m^3s^{-1} plus the EF release, so the river as represented by EF Site 2 receives more water during the direst times in the record than was the case for the original scenarios. This is particularly the case for the scenarios with higher EF releases, such as G12ORPro2 and G16ORPro2, as these releases result in higher inflows (32 and 36 m^3s^{-1}, respectively) at which the turbines must be switched off, and thus more frequent periods of no power generation when EF Site 2 receives the full river flow.

Except for G4ORPro2, the other scenarios with Protection Level 2 are predicted to enhance the integrity of the river ecosystem at EF Site 2 relative to 2013 condition or at least result in little change. In terms of overall health, there is little to choose from between G6ORPro and G8ORPro, both of which should maintain overall health at about 2013 levels. River health would decline under the BAU scenarios. With Gulpur weir in place, it is predicted that the condition would drop two condition classes from baseline to a highly impacted E category.

C.4.3 Gulpur EF Site 3 (Gulpur Bridge)

EF Site 3 is downstream of the Gulpur tailrace and receives the flow returning to the river after diversion downstream of EF Site 1 and passage through the power house. As modelled, the flow at EF Site 3 is essentially the same as at EF Site 1. This is because the reservoir at the dam is small and cannot store much water, and also because the approved design for the dam excludes peaking hydropower releases.

As with the other sites, EF Site 3 is affected by the barrier that the Gulpur weir poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir or tunnel, such as an increase in zooplankton or a decrease in oxygen.

C.4.3.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 3

The main characteristics of the flow regimes at Gulpur EF Site 3 associated with each of the scenarios are summarised in Appendix Table 4.

Appendix Table 4 Characteristics of the flow regime of the additional scenarios at Gulpur EF Site 3. Median values are given for the flow indicators. Italicised scenarios are repeats (see Sections 6.2 and C.2).

Scenario/EF indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	m^3s^{-1}	weeks[4]	m^3s^{-1}	days	weeks	m^3s^{-1}	days
NDPro1	*128.91*	*40*	*20.55*	*114*	*7*	*726.46*	*225*
NDBAU	*128.91*	*40*	*20.55*	*114*	*7*	*726.46*	*225*
NDPro2	*128.91*	*40*	*20.55*	*114*	*7*	*726.46*	*225*
G4ORBAU	128.91	40	20.55	114	7	726.46	225
G4ORPro2	128.91	40	20.55	114	7	726.46	225
G6ORBAU	128.91	40	20.55	114	7	726.46	225
G6ORPro2	128.91	40	20.55	114	7	726.46	225
G8ORBAU	128.91	40	20.55	114	7	726.46	225
G8ORPro2	128.91	40	20.55	114	7	726.46	225
G12ORBAU	128.91	40	20.55	114	7	726.46	225
G12ORPro2	128.91	40	20.55	114	7	726.46	225
G16ORBAU	128.91	40	20.55	114	7	726.46	225

The scenario time-series for EF Sites 3 and 4 are the same for all EF releases, and are almost identical to those for the original scenarios. The only difference may be because dam

[4] Weeks = calendar weeks

evaporation was included in the additional scenarios, and some small differences in scaling the discharge from the Rehman Bridge Gauge. None of which materially affect the predicted outcomes for the river.

C.4.3.2 Mean percentage changes

The mean percentage changes (relative to Baseline) for the indicators for the scenarios at Gulpur EF Site 3 (Gulpur Bridge) are given in Appendix Table 5. The values provided in Table 6.6 are averages for the last 30 years of the record (1982-2012). This is because the modeled influence of the management options takes c. 5-10 years to take effect, and so early part of the record can be quite different from the middle and later part (see time-series graphs in Section C.4.3.3).

C.4.3.3 Time-series

The time-series for the scenarios for the biophysical indicators (Appendix Figure 11 to Appendix Figure 17) show the annual changes in abundance encapsulated in the mean values given in Appendix Table 5.

The period simulated is 1960-2010. The plots show the year-on-year changes in each indicator in response to the prevailing conditions. These conditions, derived using the historical flow records, show the predicted response for each indicator, under the condition specified in each scenario, should the same flow conditions be replicated into the future. In the plots, some scenario lines are hidden underneath others. Where the visible scenarios are quite different, the location of the hidden scenario(s) is given in the text.

Geomorphology

The changes in geomorphology at EF Site 3 (Appendix Figure 11) are driven by:

- reduced bedload supply; and,
- reduced suspended sediment supply for much of the year as a result of trapping of sediments in the reservoir.

The overall predictions, relative to the no dam (ND) scenarios, are that channel width would remain about the same, with a gradual armouring of the river bed and a concomitant (but small) loss of cobble bars.

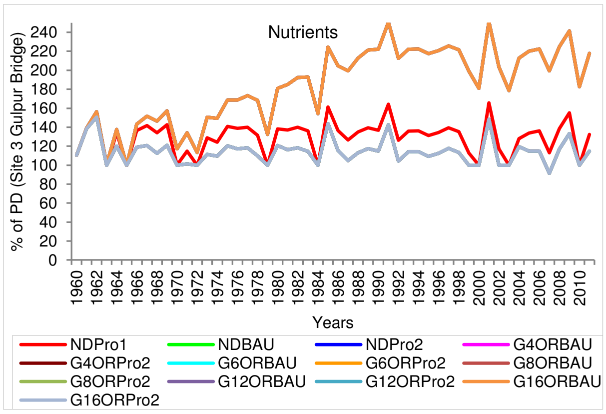
Appendix Table 5 Gulpur EF Site 3: The mean percentage changes (relative to 2013) for the indicators under the additional scenarios. Blue and green are major changes that represent a move towards natural: green = 40-70% change from baseline; blue = >70%. Orange and red are major changes that represent a move away from natural: orange = 40-70%; red = >70%. Baseline, by definition, equals 100%. Italicised scenarios are repeats (see Sections 6.2 and C.2).

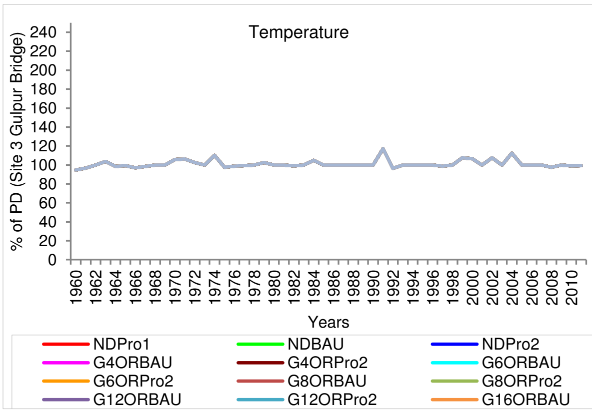
Indicators		*NDPro1*	*NDBAU*	*NDPro2*	G4ORBAU	G4ORPro2	G6ORBAU	G6ORPro2	G8ORBAU	G8ORPro2	G12ORBAU	G12ORPro2	G16ORBAU	G16ORPro2
Geomorphology	Active channel width	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
	Area of silt/mixed deposits	-3.3	-8.8	0.7	-10.5	-0.5	-10.5	-0.5	-10.5	-0.5	-10.5	-0.5	-10.5	-0.5
	Area of cobble bars	2.3	-15.7	2.0	-44.3	-18.5	-44.3	-18.5	-44.3	-18.5	-44.3	-18.5	-44.3	-18.5
	Bed sediment type (armouring)	-12.3	-20.0	-5.4	14.1	28.6	14.0	28.6	14.0	28.6	14.0	28.6	14.0	28.6
	Depth of pools	0.8	-10.9	1.2	-21.4	-4.0	-21.4	-4.0	-21.4	-4.0	-21.4	-4.0	-21.4	-4.0
	Area of 2o channels and backwaters	-9.2	-10.1	0.3	-15.0	-4.6	-15.0	-4.6	-15.0	-4.6	-15.0	-4.6	-15.0	-4.6
Water Quality	Nutrients	31.6	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1
	Temperature	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Algae	Periphyton biomass	-1.1	10.0	-2.1	9.8	-2.2	9.8	-2.2	9.8	-2.2	9.8	-2.2	9.8	-2.2
Riparian vegetation	Dry bank trees and shrubs	-16.6	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3
Macro-invertebrates	Simulidae	-5.6	-10.1	-1.3	6.5	17.7	6.4	17.6	6.4	17.6	6.4	17.6	6.4	17.6
	EPT biomass	5.0	7.9	-5.4	12.9	7.1	12.9	7.1	12.9	7.1	12.9	7.1	12.9	7.1
Fish	Pakistani labeo	-59.1	-87.4	58.9	-88.5	60.8	-88.5	60.8	-88.5	60.8	-88.5	60.8	-88.5	60.8
	Mahaseer	-58.4	-94.4	51.3	-100.0	-7.7	-100.0	-7.8	-100.0	-7.8	-100.0	-7.8	-100.0	-7.8
	Twin-banded loach	-1.2	-53.3	48.2	-6.7	89.3	-6.9	89.3	-6.9	89.3	-6.9	89.3	-6.9	89.3
	Kashmir catfish	-7.9	-62.2	19.6	-46.0	57.4	-46.1	57.3	-46.1	57.3	-46.1	57.3	-46.1	57.3
	Garua bachwaa	-60.3	-95.7	80.2	-99.0	64.4	-99.0	64.2	-99.0	64.2	-99.0	64.2	-99.0	64.2
Wildlife	Fish-eating wildlife	-53.0	-99.2	39.3	-99.4	42.0	-99.4	42.0	-99.4	42.0	-99.4	42.0	-99.4	42.0
	Wildlife water needs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riverine insectivores	-1.7	2.7	-4.5	1.2	-0.9	1.2	-0.9	1.2	-0.9	1.2	-0.9	1.2	-0.9

Appendix Figure 11 Time-series of predicted changes in geomorphological indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

Water Quality

The scenarios plot according to the protection measures indicating that no major water quality changes are predicted for EF Site 3 as a result of the presence of Gulpur weir (Appendix Figure 12). Some changes are predicted, however, due to the two management options. The BAU scenarios are expected to result in an increase in the amount of nutrients entering the river from towns and settlements in the upper catchment and thus higher levels in the river. The protection measures associated with Pro2 should result in decreased nutrient inflows into the system.

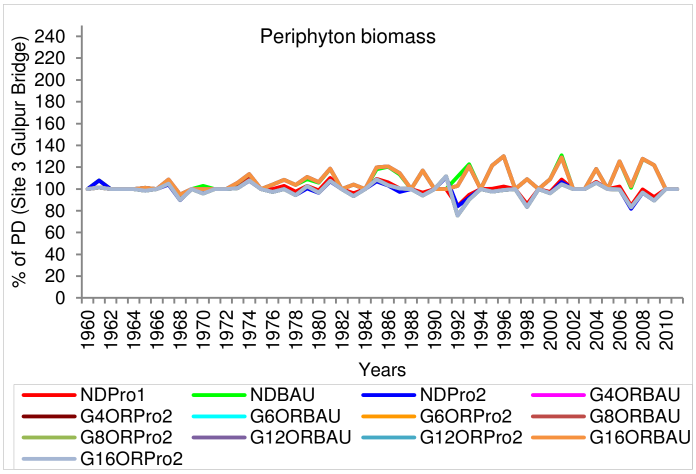




Appendix Figure 12 Time-series of predicted changes in water quality indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

Algae

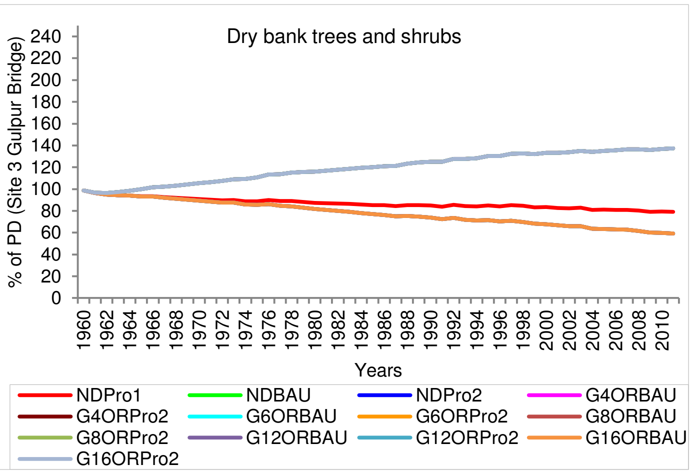
The periphyton changes predicted at EF Site 3 are likely to take the form of sporadic changes in periphyton densities in response to climatic and catchment conditions (such as inflows of nutrients; Appendix Figure 13). Because of their ephemeral nature, it is not possible to predict where, when and over what area these will occur. However, the clearer water at EF Site 3 is expected to favour periphyton growth.



Appendix Figure 13 Time-series of predicted changes in algal indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

Riparian Vegetation

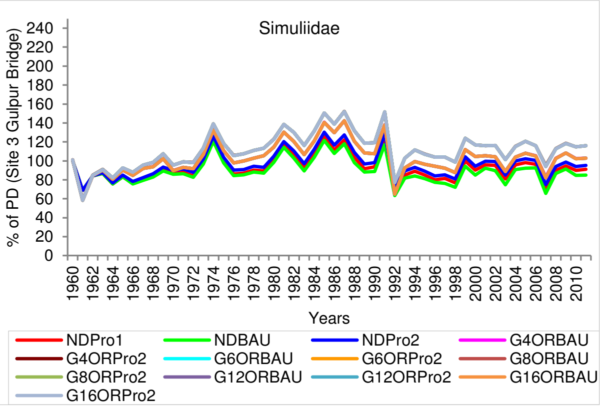
There are no major changes in riparian vegetation expected at EF Site 3 as a result of the presence of Gulpur weir (Appendix Figure 14), but differences between the scenarios are expected because of the management options. The BAU scenario is expected to result in an increase in the harvesting and utilization of trees and shrubs from the riparian area, whereas the Pro2 protection measures will be aimed at halving harvesting in the riparian area, which should result in an increase in the density of riparian vegetation.

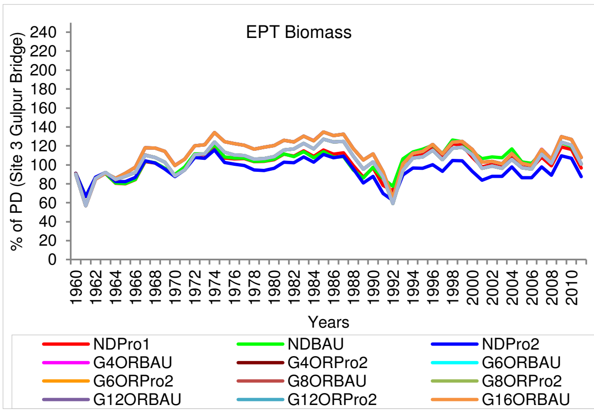


Appendix Figure 14 Time-series of predicted changes in vegetation indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

Macroinvertebrates

Aquatic invertebrates would remain at approximately baseline abundances under all scenarios (Appendix Figure 15).

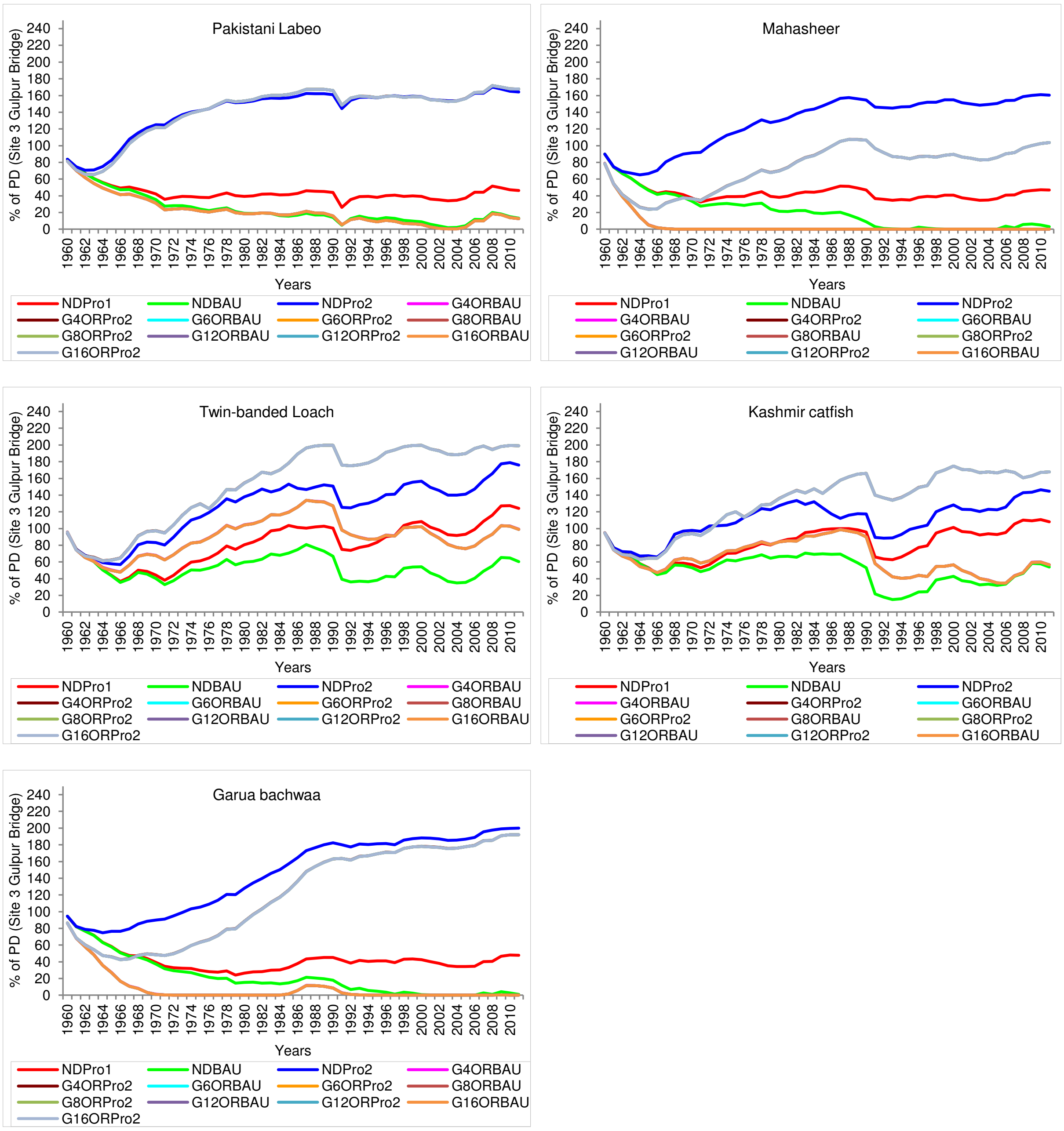




Appendix Figure 15 Time-series of predicted changes in invertebrate indicators at EF Site 3. Scenario lines not visible are hidden by those showing.

Fish

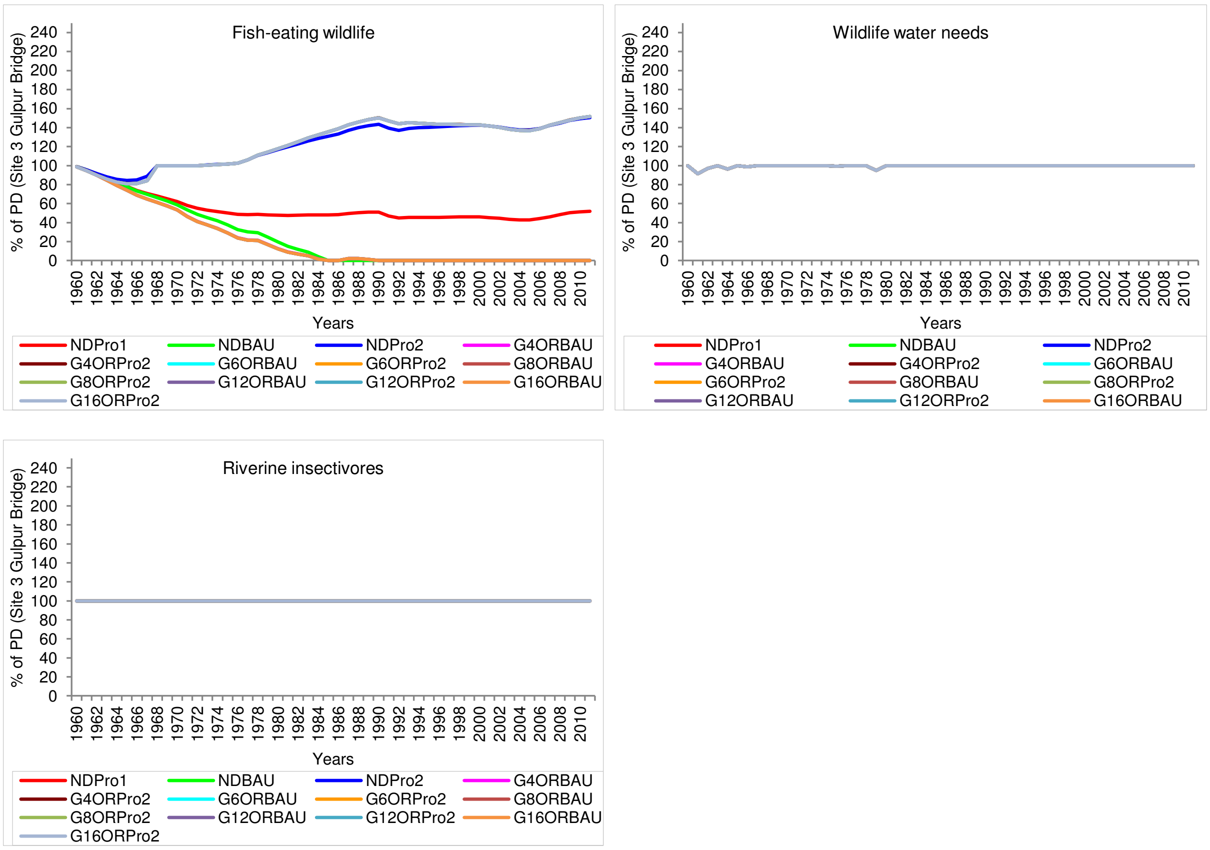
The fish species (Appendix Figure 16) are predicted to increase in abundance, or at least maintain approximately baseline levels, under Protection Level 2, even with Gulpur weir in place. In fact, the expected increase in some macroinvertebrates with the weir in place as a result of fewer sediments may benefit some of the fish, such as Kashmir catfish. Under the BAU scenarios they would decline in abundance as a result of overfishing.



Appendix Figure 16 Time-series of predicted changes in fish indicators at EF Site 3. Scenario lines not visible are hidden by those showing. G4-, G6-, G8 and G12ORPro2 are under G16ORPro2, and G4-, G6-, G8- and G12ORBAU are under G16ORBAU.

Wildlife

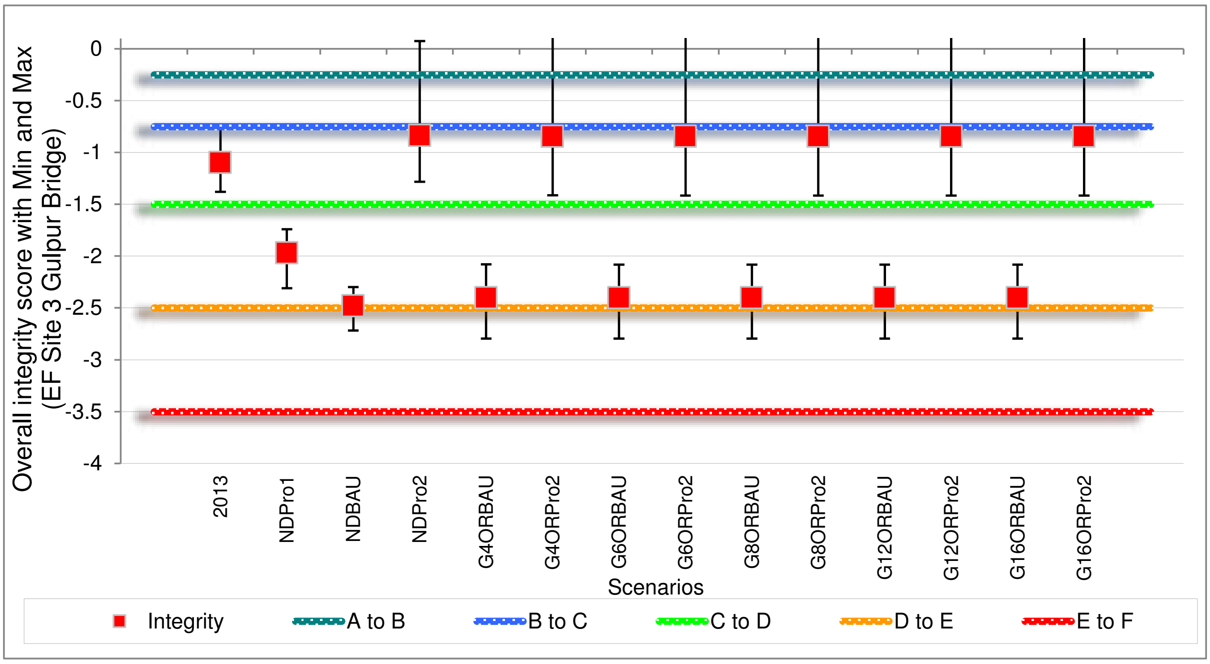
Fish-eating wildlife at EF Site 3 are predicted to follow much the same patterns of abundance as the fish they eat., while no impacts are expected on the wildlife that depend on the rivers for water or invertebrate food (Appendix Figure 17).



Appendix Figure 17 Time-series of predicted changes in wildlife indicators at EF Site 3. Scenario lines not visible are hidden by those showing. For wildlife water needs all the scenarios are underneath G16Pro2.

C.4.3.4 Overall Integrity

The Overall Integrity for each the scenarios at Gulpur EF Site 3 is illustrated in Appendix Figure 18. All of the scenarios with Protection Level 2 would enhance the integrity of the river ecosystem at EF Site 3. River health would decline under Protection Level 1 and the BAU scenarios, dropping to a low D category for BAU.



Appendix Figure 18 Overall ecosystem integrity scores for the scenarios at Gulpur EF Site 3 (Gulpur Bridge). Baseline (2013) integrity is shown on the extreme left.

C.4.4 Gulpur EF Site 4 (Billiporian Bridge)

EF Site 4 is downstream of EF Site 3 and the Gulpur tailrace. As is the case with EF Site 3, it is mainly affected by flow returning to the river after passing through the power house. The site is also affected by the barrier that the Gulpur weir poses to sediments and fish, and by any limnological changes that may take place in the Gulpur reservoir or tunnel, such as an increase in zooplankton or a decrease in oxygen, but to a slightly lesser extent than is EF Site 3.

C.4.4.1 Characteristics of the flow regime of each scenario at Gulpur EF Site 4

The main characteristics of the flow regimes at Gulpur EF Site 4 associated with each of the scenarios are summarised in Appendix Table 6.

The scenario time-series for EF Sites 3 and 4 are the same for all EF releases, and are almost identical to those for the original scenarios. The only difference may be because dam evaporation was included in the additional scenarios, and some small differences in scaling the discharge from the Rehman Bridge Gauge. None of which materially affect the predicted outcomes for the river.

Appendix Table 6 Characteristics of the flow regime of the additional scenarios at Gulpur EF Site 4. Median values are given for the flow indicators. Italicised scenarios are repeats (see Sections 6.2 and C.2).

Scenario/EF indicator	Median annual runoff	Dry season: Onset	Dry: Minimum 5-day discharge	Dry season: Duration	Wet season: Onset	Wet: Peak 5-day discharge	Wet season: Duration
Units	m^3s^{-1}	weeks[5]	m^3s^{-1}	days	weeks	m^3s^{-1}	days
NDPro1	*138.91*	*40*	*22.06*	*114*	*7*	*780.04*	*225*
NDBAU	*138.91*	*40*	*22.06*	*114*	*7*	*780.04*	*225*
NDPro2	*138.91*	*40*	*22.06*	*114*	*7*	*780.04*	*225*
G4ORBAU	138.91	40	22.06	114	7	780.04	225
G4ORPro2	138.91	40	22.06	114	7	780.04	225
G6ORBAU	138.91	40	22.06	114	7	780.04	225
G6ORPro2	138.91	40	22.06	114	7	780.04	225
G8ORBAU	138.91	40	22.06	114	7	780.04	225
G8ORPro2	138.91	40	22.06	114	7	780.04	225
G12ORBAU	138.91	40	22.06	114	7	780.04	225
G12ORPro2	138.91	40	22.06	114	7	780.04	225
G16ORBAU	138.91	40	22.06	114	7	780.04	225

C.4.4.2 Mean percentage changes

The mean percentage changes (relative to Baseline) for the indicators for the scenarios at Gulpur EF Site 4 (Billiporian Bridge) are given in Appendix Table 7. The values provided in Appendix Table 7 are averages for the last 30 years of the record (1982-2012). This is because the influence of the management options takes c. 5-10 years to take effect, and so early part of the record can be quite different from the middle and later part.

C.4.4.3 Time-series

The time-series for the scenarios for the biophysical indicators for EF Site 4 are not shown as the patterns of change and the explanations therefor are basically the same as for EF Site 3 (Section C.4.3.3).

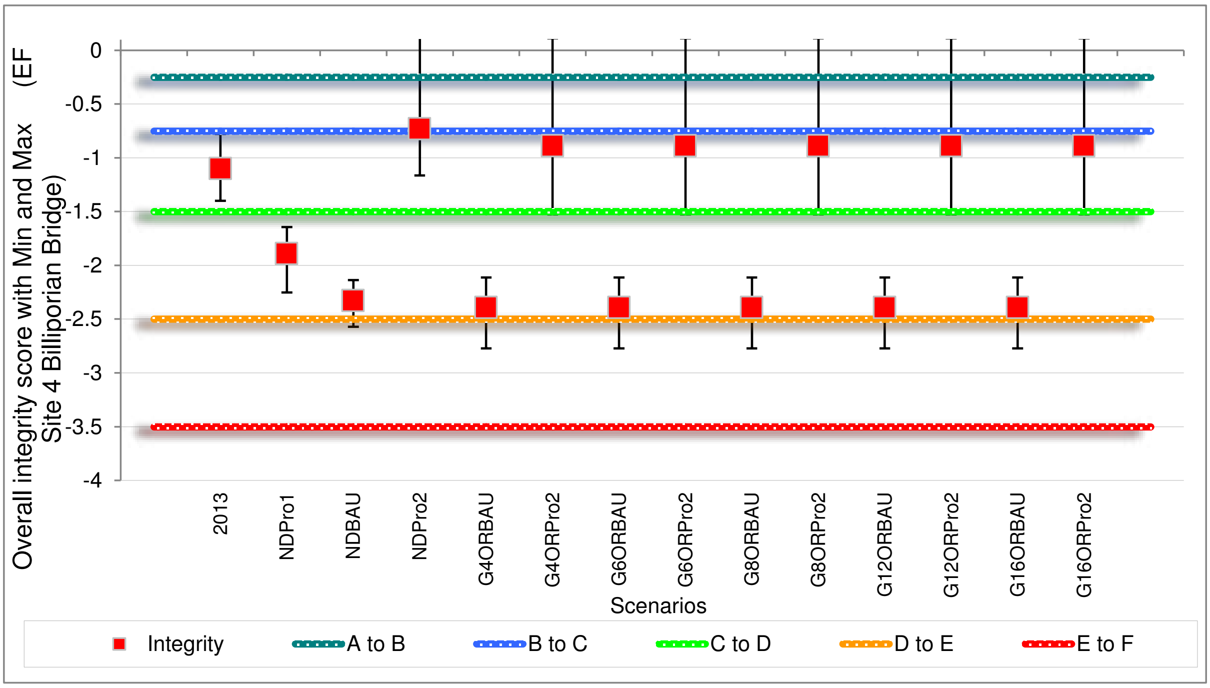
C.4.4.4 Overall Integrity

The Overall Integrity for each the scenarios at Gulpur EF Site 4 are illustrated in Appendix Figure 19.

[5] Weeks = calendar weeks

Appendix Table 7 Gulpur EF Site 4: The mean percentage changes (relative to Baseline) for the indicators under the additional scenarios. Light blue = change 10-20%; green = change 20-40%; orange = change 4070%; red = change >70%. Baseline, by definition, equals 100%. Italicised scenarios are repeats (see Sections 6.2 and C.2).

Indicators		*NDPro1*	*NDBAU*	*NDPro2*	G4ORBAU	G4ORPro2	G6ORBAU	G6ORPro2	G8ORBAU	G8ORPro2	G12ORBAU	G12ORPro2	G16ORBAU	G16ORPro2
Geomorphology	Active channel width	-0.6	-0.6	-0.6	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Area of silt/mixed deposits	-3.4	-8.9	0.6	-9.2	0.2	-9.2	0.2	-9.2	0.2	-9.2	0.2	-9.2	0.2
	Area of cobble bars	2.3	-15.7	2.0	-41.5	-15.0	-41.5	-15.0	-41.5	-15.0	-41.5	-15.0	-41.5	-15.0
	Bed sediment type (armouring)	-12.3	-20.0	-5.4	10.2	24.8	10.2	24.8	10.2	24.8	10.2	24.8	10.2	24.8
	Depth of pools	0.9	-10.8	1.2	-19.4	-2.0	-19.4	-2.0	-19.4	-2.0	-19.4	-2.0	-19.4	-2.0
	Area of 2o channels and backwaters	-9.2	-10.1	0.3	-14.4	-4.1	-14.4	-4.1	-14.4	-4.1	-14.4	-4.1	-14.4	-4.1
Water Quality	Nutrients	31.6	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1	111.7	14.1
	Temperature	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Algae	Periphyton biomass	-1.1	10.1	-2.1	9.7	-2.4	9.7	-2.4	9.7	-2.4	9.7	-2.4	9.7	-2.4
Riparian vegetation	Dry bank trees and shrubs	-16.6	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3	-30.4	29.3
Macro-invertebrates	Simulidae	-5.6	-10.1	-1.3	3.8	14.8	3.8	14.8	3.8	14.8	3.8	14.8	3.8	14.8
	EPT biomass	4.1	3.1	-6.5	10.8	5.8	10.8	5.8	10.8	5.8	10.8	5.8	10.8	5.8
Fish	Pakistani labeo	-62.0	-87.7	55.9	-89.2	56.5	-89.2	56.5	-89.2	56.5	-89.2	56.5	-89.2	56.5
	Mahaseer	-53.2	-86.8	55.9	-99.5	-5.2	-99.5	-5.2	-99.5	-5.2	-99.5	-5.2	-99.5	-5.2
	Twin-banded loach	-3.4	-43.1	33.6	-7.1	58.6	-7.1	58.6	-7.1	58.6	-7.1	58.6	-7.1	58.6
	Kashmir catfish	-55.9	-71.3	58.5	-65.6	78.9	-65.6	78.9	-65.6	78.9	-65.6	78.9	-65.6	78.9
	Garua bachwaa	-42.7	-77.9	43.7	-98.4	20.6	-98.4	20.6	-98.4	20.6	-98.4	20.6	-98.4	20.6
Wildlife	Fish-eating wildlife	-58.4	-99.9	33.2	-99.9	33.6	-99.9	33.6	-99.9	33.6	-99.9	33.6	-99.9	33.6
	Wildlife water needs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Riverine insectivores	-1.5	-0.2	-5.3	1.7	-1.3	1.7	-1.3	1.7	-1.3	1.7	-1.3	1.7	-1.3



Appendix Figure 19 Overall ecosystem integrity scores for the scenarios at Gulpur EF Site 4 (Billiporian Bridge). Baseline (2013) integrity is shown on the extreme left.

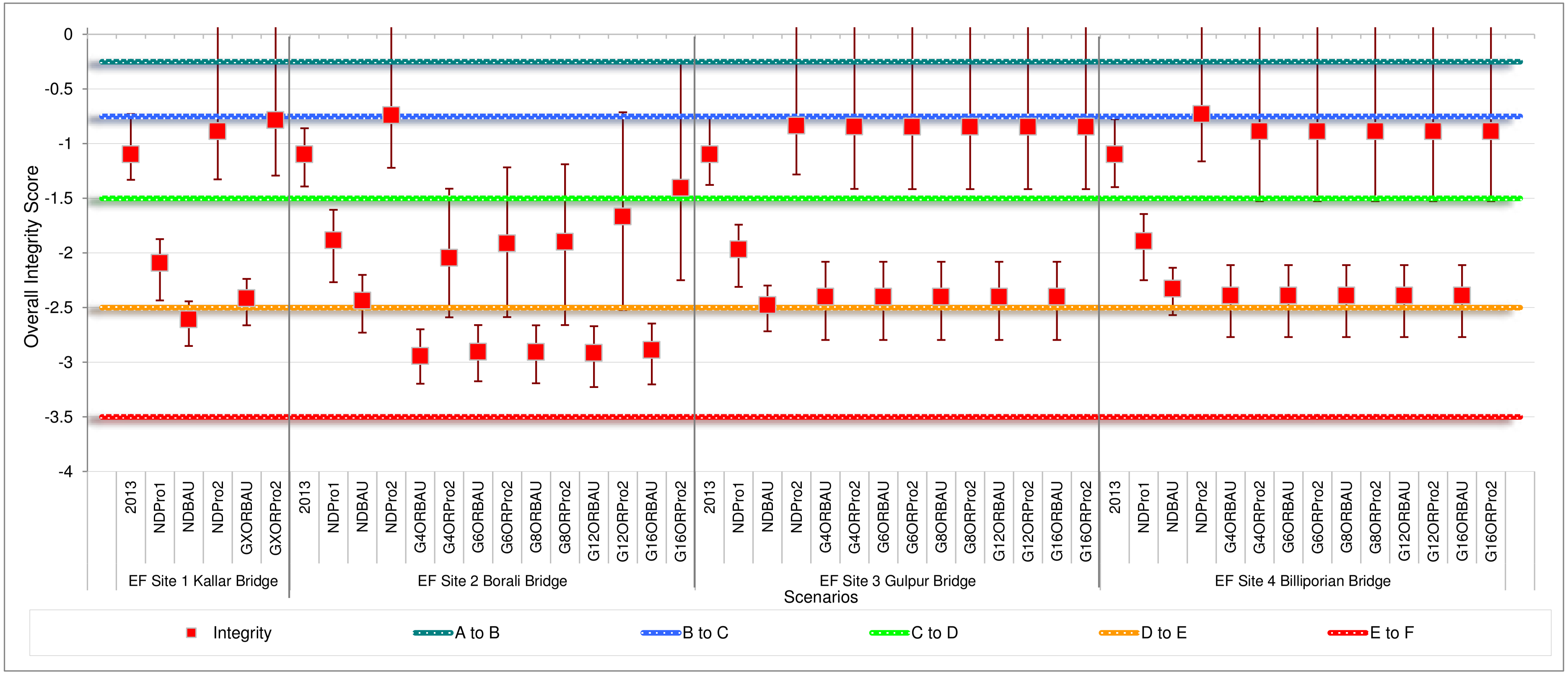
C.4.5 Overall integrity for all sites and all scenarios

The overall integrity scores for all sites and all scenarios are presented in Appendix Figure 20, which gives an indication of the distribution of impacts on the Poonch River in the study area.

C.5 Summary

The results of the DRIFT DSS evaluation of the ten additional scenarios yielded the following conclusions with respect to the impacts of Gulpur Weir on the Poonch River.

EF Site 1 (Kallar Bridge) will not be affected by flow releases from Gulpur weir as it is upstream of the impundment, but the river ecosystem at this point will be affected by the barrier effect of Gulpur weir. The most significant of these effects are expected to be on the fish communities. Some fish, Pakistani labeo, mahaseer and snow trout are expected to colonise the Gulpur reservoir, which may result in an increase in these fish at EF Site 1 relative to the no dam (ND) scenarios. Garua bachwaa is not expected to colonise the reservoir, and will also lose access to many of its favoured breeding areas, which are downstream of the weir. Offsetting this is the fact that there are some remaining breeding sites upstream of the reservoir, and garua will benefit from the expected increase in the other fish, which it eats. Thus, the net result for garua is difficult to predict, but is expected to maintain abundances similar to those in 2013 under the Gulpur release scenarios.



Appendix Figure 20 Overall integrity scores for all sites and all scenarios. Baseline (2013) integrity is labelled 2013.

EF Site 2 (Borali Bridge) represents the river reach that will be most affected by Gulpur HPP. Again the most significant of these effects are expected to be on the fish communities. Except for situations of 16 m^3s^{-1} EF releases and the no dam options, most fish are expected to decline to extremely low numbers in this section of the river. The exception to this is the Pakistani labeo, which is expected to maintain close to 2013 levels under G6-, G8-, G12- and G16ORPro2

EF Site 3 and 4 are not expected to be majorly impacted by Gulpur HPP despite the barrier effect of the weir. Furthermore, under the Pro2 scenarios river condition is expected to improve significantly even with Gulpur HPP in place.

C.6 References

SKAT. 1985. Local Experience with Micro-Hydro Technology. 171 pp. Web address: http://www.fastonline.org/CD3WD_40/CD3WD/APPRTECH/SK30LE/EN/B1080_1.HTM

Appendix I: Climate Change Assessment

See following pages.

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Study of Climate Change Risk for Mira Power's Gulpur Hydropower Project

Final Report

April 10, 2014

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Abbreviations/Acronyms

AJK	Azad Jammu and Kashmir
AR4	Fourth Assessment Report (IPCC)
AR5	Fifth Assessment Report (IPCC)
ARI	average recurrence interval
C	Celcius
CCHF	Crimean-Congo Hemorrhagic Fever
CDD	consecutive dry days
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CDF	cumulative distribution factor
CMIP	Coupled Model Intercomparison Projects
CN	U.S. Soil Conservation Service Curve Number
CWD	consecutive wet days
d	day
ECHAM5	European Center – HAMburg, version 5, a global climate model
FFA	flood frequency analysis
g	grams
GCM	Global Climate Model
GFDRR	Global Facility for Disaster Reduction and Recovery (United Nations)
GEV	Generalized Extreme Value
GHG	greenhouse gas
GHM	global hydrological model
HADGEM2-ES	Hadley Global Emission Model 2 – Earth Systems
HEC-HMS	Hydrologic Engineering Center-Hydrologic Modeling System
HPD	heavy precipitation days
HPP	hydropower project
IDD	International Disaster Database
IEA	International Energy Agency
IFD	intensity-frequency-duration
IHA	International Hydropower Association
ISI–MIP	Inter-Sectoral Impact Model Intercomparison Project
IPCC	Intergovernmental Panel on Climate Change
IWD	irrigation water demand
kg	kilogram
km	kilometer
kWh	kilowatt-hour
LCA	lifecycle analysis

LMM	Liverpool Malaria Model
m^3/s	cubic meters per second
MLE	maximum likelihood estimation
mm	millimeter
MW	megawatt
MWh	megawatt-hour
NREL	U.S. National Renewable Energy Lab
OFDA/CRED	U.S. Office of Foreign Disaster Assistance/(Columbia University) Center for Research on Environmental Decisions
PDSI	Palmer Drought Severity Index
PMD	Pakistan Meteorological Department
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PRECIS	PRoviding REgional Climates for Impacts Studies
RCM	Regional Climate Model
RCP	representative concentration pathway (for greenhouse gas emissions scenarios)
REGCM4	REGional Climate Model, version 4
SCS	U.S. Soil Conservation Service
SRES	Special Report on Emissions Scenarios (IPCC)
SRRES	Special Report on Renewable Energy Sources and Climate Change (IPCC)
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	U.S. dollars
VIC	Variable Infiltration Capacity model
WHO	World Health Organization
Yr	year

Executive Summary

Introduction

Mira Power plans to develop the 100-megawatt (MW) Gulpur hydropower project (HPP), to be located near Kotli, Pakistan. Extensive analysis and documentation to support the development of the project have already been completed but considerations of climate change have not been emphasized. The purpose of this report is to provide an evaluation of climate change and its potential impacts on issues that are relevant to the operation of the hydropower plant.

This report provides quantitative and/or qualitative evaluation of several key issues:

Chapter 1 provides an introduction to the project and reviews the area's historic risks and vulnerabilities to natural hazards. These serve to establish the baseline conditions for which the design of the proposed Gulpur HPP should be prepared.

Chapter 2 provides a summary of the current science of climate change for the region of the Gulpur HPP, showing two key scenarios for potential changes for three future periods (near-term, medium-term, long-term) through 2100, using regionally downscaled climate projections of temperature and precipitation. The results are discussed in the context of Annex I of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), which serve as the basis for the analyses in the subsequent chapters of this report.

Chapter 3 presents the results of a hydrologic analysis of the impacts of the projected changes in temperature and precipitation on the availability of water for the Gulpur HPP. It includes a qualitative evaluation of climate-induced hazards and conditions which may impact the Gulpur HPP including flood and landslide. The evaluation includes a qualitative evaluation of climate-induced hazard and vulnerability components with low, medium, and high rankings.

In Chapter 4, water supply for the Gulpur HPP is presented in the context of upstream and downstream competing uses, focusing on agricultural irrigation needs. This chapter incorporates qualitative considerations of the results in Chapters 2 and 3. Water demand, agricultural, and environmental impacts of changed hydrology under future climate have been evaluated in several of the global hydrologic models described in Chapter 3; these are discussed, as is the risk of projected temperature and precipitation on the potential for drought.

Chapter 5 presents an overview of the recent science of quantifying greenhouse gas (GHG) emissions from hydropower reservoirs and how these emissions may change in the future.

Chapter 6 presents an overview of the potential effects of climate change on disease risks to human and animal populations in the area of the Gulpur HPP. The potential disease impacts of climate change are examined for three key diseases: malaria, dengue fever and Crimean-Congo Hemorrhagic Fever (CCHF). The results from the prior chapters are assessed to provide qualitative observations of potential increases in disease risk based on factors such as temperature, precipitation, and flood events.

Chapter 7 presents a compilation of the key conclusions from each of the prior chapters.

Approach and Results

Initial Risk Screening

The screening process in this section establishes the baseline conditions which the design of the proposed Gulpur HPP should be prepared to address. With its location in Pakistan, the project area has a history of extremely hot weather in the summer and moderately cold weather in the winter. The region receives most of its annual rainfall during the summer monsoon season, primarily in July and August. The historical natural hazards relevant to the project include flood, landslide, drought, and disease. The diseases addressed are those that are endemic in Pakistan: malaria, dengue fever and CCHF. The initial risk screening has a hazard and vulnerability component. The screening considers the frequency, severity and magnitude, as well as the project's vulnerability, including sensitivity and exposure to each hazard. Based on historical experience with current climate conditions, the frequency for floods is high; for disease, the frequency is medium; and for drought and landslides, the frequency is low. However the magnitude of the drought hazard is high, and can be ranked as medium for flood, landslide and disease hazards.

The Gulpur HPP project area can be considered to be at moderate risk of flood and disease and at low risk for drought. Landslides are a current problem and will remain a risk for the Gulpur HPP and conditions could produce landslide events as a cascading effect. The proposed site on the Poonch River has steep slopes and loose soils around the power generating and support facilities and is located in landslide-susceptible areas.

Analysis of Downscaled GCM Results

Global climate models (GCMs) do not provide sufficient spatial resolution to fully understand climate impacts at the scale of the Poonch River watershed due to their coarse spatial resolution and rough approximations of local topography. A "downscaling" procedure is needed to evaluate impacts at the watershed scale. This can be done either through statistical methods or by using the GCMs as boundary conditions for regional climate models (RCMs) that provide better spatial resolution (i.e., through dynamical downscaling). The first step was to obtain the detailed output of available dynamical downscaling efforts provided by the "Numerical Modeling Group of Research and Development Division, Pakistan Meteorological Department (PMD), Islamabad, Pakistan." The PMD data provides results for the A1B scenario as defined by the IPCC from one of the GCMs, downscaled to a resolution of 25 km for Pakistan using the "PRECIS" and "REgCM4" RCMs. Climate change effects were developed for two future 30-year time periods, with mid-points of 2025 and 2055, respectively, using a base period of 1961 to 1990.

The results show that temperature predictions tend to indicate increases with each time horizon for both RCMs. Annual average temperatures increase over time with both PRECIS and RegCM4 models. Annual average temperature increase at Kotli for the PRECIS scenario for 2025 was 0.8^{o}C and 2.1^{o}C for 2055, whereas for RegCM4 it was 0.5^{o}C and 2.2^{o}C. Overall for the entire watershed (based on area weighting) the PRECIS model showed an increase of 1^{o}C and 3.05^{o}C for 2025 and 2055, whereas the RegCM4 model showed an increase of 0.74^{o}C and 2.65^{o}C.

Seasonal precipitation for the PRECIS scenario compared to the baseline indicates an adjustment in the monsoon season, with precipitation peaks shifting by a month from July to August, with a duration extending slightly longer than the experience during the baseline period. The maximum percent changes were observed during the spring season in March during the 2025 period; however, these were relatively less for the 2055 period. Note that seasonal summaries are provided only for the PRECIS scenario because the RegCM4 scenarios only had annual decadal data available.

The available dynamically downscaled data are based on one GCM, and results are likely to differ for other GCMs. Therefore, the future climate results are also discussed in the context of Annex I of the IPCC AR5, which provides information on projected results for the 2050s using 16 statistically downscaled GCMs. The central tendency of the 16 models over the project area suggests little overall change, consistent with the regional analysis. These results suggest that the project area will likely experience an air temperature increase of around 1° Celsius (C) by the 2020s and more than 2°C by the 2050s, while average annual precipitation changes are likely to be small.

Hydrologic analysis results

Although the annual results suggest a relatively small impact on temperature and precipitation from climate change, many studies show that climate extremes may be more pronounced. This is evaluated for the Gulpur HPP by examining key measures of extreme climate events, including changes to the probable maximum flood (PMF), probable maximum precipitation (PMP), daily changes in temperature and precipitation, extreme water flows, and sediment transport, as well as the related risks of flood and landslide events.

A conservative estimate of the PMF as a result of climate change is estimated by evaluating daily discharge data computed using a GCM that predicts wetter conditions for the project area (Hadley Centre Model, HadGEM2-ES), coupled with the variable infiltration capacity (VIC) hydrologic model . Model output was available from 1970-2100. The relatively coarse scale of the VIC model does not allow for an exact estimate of flow volume in a single small catchment, such as the Poonch River. However, the relative changes between scenarios in VIC model predictions provide a reasonable indication of the relative changes expected in actual catchment flows. The PMF is projected to increase by 10.1 percent 2040 and 36.6 percent by 2070 based on a Gumbel extreme-value analysis. This increase in PMF will need to be accounted for in the design of the hydropower plant as it will result in a larger floodplain in the future.

Computation of the PMP involved an approach widely recommended for use in hydrologic planning (Koutsoyiannis, 1999; Chin, 2005). Typically, PMP estimates are based on the maximum possible rainfall that can occur over a specific location, and based on meteorological evaluations. Where data are limited, statistical approaches may be used. The results indicate higher daily precipitation values are more extreme in the 21st century periods compared to historical values (model to model comparisons; observed values are higher than modeled). The results for the watershed indicate that the magnitude of the PMP is expected to increase by 30 and 47 percent for the 2040 and 2070 time horizons, respectively. More broadly, multiple models and studies suggest that there might be an increase in the extreme precipitation in the project region, which may suggest the need for a more detailed the climate change analysis for the Gulpur HPP project.

In addition to the uncertainties in the climate model and discharge model projections, it is important to highlight that this report also presents the extrapolation of the extreme value probability distribution to a return period with very little data. This adds uncertainty but is inherent in extreme event projections, which by their nature, have very few observations associated with them.

As the Gulpur HPP is currently designed, there is no provision for adding spillway capacity in the future. If the design flood were to be larger in the future one would expect some small overtopping. The project engineers do not expect significant damage from a small amount of overtopping. Additional analysis performed by the project engineers suggests that even in the case of catastrophic failure of the dam, downstream water flows would not reach inhabited locations. Furthermore, because this is a run-of-the river project, with limited water storage, it allows some resiliency through changing operational criteria to adapt to future flow conditions that differ from historical patterns. Given this information, and the overall scale of the Gulpur HPP, the project can be considered to be at medium risk from climate change.

Besides the flood risk analysis, the hydrologic analysis also considered changes in streamflow quantities and timing, using the WATERGAP model, which are influenced by changing precipitation patterns and snowmelt timing. The change in the timing and seasonality of the discharge as shown here is of much greater consequence to the future operation of the dam in comparison to the potential human demands upstream which constitute about 5% of the discharge. Flows in February and March are higher and flows in May and June are lower, both as a result of earlier snowmelt. This change is an important consideration for future hydropower operations, because some of the peak demand months in May and June also correspond to low flows.

The hydrologic analysis was performed in a streamlined manner to highlight key changes using a modeling framework, including the most recent downscaled climate data from a representative model and coupled hydrologic models. Wherever possible, additional support was developed from ensembles of model results in the recent published literature. If the issues raised here require further evaluation, additional hydrologic modeling assessment may be performed, considering site-specific analysis for a larger number of model scenarios. Going further, more local-scale data collection on flows and precipitation at different altitudes may support this modeling. Not all of this is practical in the time frame and project scope of this report; however, the general direction of potential future work is summarized here.

Reservoir Sedimentation

For consistency, the same daily discharge data used in the PMF calculations (from the VIC model, coupled with the HADGEM2-ES GCM) to estimate changes in suspended sediment load entering the Gulpur HPP reservoir. The changes in monthly suspended sediment loads display a non-uniform seasonal pattern. Future projections are larger than baseline values in March, April, and August but generally smaller in May and June. The 2040 and 2070 climatologies generally display increased variability relative to the baseline period. At the yearly level of aggregation, the baseline and 2040 climatologies display a very similar distribution. The suspended sediment load data for the 2070 climatology have a median value comparable to the other two periods, but the variability of the data is increased with more instances of large annual loads relative to the baseline and 2040 periods. However, in light of existing plans to flush sediment build-up every eight years, it appears that the risks of substantial increases in reservoir sedimentation rate due to climate change are small.

Future Precipitation and Landslide Risk

From a modeling perspective, it is reasonable to assume that extreme flood volumes in the basin may be higher than historical levels. To address uncertainty in flood risk estimates and improve calibration of models it is recommended that the following monitoring be carried out:

- continuous flow measurements at selected dam site
- sub-daily precipitation in upstream locations within the catchment

Data from monitoring will allow more accurate estimates of PMF using catchment-specific unit hydrographs and storm temporal patterns, particularly if a flood event is observed.

From a qualitative perspective, the conditions exist for a rise in frequency and magnitude of landslide events, as shown in Table 3 16. The future vulnerability conditions, shown in Table 3 17 look similar since development will probably occur as it has in the past. A landslide could directly impact Mira Power facilities or the sediment produced by the landslide could be transported into the reservoir, also impacting Mira Power, as shown in Table 3 18. With wetter conditions and the potential for more extreme events, there is a greater risk of landslides.

Projected Climate Change Impacts on Water Supply

Any impacts of climate change on water demands may potentially affect inflows into the dam, but other large-scale demand changes downstream of the Gulpur HPP are likely to be addressed through the major multipurpose dams in the system that are downstream. This section focuses on the increase in water demand for irrigation as a function of climate change, while also acknowledging that population growth clearly has the potential to further exacerbate the problem. Given Pakistan's unique situation as a country with low rainfall in the lower elevations and with intensive irrigation, the focus on changes in irrigation demand is appropriate.

The potential effects of climate change on the supply of water is introduced first at the global level and then considered at the watershed level in the context of upstream and downstream competing uses. The primary watershed focus is on the irrigation needs of the agricultural sector; the potential impact of climate change on drought risk is also presented. The analysis approach used here includes evaluation of climate change model results for evapotranspiration at different points in time, for periods two to six decades into the future. Large-scale analyses of changes been reported in the literature provide a strong basis for this assessment. In an analysis highly relevant to this work, Wada et al (2013) show the impact of climate change on future irrigation water demand (IWD), using a set of seven global hydrological models (GHMs) to quantify the impact of projected global climate change. They also assessed the resulting uncertainties arising from both the GHMs and climate projections. The resulting ensemble projections generally show an increasing trend in future IWD, but the increase varies substantially depending on the degree of global warming and associated regional precipitation changes. In Pakistan, the irrigation water demand is expected to increase by more than 20 percent for warming by 2°C or more. Using a suite of seven global hydrological models, forced with multiple climate projections, Haddeland et al. 2013 estimated irrigation water consumption with and without taking into account impacts of human interventions such as dams and water withdrawals on the hydrological cycle. Model results were analyzed for different levels of global warming. It was shown that irrigation water consumption is generally projected to increase with higher global mean temperatures. Irrigation water scarcity was found to be particularly large in parts of southern and eastern Asia, including Pakistan, and is expected to become even larger in the future. There is a strong indication across most of the model frameworks examined that there will be greater incidence of drought by more than 10 percent over South Asia. Assuming agricultural production needs to be sustained over these periods indicates an increase in irrigation water demand across most of the models examined.

Analysis shows the Gulpur HPP watershed itself is not a major user of irrigation water and irrigation demand change upstream is unlikely to reduce inflows into reservoir. Evaporation changes in the Gulpur HPP basin may occur as a result of climate change, even in the absence of irrigation demand.

In assessing the potential impact of climate change on droughts, a study was conducted in 2009 by the PMD to analyze regional changes to precipitation and temperature including frequency of "consecutive dry days". A "dry day" is any day with precipitation totaling less than 1 millimeter (mm). A review of future precipitation values and consecutive dry days indicate conditions exist for an increase in frequency of future drought events. Furthermore, increases in population will also add pressures for water directly in cities and villages, and for food production through irrigation. It is well understood in current water balance studies, even in the absence of climate change, that Pakistan is a water stressed country with no known sources of new water to address future growth needs. Climate change, combined with development pressures, population growth, and conservation needs may increase the risk of this hazard in the future.

<u>GHG Emissions from the Gulpur HPP Reservoir</u>

It is widely acknowledged among scientists and policymakers that the scientific community has not reached agreement regarding the methodology that is appropriate for projecting GHG emissions from a proposed hydropower project (IPCC SRRES, 2011). Therefore, this report provides further insight into the factors that are relevant to the calculation for the Gulpur HPP and an initial estimate of these emissions based upon a review of relevant literature. Detailed data collection and analysis specific to the Gulpur HPP will further improve upon these estimates. The amount of GHGs that is released from the reservoir changes over time due to a variety of factors that include climate, water flow through the reservoir, and the composition (i.e., carbon content) of the submerged biological matter. Review of relevant literature confirms that a reliable set of calculations and emission factors are not available for estimating GHG emissions for a potential reservoir. Collected data from existing reservoirs do not provide the basis for reliable estimates. However, analysis of seven key studies provides some useful insight into the likely range of GHG emissions from the Gulpur HPP reservoir, as well as the sources of uncertainty in the estimates. Of the studies presented, the range of annual emissions of a HPP similar in size and location to the Gulpur HPP could be between 1,407 tons and 27 million tons. In light of the acknowledged limitations of applying existing data to new reservoirs, the applicability of this wide estimate range to the Gulpur HPP can be further questioned.

Among stakeholders concerned about climate change, hydropower projects are routinely cited as having clear GHG benefits compared to fossil-fuel-fired power plants due to the relatively high carbon content of fossil fuel as compared to the absence of carbon in the fuel (water) for HPPs. However, it is increasingly understood that GHG emissions from hydropower reservoirs can be substantial – especially in tropical climates – to the degree that they may emit more GHGs than a comparably sized fossil fuel plant, particularly in the first 10 years or so.

Evaluation of Disease Risk

The potential disease impacts of climate change is examined for three key diseases: malaria, dengue fever and CCHF. The climate change results from the prior chapters are assessed to provide qualitative observations of potential increases in disease risk based on factors such as temperature, precipitation, and flood events. The IPCC has concluded that climate change is likely to expand the geographical distribution of several vector-borne diseases, including malaria, dengue and leishmaniasis to higher altitudes (high confidence) and higher latitudes with limited public health defenses (medium/low confidence), and to extend the transmission seasons in some locations (medium/high confidence) (IPCC, 2001). For some vector-borne diseases in some locations, climate change may decrease transmission by reductions in rainfall or temperatures creating conditions that are not conducive to vector transmission (medium/low confidence) (IPCC, 2001).

A changing climate will alter physical and ecological conditions for a variety of disease-carrying insects and parasites. Mosquitoes and ticks are sensitive to physical conditions, such as humidity, daily high and low temperatures, rainfall patterns, and winter snowpack. The distribution and growth-rate of vector populations have been correlated with ambient temperature. Numerous studies have concluded that an increase in ambient temperature will lead to net increases in the geographical distribution of many vector organisms, including several species of mosquitos that carry malaria and dengue fever. The PRECIS model dynamically downscaled climate results (based on the ECHAM5 GCM simulations under the A2B emissions scenario) discussed in Chapter 2 indicate that the average annual temperature in the project area will increase from the baseline of 13.5^{o}C by approximately 1^{o}C for 2025 and by approximately 3^{o}C for 2055. Area-weighted precipitation values showed an overall 14 percent increase for 2025 and 2 percent decrease 2055. Increased air temperature and possibly increased precipitation could both increase malaria risk. The Liverpool Malaria Model (LMM) was used to better determine malaria risk to the project area under future climate conditions. The LMM is a mathematical-biological model of malaria parasite dynamics using daily temperature and precipitation data.

Studies compiled by the World Health Organization (WHO) have linked outbreaks of dengue fever with high rainfall, elevated temperatures and humidity, as well as to other intrinsic factors such as population immunity. Based on these findings, the WHO (2003) concluded that climate change could increase the range of the relevant mosquito species (*Aedes aegypti)* and rates of transmission. Similar to mosquitoes, tick life cycles depend on a complex combination of variables. Climate affects tick development and mortality, as well as their activity rates. In addition to climate factors, host availability and vegetation significantly impact tick populations.

The risk assessment analysis for these diseases shows that the project area is currently impacted by endemic malaria, and experiences sporadic cases of dengue fever and CCHF. Climate change temperatures and precipitation will provide a more suitable habitat for malaria in the project area, particularly in the 2050 time horizon. It is possible that warmer temperatures will also extend the range and incidence rate of dengue fever and CCHF. In the case of CCHF, other factors such as landscape and number of domestic animals are also important.

The simplest method of approximating the impact of climate change is to assume that proportional changes in exposure (e.g., proportion of people livening in areas climatically suitable for malaria), are directly related to proportional changes in disease burden. For example if climate change in a particular region is estimated to cause a 20% increase in the number of people living in areas that are defined as climatically suitable for malaria transmission, then this is most likely to lead to a 20% increase in the disease burden, compared to the situation if climate change did not occur.

Conclusions

As with other infrastructure projects, the Gulpur HPP can benefit from an understanding of the potential risks to it that are posed by climate change. This study provides an initial review of these issues, including summaries of relevant literature and assessment of local impacts. While the future remains uncertain with regard to a precise projection of the nature and extent of these risks for specific locations, the general scientific relationships are increasingly well understood and strongly suggest that each major project stakeholder should continue to anticipate and evaluate the effects of a changing climate, particularly the potential for adverse effects.

Temperature is expected to increase by about 1° to 3°C; average annual precipitation is expected to remain similar to past experience. Of critical importance for precipitation, however, is the fact that average annual values fail to reveal potentially large intra-annual changes. This report suggests that the timing of the seasonal monsoon may be delayed by up to one month by 2100 and that annual precipitation may be delivered in fewer, larger events. Climate change, development pressures, population growth and environmental conservation needs could increase the risk of drought and drought-related stresses in the future. This information, as well as global studies spanning multiple models, support the likelihood of greater magnitudes of extreme floods in future decades. An assessment of flood hazard supports a flood frequency ranking of *high risk*. Reviewing the future hazard screening, the conditions exist for a rise in frequency and magnitude of landslide events (ranked as a *medium* risk*)*. A review of future precipitation values and consecutive dry days indicate conditions exist for an increase in frequency of future drought events (ranked as a *medium* risk*)*. Of the four diseases in

Pakistan addressed by this report, the projected temperature and precipitation impacts of climate change could increase the future risk of malaria, dengue fever and CCHF (ranked as a *medium* risk).

GHG emissions from reservoirs are difficult to estimate in advance of the existence of the reservoir. It is increasingly understood that GHG emissions from hydropower reservoirs can be substantial – especially in tropical climates – to the degree that they may emit more GHGs than a comparably sized fossil fuel plant, particularly in the first 10 years or so. The impacts of climate change will have a complex set of impacts on the Gulpur HPP reservoir. A review of the current state of the science indicates that several international, multi-stakeholder efforts are increasingly focused on developing a consistent, rigorous approach for GHG quantification. Participation in the multi-stakeholder efforts, coordinated by respected bodies, may provide a dual benefit to Gulpur HPP project proponents – such participation could allow issues of importance for the Gulpur HPP to be acknowledged and incorporated into these international efforts; at the same time, Gulpur HPP representatives may gain useful insight into their quantification efforts for the Gulpur HPP.

The present analysis serves to highlight the most important climate-related issues for the project based on the most current scientific data (including data that are being used to develop the regional studies for the upcoming IPCC report, expected later in 2014). As the Gulpur HPP is developed and becomes operational, additional local data collection, on meteorological, socioeconomic, and ecological metrics will no doubt improve these analyses, and are strongly recommended to better understand and manage future risks in coming years.

1. Scoping of Climate Change Issues, Initial Risk Screening

1.1 Introduction

The objective of this report is to identify the potential climate change impacts on the Gulpur HPP and the surrounding area, including the risk considerations and potential impacts related to the planned project. Extensive analysis and documentation have already been produced to evaluate a wide range of engineering, environmental and social impacts of the Gulpur HPP. However, these have included very limited discussion of climate change; its timing and extent; and its potential effects on the Gulpur HPP, its surrounding ecosystems and populations. This document begins to address these issues; however, for each component of this report, further analysis is warranted to more fully inform Gulper HPP decision-makers regarding the potential extent of climate change impacts on the project, and viable responses.

Chapter 1 reviews the area's historic risks and vulnerabilities to natural hazards. These serve to establish the baseline conditions for which the design of the proposed Gulpur HPP should be prepared.

Chapter 2 provides a summary of the current science of climate change for the region of the Gulpur HPP, showing two key scenarios for potential changes for three future periods (near-term, medium-term, long-term) through 2100, using the regionally downscaled climate projections of temperature and precipitation. The results are discussed in the context of Annex I of the IPCC AR5, which serve as the basis for the analyses in the subsequent chapters of this report.

Chapter 3 presents the results of a hydrologic analysis of the impacts of the projected changes in temperature and precipitation on the availability of water for the Gulpur HPP. It includes a qualitative evaluation of climate-induced hazards and conditions which may impact the Gulpur HPP including flood and landslide. The evaluation includes a qualitative evaluation of climate-induced hazard and vulnerability components with low, medium, and high rankings.

In Chapter 4, water supply for the Gulpur HPP is presented in the context of upstream and downstream competing uses, focusing on the irrigation needs of agricultural. This reflects qualitative considerations of the results in Chapters 2 and 3. Water demand, agricultural, and environmental impacts of changed hydrology under future climate have been evaluated in detail in several of the global hydrologic models described in Chapter 3; these are discussed, as is the risk of projected temperature and precipitation on the potential for drought.

Chapter 5 presents an overview of the recent science of GHG emissions from hydropower reservoirs and how these emissions may change in the future.

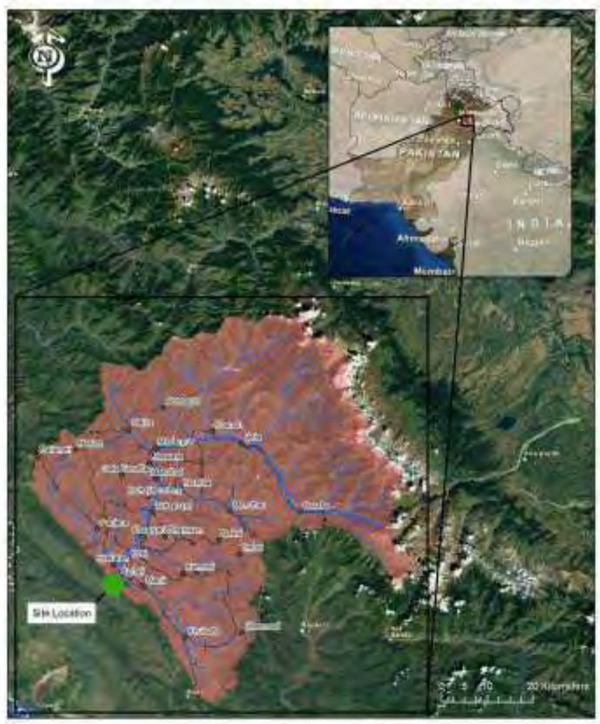
Chapter 6 presents an overview of the potential effects of climate change on disease risks to human and animal populations in the area of the Gulpur HPP. The potential disease impacts of climate change is examined for three key diseases: malaria, dengue fever and Crimean-Congo Hemorrhagic Fever. The results from the prior chapters are assessed to provide qualitative observations of potential increases in disease risk based on factors such as temperature, precipitation, and flood events.

Chapter 7 presents a compilation of the key conclusions from each of the prior chapters.

1.2 Historical Climate Drivers

As shown in Figure 1-1 below, the Gulpur HPP is located in the Azad Jammu and Kashmir (AJK) Territory; the Kotli district approximately five kilometers (km) south of Kotli on the Poonch River. The southern parts of AJK, including Kotli district, have extremely hot weather in the summer and moderately cold weather in the winter. The region receives rain mostly during the monsoon season (summer).

The Jhelum River and its upper tributaries, including the Poonch River, have cut deep valleys through moderate mountain ranges. The Jhelum constitutes most of the western boundary of AJK. The southern part of the territory consists of a narrow zone of plains characterized by interlocking sandy alluvial fans.



Gulpur Hydropower Project - Site Location Map

Figure 1-1: Area Map

The changes in precipitation and temperature are capable of altering the geophysical, ecological, agricultural, economic, and human livelihood and health environment of Pakistan and the project's basin. The impacts due to changes in temperature and precipitation on the viability of the Gulpur HPP need to be considered locally and at the regional and national level. This screening recognizes that hydropower operations do not operate in isolation but operate within an area with various natural hazards and economic/environmental sectors that must also be considered.

1.3 Risk Screening

This risk screening considers available information to help answer the following fundamental question, which is the cornerstone of the adaptation planning process: *"What could happen to the Gulpur HPP?"*

This screening methodology will consider climate-exacerbated hazards, including their frequency, severity and magnitude; and the project's vulnerability including sensitivity and exposure to the particular hazard.

The hazard screening uses available hazard information to determine what types of disasters may affect the project directly and indirectly, how often these events may occur in the present and future, and the potential severity of their consequences. The hazard screening for this project also considers the potential exacerbating impacts of climate change on hazard frequency and severity. The vulnerability screening evaluates the potential impact that hazard events may have on hydropower operations and stakeholders – both currently and in the future. The vulnerability screening also tries to capture the adaptation potential of the people and infrastructure at risk. The overall risk screening is used to help identify priority risks that would benefit from further study and potentially adaptation efforts. This screening helps justify further study and inform the adaptation identification and recommendation process.

This section evaluates four hazards identified by Mira Power as hazards of interest which may be exacerbated by climate change. They include flood, drought, landslide, and disease.

1.3.1 Flood Risk

According to the Office of U.S. Foreign Disaster Assistance and the Collaborating Centre for Research on the Epidemiology of Disasters (OFDA/CRED) International Disaster Database, seven of the top ten economic disasters occurring between 1980 and 2010 in Pakistan were floods. Over this 30-year timeframe, there were 1.87 floods annually, each causing damages of roughly USD $195,000, killing 157 people, and affecting 813,000 people. The most destructive flood was the recent 2010 Pakistan floods which swept away the 20 percent of Pakistan's land. It was the result of unprecedented Monsoon rains which lasted from 28 July to 31 July 2010. According to the governmental Federal Flood Commission, the floods caused the deaths of at least 1,540 people, injured 2,088 people, destroyed 557,226 homes, and displaced over 6 million people (Ahmadani, 2010). Other floods which caused major loss includes the flood of 1950, which killed 2910 people; the 1977 heavy rains and flooding in Karachi, which killed 248 people with 207 mm of rain falling in 24 hours (Dawn, 2010); and the 1992 flooding during the monsoon season which killed 1,834 people across the country.

The population of the region is very susceptible to disasters due to a high degree of poverty (which results in fewer resources to prepare for, respond to, and recover from a hazard) and large numbers of children. Children are always one of the most sensitive population groups to hazards because they are not able to provide for themselves and often require special consideration for evacuation and post-hazard protection (from disease and other elements).

Hydropower activities could be suspended due to flooding and flood-induced mudslides. Appropriate flood control should be incorporated into the design of the hydropower operation which will help the facility adapt to this hazard.

The hazard screening shows that floods are occurring frequently at approximately 1.87 times each year in Pakistan between 1980 and 2010 (OFDA/CRED, 2007) and using the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR) data shows 53 events from 1926 to 2006 (GFDRR, 2007). In August of 2013, eight died and 1,500 houses suffered extensive damage as flash floods impacted the Jammu region. Several landslides also were triggered as a result of the flooding.

The vulnerability screening shows that there is an overall high degree of exposure to floods in Pakistan, since the floodplains cover much of the populated areas. Vulnerability was ranked as moderate because many people live in the floodplains and their livelihoods are often tied to the water and land. If the hydropower operation does not account for this change in the floodplain, it will be susceptible to flooding since flooding could lead to conditions that would interfere with site operations.

The country has a low adaptive capacity to the flood hazard because there are few financial and social networks in place to support displaced people and rebuild homes. The Gulpur HPP has a moderate adaptive capacity through its resources and ability to cope with flooding events.

The risk screening shows that the country is at high risk to floods and climate change may exacerbate the severity of flood events. Mira Power has a moderate flood risk due to its proximately to the hazard and potential vulnerability. This risk may increase in the future due to climate change. Chapter 3 provides additional information on climate change impacts to this risk for this region.

1.3.2 Drought

According to the joint effort of the U.S. Office of Foreign Disaster Assistance and the (Columbia University) Center for Research on Environmental Decisions (OFDA/CRED) International Disaster Database (IDD), there was one major drought that occurred between 1980 and 2010 in Pakistan, which caused USD $247,000 in losses, killed 143 people, and affected 2.2 million people. The GFDRR data shows four events from 1926 to 2006 (GFDRR, 2007). This drought occurred between 1998 and 2002.

The drought hazard screening shows that the frequency of droughts should be considered to be relatively low since they have occurred relatively infrequently (OFDA/CRED, 2007). Review of previous events and their durations indicates that the drought magnitude can be considered to be moderate. Chapter 4 provides additional detail concerning climate change impacts and current and future water demands.

The vulnerability screening shows that there is high exposure to drought since the hazard has impacted most of the country at some point in time. The country has a high sensitivity to droughts, as evidenced by the historical social losses and impacts. For the hydropower facility, the current sensitivity is low since most demands occur downstream of the project, and flows and water supplies that address these demands are modulated by other, larger dams on the Jhelum River that is downstream of the proposed project.

The country has a low adaptive capacity since there are few financial and social networks in place to support displaced people, impacted environmental areas, and failing agriculture. Mira Power has a moderate adaptive capacity to cope with drought events using operational procedures.

The risk screening suggests that the country is at moderate risk to drought and the Gulpur HPP has a low drought risk due to its low vulnerability. This risk may increase in the future due to climate change exacerbating the drought hazard and the additional pressure of non-climate stressors like competing water uses and needs and is discussed more in Chapter 4.

1.3.3 Landslides

Landslides are geological phenomenon, which result from a range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows. Usually landslides occur in areas with steep slopes (through natural terrain or development), particular soil types, ground cover, and erosion conditions. They are often caused by precipitation or earth moving events including earthquakes, volcanoes, or human-caused shaking. Climate change may cause large storm events, flooding, and expansion of rocky terrain due to temperature increases which would increase landslide frequency. This section considers the landslide hazard, including current and future conditions of the hazard (frequency, severity) and current and future vulnerability to the hazard (exposed population and structures). It also considers the potential exacerbating impacts of climate change.

Historical losses were identified in data collected by the United Nations from 1980 to 2010. No large-scale landslides were identified in Pakistan over this time period. The project team also considered available local data which indicates landslides could impact facilities directly. Large landslide frequencies are listed as 0.58 per year by the OFDA/CRED IDD for Pakistan. The Poonch River has steep slopes around potential hydropower facilities which are located in landslide-susceptible areas due to the soils and topography. Images of the locations are shown in Figure 1-2 below.

Figure 1-2: Topography of Potential Gulpur HPP Infrastructure

The Gulpur HPP Basic Design Report includes a description of the potential hydropower sites. These sites consist of some vegetation on the slopes (a positive), jointed and weakly connected rocks and soils, and areas of existing landslide activity (all negatives).

The results of the flood screening indicate that landslides are a current problem and will remain a risk for the Gulpur HPP and that these conditions could produce landslide events as a cascading effect. Historical losses were identified in data collected by the United Nations from 1980 to 2010 (OFDA/CRED, 2007). Landslides kill 32 people per event, affect 1,892 people, and cause an unknown amount of damage. The conditions around the proposed site provide conditions that are vulnerable to the landslide hazard. That is, the Poonch River area has steep slopes and loose soils around the power generating and support facilities and are located in susceptible areas.

The hazard screening shows that landslide risk of occurrence should be considered moderate since they occur occasionally. Previous events and the amount of land moved indicate the landslide magnitude should be rated as moderate. The proposed hydropower sites have steep slopes around their facilities and are located in susceptible areas.

The vulnerability screening shows that the country has a low exposure to landslides since landslides occur mostly in areas with large elevation changes, certain soil types, and land cover. The Gulpur HPP's exposure is high because its power generation facilities are located in valleys where there are large elevation changes and susceptible soil types. The country has a high sensitivity to landslides which may be seen from the social and economic losses from historical events. The infrastructure and people in the impacted area suffer severe losses although these areas are typically smaller when compared to drought, flood, or other hazard events. The country has a low adaptive capacity since there are few financial resources and social networks in place to support displaced people and destroyed structures in the event of a landslide event. The Gulpur HPP has a moderate adaptive capacity with the ability to cope with landslide events.

The risk screening shows that the country is at low risk to landslides due to a lack of exposure. The risk may increase in future conditions. The Gulpur HPP has a moderate risk due to its higher vulnerability. This risk may increase in the future due to climate change exacerbating the landslide hazard and the addition of several non-climate stressors like vegetation removal and land use changes. These changes are detailed in Chapter 3.

1.3.4 Disease

In Pakistan, two of the most significant disease vectors are mosquitoes that convey malaria and dengue fever, and ticks that transmit CCHF. Malaria, dengue fever, and CCHF are considered endemic in Pakistan with seasonal increases in cases that often reach epidemic levels (Pakistan National Institute of Health, 2013). In addition to these, there are other vector-borne diseases that have been found in Pakistan, including Sand Fly Fever (*Phlebotomus papatasi* sand flies), West Nile Virus (*Culex tritaenorrhynchus* mosquitos), Sindbis Fever (*Culex modestus, Cx. Tritaeniorrhynchus* mosquitos), Japanese Encephalitis (*Culex tritaeniorhynchus* mosquitos), Bhanja Fever (*Hyalomma marginatum* ticks), Dhori Fever Virus (*Hyalomma dromedarii* ticks), and Chikungunya Fever (*Aedes aegypti* mosquitos) (Faulde, 2013).

The current hazard conditions of the three epidemic-prone diseases are presented below.

Malaria

With an estimated 1.5 million cases annually, Pakistan has been categorized by the WHO in the Group 3 countries of the WHO Eastern Mediterranean Region, along with Afghanistan, Djibouti, Somalia, South Sudan, Sudan and Yemen. These countries account for sharing 95 percent of the total regional malaria burden. Disease should be considered as a moderate frequency hazard since there is an epidemic 0.29 times a year (about once every 3 or 4 years) (OFDA/CRED, 2007). The GFDRR data shows 10 events from 1926 to 2006 (GFDRR, 2007).

Malaria is primarily transmitted in Pakistan by two mosquito species: *Plasmodium falciparum* and *Plasmodium vivax*, with the latter accounting for the majority of malaria cases. Approximately 60 percent of Pakistan's population live in malaria-endemic regions and the country experiences an estimated 50,000 malaria attributable deaths every year (Khattak et al., 2013).

Studies have found that temperature and humidity have been the most sensitive climatic factors in forecasting malaria epidemics (Bouma et al., 1996; WHO, 2003; WHO, 2005). A temperature range between 20^{o}C to 30^{o}C is considered optimal for *P. falciparum* and *P. vivax* (Bouma et al., 1996 and Dhiman et al., 2008). Parasite development cannot be completed below 17^{o}C to 19^{o}C for *P. falciparum* and below 15^{o}C for *P. vivax (*Bouma et al., 1996). A humidity level greater than 55 percent is considered optimal for vector longevity, in addition to requiring standing water for breeding (Bouma et al., 1996 and Dhiman et al., 2008). The spatial limit of malaria transmission for each strain in 2010 is illustrated in Figure 1-3 and Figure 1-4. The project area is not within the historical extent of the *P. falciparum* strain but the *P. vivax* strain exists throughout the project area.

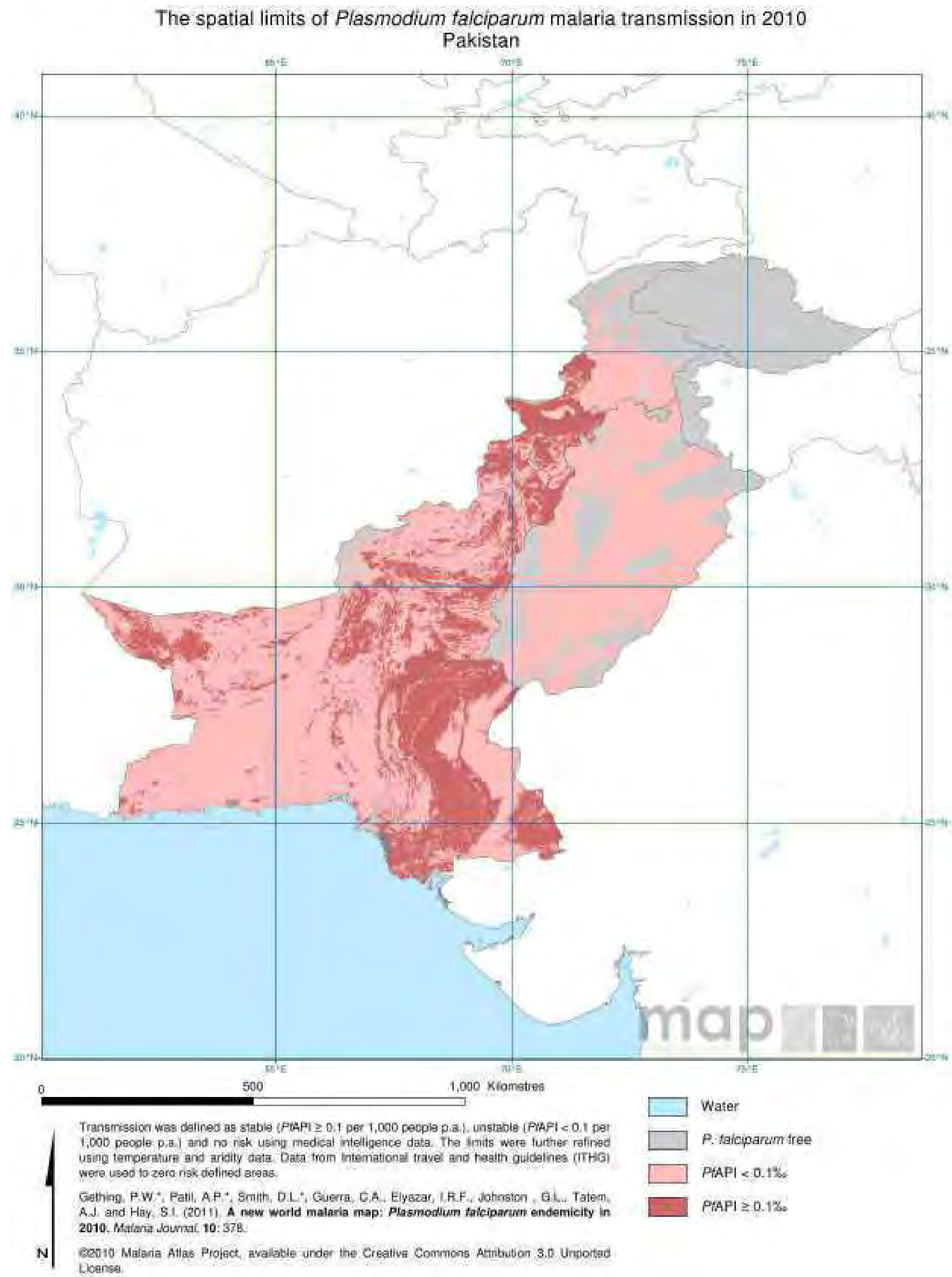


Figure 1-3: Spatial Extent of *Plasmodium Falciparum*

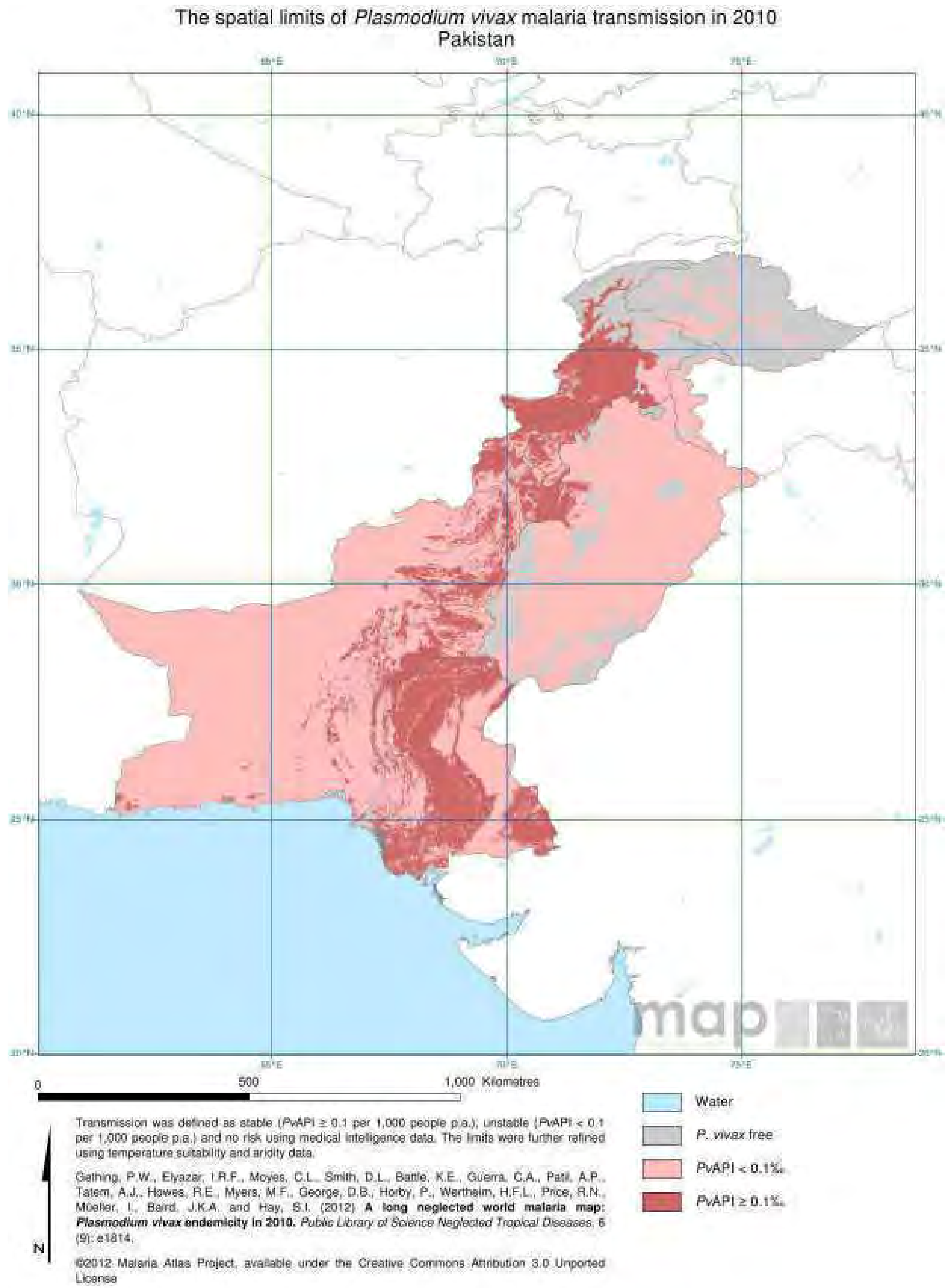


Figure 1-4: Spatial Extent of *Plasmodium Vivex*

The epidemiological profile for malaria in Pakistan is detailed below in Table 1-1 and Figure 1-5 as the latest figures available from the World Malaria Report (WHO, 2013b).[1]

Population at Risk for Malaria Transmission	Confirmed Cases per 1000 Population for 2012	Percentage of Total
High transmission (>1 case per 1000 population)	51,800,000	29
Low transmission (0–1 cases per 1000 population)	124,000,000	69
Malaria-free (0 existing cases)	3,030,000	2
Total	178,030,000	100

Table 1-1: Malaria Rates in Pakistan, 2012 (WHO, 2013b)

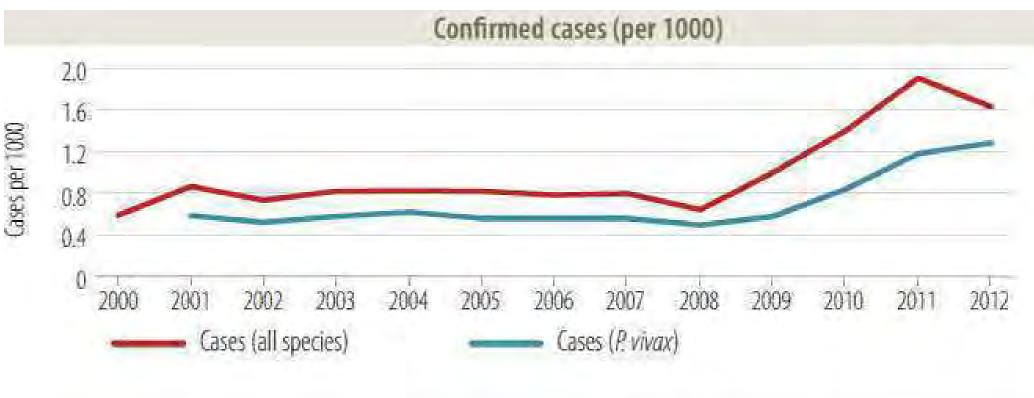


Figure 1-5: Malaria Rates in Pakistan

Note: confirmed cases per 1000 population, 2000 – 2012 (WHO, 2013b)

Malaria transmission is generally seasonal, with peaks between August and December following the monsoon season. The greatest prevalence of malaria is found in coastal areas (Balochistan and Sindh provinces) and the western borders (Federally Administered Tribal Agencies and Khyber Pukhtunkhwa), where malaria persists throughout the year (Khattak et al., 2013). AJK has a relatively low reported rate of malaria compared to the other provinces under current climate. The Pakistan Directorate of Malaria

[1] Note that the Pakistani Directorate of Malaria Control also maintains data on malaria infection rates; however, data are only available for public-sector facilities. The most recent data from the Directorate are from 2011, with 319,592 reported malaria cases from all the districts; including 205,879 (67%) cases due to *P. vivax* infection and 113,713 (33 %) due to *P. falciparum* infection. The Directorate estimated that approximately 70-80 percent of the population went to private-sector facilities for treatment; therefore, the actual malaria burden could be four to five times higher during that time-period. For more see: http://www.dmc.gov.pk/index.php?option=com_content&view=article&id=55&Itemid=78.

Control reported a 0.07 percent annual parasite incidence per 1,000 persons in AJK in 2009 (Malik et al., 2013).

Pakistan has malaria control programs in place and is a signatory to the global Rolling Back Malaria Program (Directorate of Malaria Control, 2013). Nation-wide interventions identified in Pakistan's Rolling Back Malaria program (Directorate of Malaria Control, 2013) include the following:

- Early diagnosis and prompt treatment
- Multiple prevention measures including promotion of insecticide treated bed nets and materials, targeted use of residual insecticide spraying, and introduction of biological and environmental vector management approaches
- Intensive and comprehensive public education activities
- Improved detection and response to epidemics and malaria emergency situations
- Developing viable public and private partnerships in the country to combat malaria

The hazard screening shows that disease frequency should be considered moderate since there is an epidemic 0.29 times a year (OFDA/CRED, 2007).

Dengue Fever

Dengue fever is transmitted by the *Aedes aegypti* mosquito and was first reported in Pakistan in 1994 (Faulde, 2013). Dengue fever has since become endemic to almost every geographic region in the country (Pakistan National Institute of Health, 2013). Figure 1-6 illustrates the rise in dengue fever cases from 2009 to 2012. In 2011, the country experienced an outbreak of dengue fever in the Punjab province, which was partly attributed to cases appearing earlier than previously recorded. Preventative mosquito spraying control programs must be undertaken one month before the transmission period in order to be effective. While there are no formal statistics on cases of dengue fever reported through the AJK Health Department, local newspapers reported cases of dengue fever in AJK province in 2006 and 2011 (Pakistan News Service, 2006 and AAJ News, 2011).

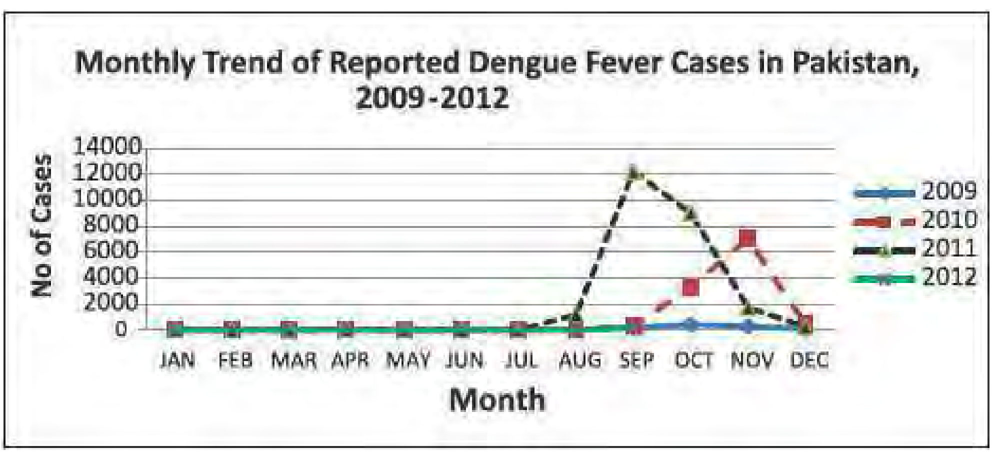


Figure 1-6: Monthly Trend of Reported Dengue Fever Cases in Pakistan, 2009 – 2012 (Pakistan National Institute of Health, 2013)

Vector prevention and control is the only available method for the prevention of dengue fever; medication has not yet been developed to treat the infection.

CCHF

CCHF is transmitted through the bite of the *Hyalomma marginatum* tick. Domestic animals, such as sheep and cows, serve as amplifying hosts. CCHF is transmitted through the bite of the adult tick, direct contact with the blood or tissue of infected domestic animals, or direct contact with the blood or tissue of infected people (Pakistan Ministry of Health and WHO, 2008). CCHF has a relatively high mortality rate (ranging from 2 to 50 percent). The global distribution of CCHF is illustrated in Figure 1-7.

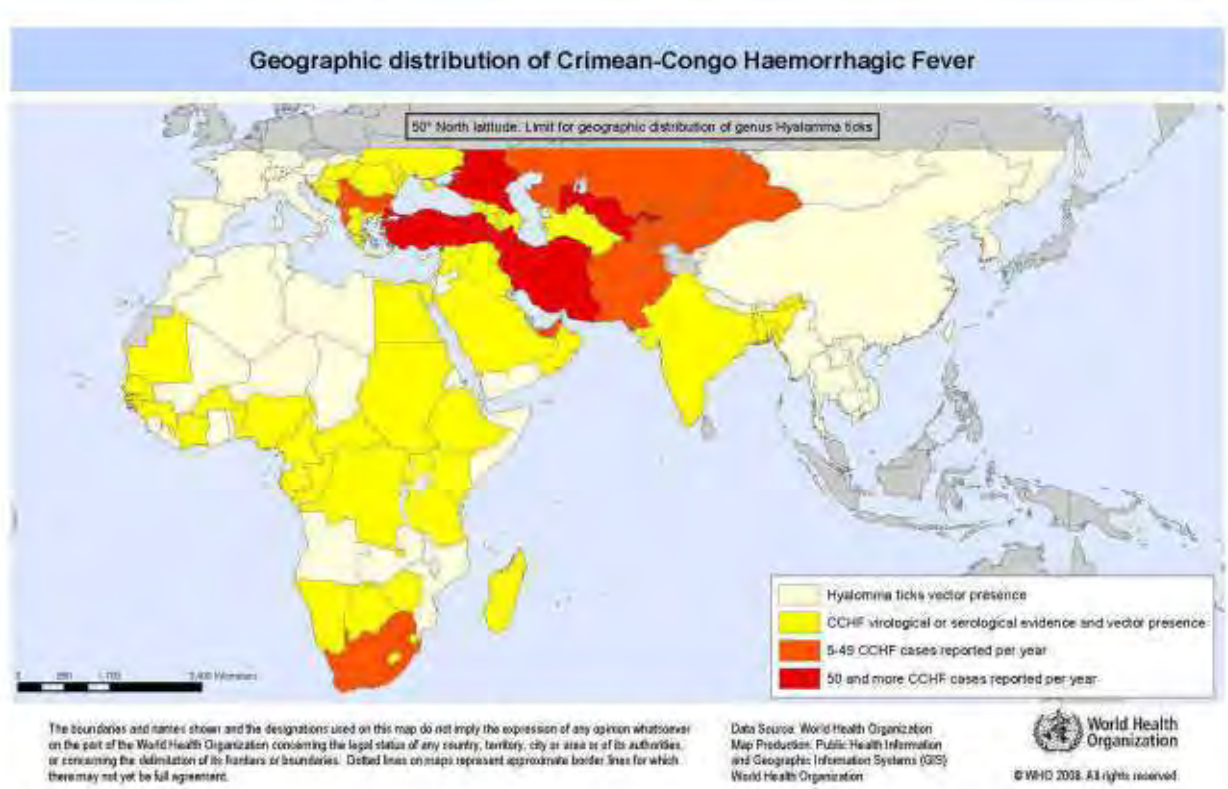


Figure 1-7: Geographic Distribution of CCHF (WHO, 2008)

CCHF was diagnosed in 1976 in Pakistan, with sporadic cases until a recent intensification of the disease across the country in 2000 (WHO, 2010). Since 2000, approximately 50 to 60 cases are reported annually. Balochistan is the most affected province in Pakistan, as shown in Table 1-2 below. AJK had one case reported in 2013.

Province	2012		2013	
	Cases	Deaths	Cases	Deaths
Azad Jammu and Kashmir	0	0	1	0
Sindh	7	3	2	1
Punjab	8	3	6	2
Islamabad (capital)	0	0	2	0
Khyber Pakhtunkhwa	9	5	6	4
Balochistan	38	7	60	8
Total	**62**	**18**	**77**	**15**

Table 1-2: Suspected Cases of CCHF reported in Pakistan, 2012 and 2013 (WHO, 2013a)

The vulnerability screening shows that there is moderate exposure to diseases since they occur in most of the country but not all the time (seasonally). The Gulpur HPP's exposure is moderate because their proposed facilities are located in areas which have been impacted by disease before. The country has a high sensitivity to disease which may be seen from the social losses from historical events. The Gulpur HPP also has a lower sensitivity to disease since their personnel are not children and they have health care. The country has a low adaptive capacity since there are no financial and few social networks in place to support sick people. The Gulpur HPP has a moderate adaptive capacity to cope with disease.

The risk screening shows that the country is at moderate risk to disease due to the prevalence of disease concerns and hazard vulnerability; this risk may increase based on projections of future conditions. The Gulpur HPP has a low risk due to its lower vulnerability. The Gulpur HPP's structures are not susceptible to the hazard, but its customers and workers are. This risk may increase in the future due to climate change exacerbating disease impacts. Chapter 6 details the impacts of climate change to the disease risk.

1.4 Risk Screening Results

The risk screenings described in previous sub-sections have been summarized in tables to facilitate comparison and ranking. Table 1-3 shows the hazard screening with the elements of frequency and magnitude for current and future conditions. Each component has been ranked high, medium, or low. Table 1-4 shows the vulnerability screening results with elements of exposure and sensitivity for current and future conditions and adaptive capacity. The adaptive capacity is a positive trait so a high adaptive capacity will decrease vulnerability, while high exposure and sensitivity will increase the vulnerability. Table 1-5 shows the overall risk screening evaluating the hazard and vulnerability.

Hazard	*Current* Frequency	*Current* Magnitude Range
Flood	H	M
Drought	L	H
Landslides	L	M
Disease	M	M

Table 1-3: Hazard Screening Table

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Exposure	*Current* Sensitivity	Adaptive Capacity
Flood	H (L*)	H (L*)	L (M)
Drought	H (H)	H (L*)	L (M*)
Landslides	L (M*)	H (M)	L (M)
Disease	M (M)	M (L)	L (M)

Table 1-4: Vulnerability Screening Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Potential Loss		
	Social	Economic	Environmental
Flood	M (L)	H (M)	M (L)
Drought	M (L)	M (L)	M (L)
Landslides	L (L)	L (M)	L (L)
Disease	M (L)	M (L)	M (L)

Table 1-5: Risk Findings Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low. Green indicates low risk, yellow indicates moderate risk; red indicates high risk.

1.5 References

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2. Analysis of Downscaled GCM Data

2.1 Overview

This chapter focuses on the analysis of potential climate change impacts on precipitation and temperature through the year 2100 using the regionally downscaled climate projections available from the PMD. Specifically climate change data hosted at the PMD website were downloaded and summarized.

Global climate models do not provide sufficient spatial resolution to fully understand climate impacts at the scale of the Poonch River watershed due to their coarse spatial resolution and rough approximations of local topography. A "downscaling" procedure is needed to evaluate impacts at the watershed scale. This can be done either through statistical methods (statistical downscaling) or by using the GCMs as boundary conditions RCMs that provide better spatial resolution (i.e., through dynamical downscaling). Statistical downscaling techniques with bias correction adjust the GCM output to local predictions based on the observed relationship between GCM output and local observations for the historical time period. These methods are cost-effective to apply but have limitations where local observations are scarce and can produce results in which different local climate endpoints (e.g., precipitation, temperature, humidity) are not fully synchronized with one another. They also make the assumption that the spatial relationship between local conditions and GCM output will remain unchanged under future climate conditions, which may be unwarranted if there are large-scale reorganizations of the climate system. Dynamical downscaling attempts to resolve these issues by applying a finer resolution climate model nested within the predictions of the GCM. This results in a fully consistent set of local climate predictions; however, RCMs are difficult and expensive to run, and therefore dynamically downscaled climate results are much less readily available than statistically downscaled results.

Because of the potential advantages of using dynamical downscaling, the available dynamically downscaled results for Pakistan are presented first. While valuable, these address only one greenhouse gas emissions scenario and one GCM run. Because other GCMs may produce different results, this report then examines the range of potential climate results produced by the suite of GCMs considered by the IPCC.

2.2 Dynamically Downscaled Climate Change Scenario Data for Pakistan

The climate data are provided by the "Numerical Modeling Group of Research and Development Division, Pakistan Meteorological Department (PMD), Islamabad, Pakistan". The climate projection archive are served at <*http://www.pmd.gov.pk/rnd/rndweb/rnd_new/climchange.php*> and include datasets representing climate change scenarios for future greenhouse gas emissions forcing global climate, defined in the IPCC Special Report on Emissions Scenarios (SRES).

Specifically, two regionally downscaled products using one GCM and two different RCMs are available:

- ECHAM5 data for A1B Scenario downscaled with PRECIS Regional Climate Model (PRECIS).
- ECHAM5 data for A1B Scenario downscaled with RegCM4 Regional Climate Model (RegCM4).

The ECHAM5 is a GCM developed by the Max Planck Institute for Meteorology. The climate projections for the ECHM5 GCM include Baseline (1961-1990) and Future Projections (2010-2100) for Decadal and Monthly Mean Temperature (°C) and Precipitation (mm/day). It should be noted that only decadal data were available for the ECHAM5/RegCM4 scenario (even though it is listed as available on the website), hence no monthly summaries could be generated for this scenario.

The data for the GCM are available at a resolution of 25 km and 50 km. The higher resolution of 25 km grid was chosen for the analysis. The precipitation and air temperature GCM model projections were downloaded and extracted for all the centroids of the grid cell locations that fell within the watershed of the proposed hydropower project. The data grid cell centroids in the vicinity of the study area watershed are shown in Figure 2-1. Note that the closest location to the proposed project is identified as Kotli at a latitude/longitude of 33.5/75.

Change statistics were calculated by comparing 30-year sets of the data with the base period defined at the PMD website i.e. from 1961 to 1990. This was done to avoid undue influence of decadal oscillations. Two future time horizons centered on 2025 and 2055 were compared to the base period to modify the weather time-series as follows:

- Time Horizon 1 centered at 2025: Compare 2011-2040 to 1961-1990
- Time Horizon 2 centered at 2055: Compare 2041-2070 to 1961-1990

Multi-year averages were first calculated for each time slice including the base or current period. For each scenario and time horizon monthly deltas and percent change statistics were then calculated for surface air temperature and precipitation using the multi-year monthly average values. The deltas were calculated as the future minus the current and the percent change was calculated as the delta divided by the current.

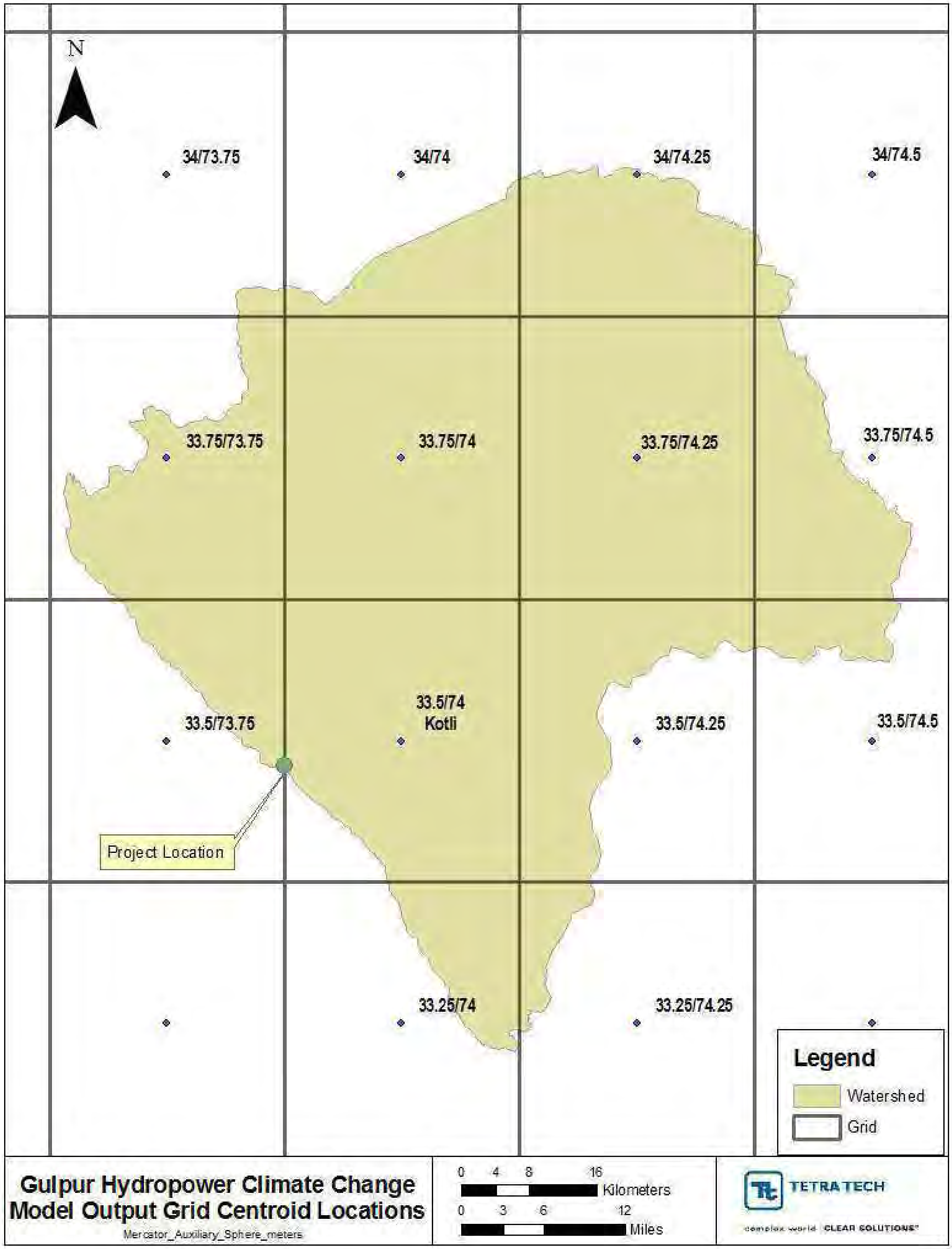


Figure 2-1: Gulpur HPP Watershed Location and Climate Model Grid Cell Locations

2.3 Scenario Result Summaries

The scenario results for each of the 14 grid cell locations shown in Figure 2-1 were extracted and summarized on an annual and monthly basis (if data were available). Table 2-1 and Table 2-2 show the monthly and annual precipitation and temperature at each of these locations for the baseline period and the two selected time horizons.

Area-weighted	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average Annual
Baseline	3.07	3.23	3.01	2.57	1.73	7.31	8.72	7.18	4.86	2.91	3.05	3.13	**4.23**
2011-2040	2.99	4.12	5.86	2.71	2.72	6.91	8.70	8.06	5.23	4.86	2.83	2.91	**4.82**
2041-2070	2.70	2.64	3.42	2.49	1.75	6.69	8.38	8.58	5.37	3.46	2.27	2.17	**4.16**

Table 2-1: Monthly Precipitation (mm/day) – ECHAM5/PRECIS

Area-weighted	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg. Annual
Baseline	2.2	4.5	9.8	16.1	23.2	23.2	21.3	20.1	17.2	13.3	7.6	4.0	**13.5**
2011-2040	3.6	6.0	10.7	17.4	23.5	24.3	22.2	21.0	18.3	13.6	8.9	5.0	**14.5**
2041-2070	5.7	8.4	13.4	19.5	25.7	26.2	24.1	22.5	19.9	15.1	11.0	7.5	**16.6**

Table 2-2: Monthly Temperature (^{o}C) – ECHAM5/PRECIS

Annex I contains tables showing the relative weight of the values from each cell was evaluated based on the watershed ratio which is the percent of the grid cell that falls within the watershed area and is shown in the tables. This was used to calculate the area weighted values for precipitation and temperature, also presented in Annex 1. In addition, the percent change values for precipitation and deltas for the temperatures were also calculated for each of the cells. The results for the two models and the three time horizons are shown in Figure 2-2 and Figure 2-3.

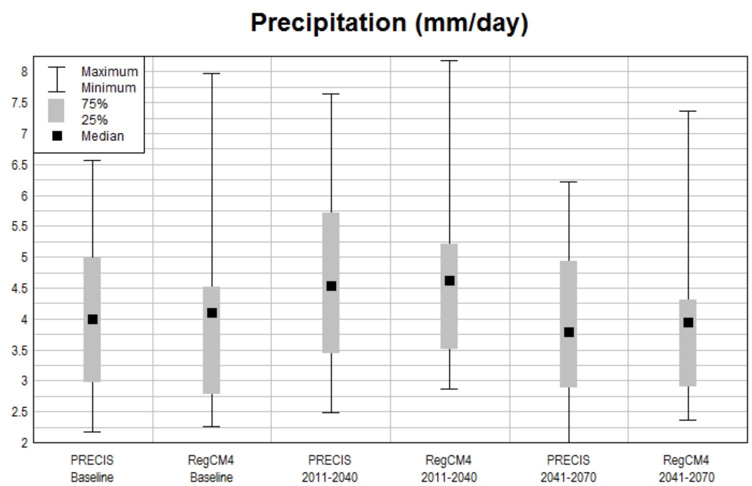


Figure 2-2: Precipitation Scenario Comparison

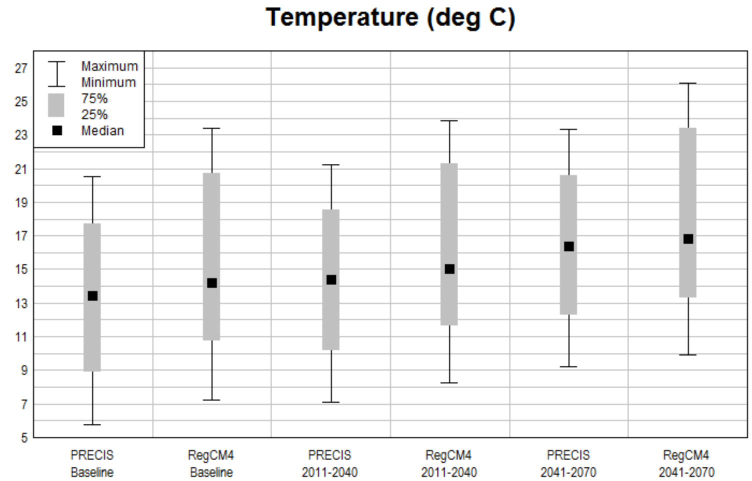


Figure 2-3: Temperature Scenario Comparison

Under baseline conditions, the area-weighted average annual temperature in the watershed is 13.5^{o}C and the average annual precipitation is 4.23 mm/d (1545 mm/yr). Scenario results for the PRECIS model at Kotli near the project location indicate an increase (13 percent) in precipitation for the 2025 scenario, however the 2055 scenario indicates a minimal increase from the baseline (actually a decrease from 2025).

Area-weighted precipitation values as compared to historic results show an overall 14 percent increase and -2 percent decreases over the two time-horizons respectively (Figure 2-4, Figure 2-5 and Figure 2-6).

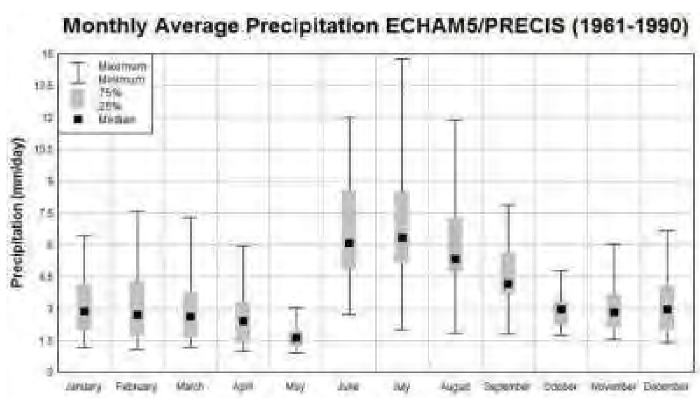


Figure 2-4: Modeled Historic Monthly Average Precipitation

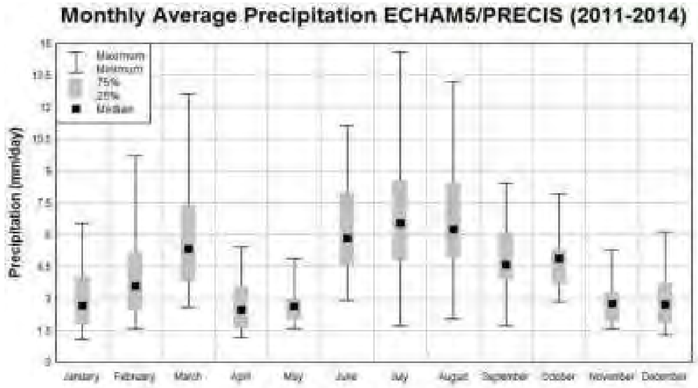


Figure 2-5: Modeled Current Monthly Average Precipitation

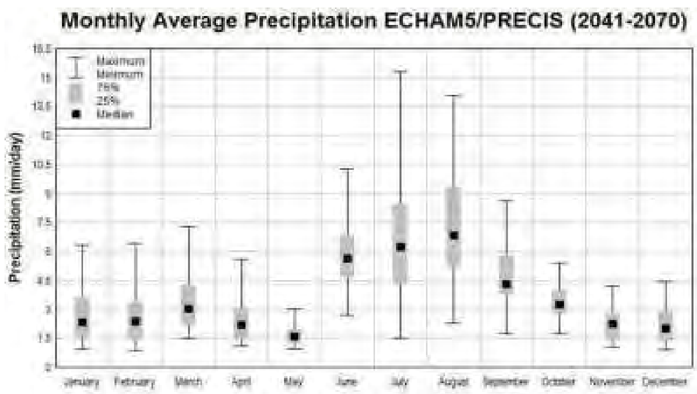


Figure 2-6: Modeled Future Monthly Average Precipitation

The RegCM4 scenario tended to predict higher precipitation compared to the PRECIS scenario. The RegCM4 results also show a similar trend at Kotli i.e. of increase in the near term for time horizon 1 and a minimal increase compared to the baseline when extending into the future for time horizon 2 (28 percent and 6 percent respectively). The area-weighted precipitation values for the RegCM4 scenario were 18 percent and -1 percent for the two time horizons which were similar to the PRECIS scenario. Annex 1 includes values for each of the grid cell locations for comparative purposes.

Temperature predictions tend to indicate increases with each time horizon for both scenarios. Annual average temperatures increase for the PRECIS and RegCM4 model. Annual average temperature increase at Kotli for the PRECIS scenario for 2025 was 0.8°C and 2.1°C for 2055, whereas for RegCM4 it was 0.5°C and 2.2°C. Overall for the entire watershed (based on area weighting) the PRECIS model showed an increase of 1°C and 3.05°C for 2025 and 2055, whereas the RegCM4 model showed an increase of 0.74°C and 2.65°C.

Box plots of annual and seasonal summaries can be found in Figure 2-7. The range in the box plots reflects the variability in the temperatures across the selected grid cell locations.

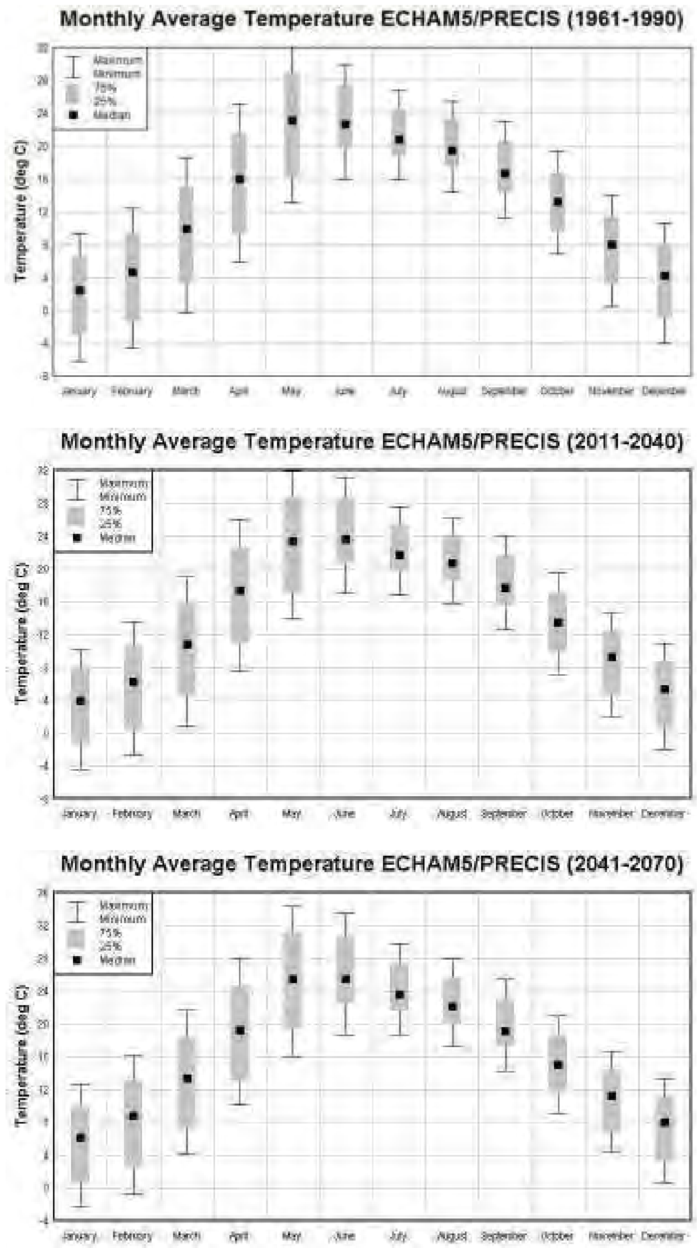
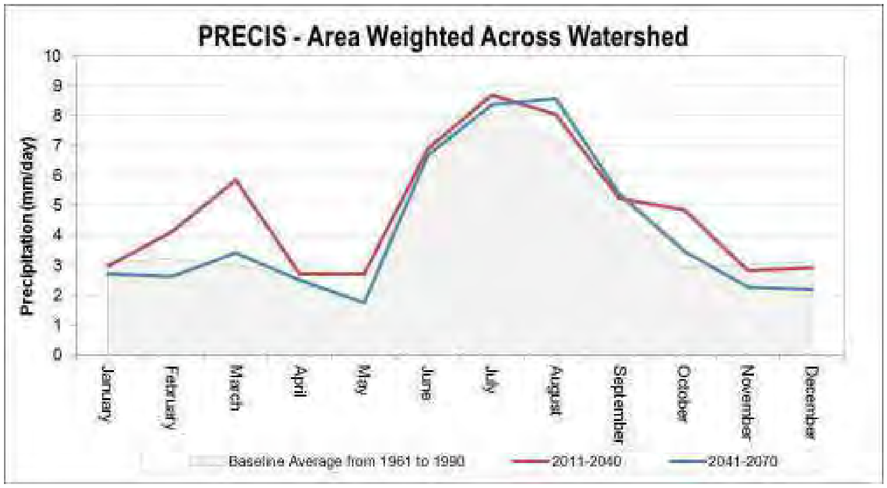


Figure 2-7: Box Plots of Temperature

Note seasonal summaries are provided only for the PRECIS scenario because the RegCM4 scenarios only had annual decadal data available. Seasonal precipitation for the PRECIS scenario compared to the baseline indicates a slight shift in the monsoon season which is typically during the months of July and August with peaks shifting by a month from July to August extending a little longer than the baseline. The maximum percent changes were observed during spring season in March during the 2025 period, however these were relatively less for the 2055 period (Figure 2-8 and Figure 2-9).



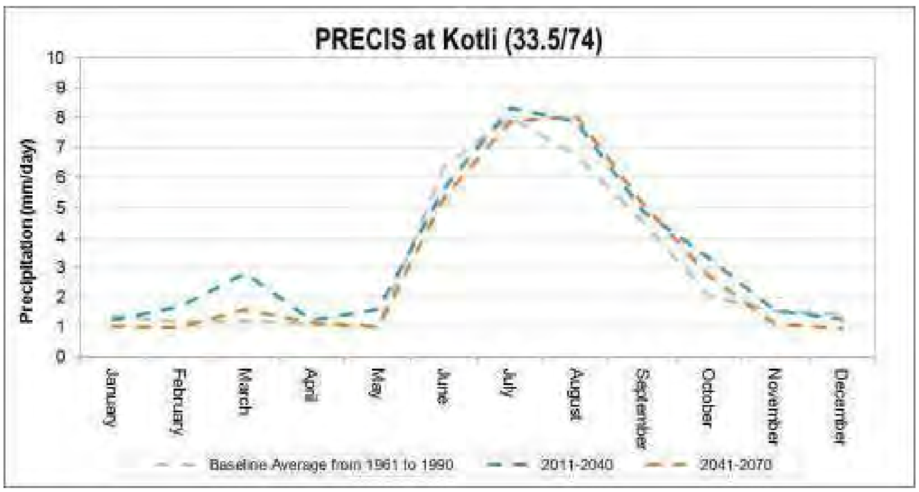
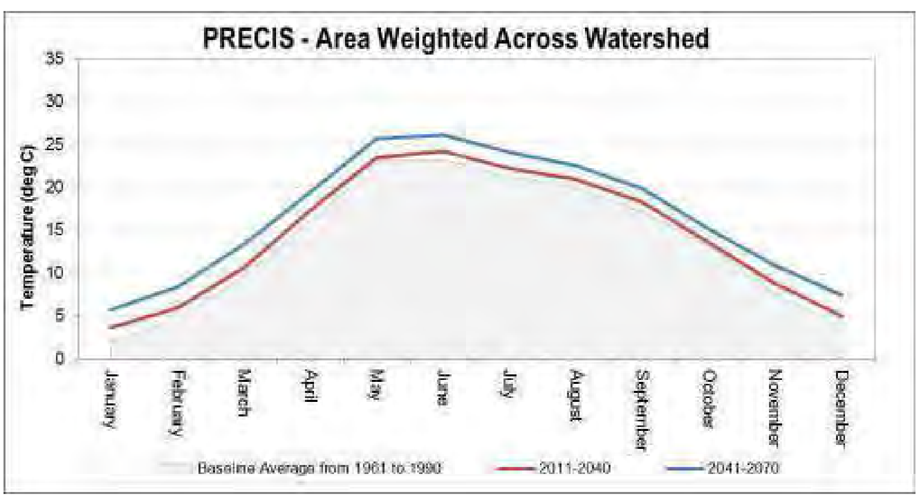


Figure 2-8: PRECIS Precipitation Data: Gulpur Watershed and Kotli



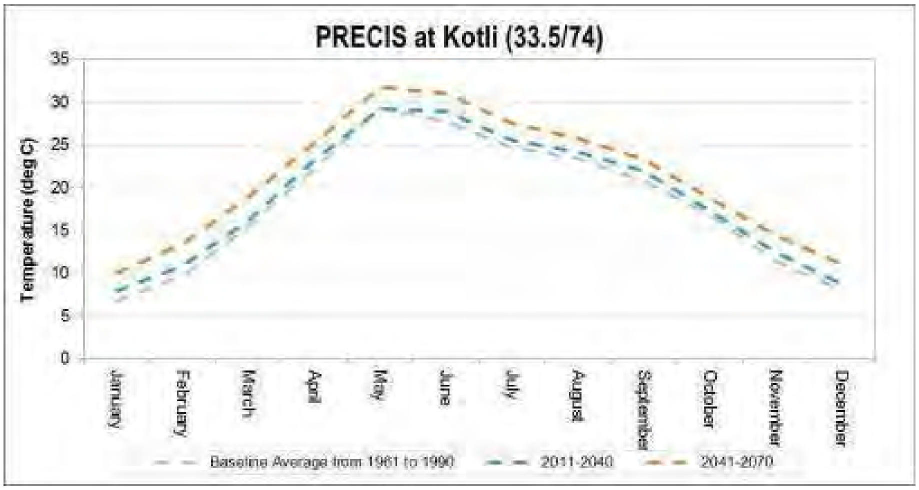


Figure 2-9: PRECIS Temperature Data: Gulpur Watershed and Kotli

In addition, the spatial variability for temperature and precipitation across the entire watershed can be also seen in maps showing the different time-horizons for the two scenarios in Figures 2-10 through 2-13. The watershed has elevations ranging from 500 m near the project location to 4500 m at the headwaters at the northwestern portion of the watershed which is much cooler and experiences more precipitation compared to the downstream project location area.

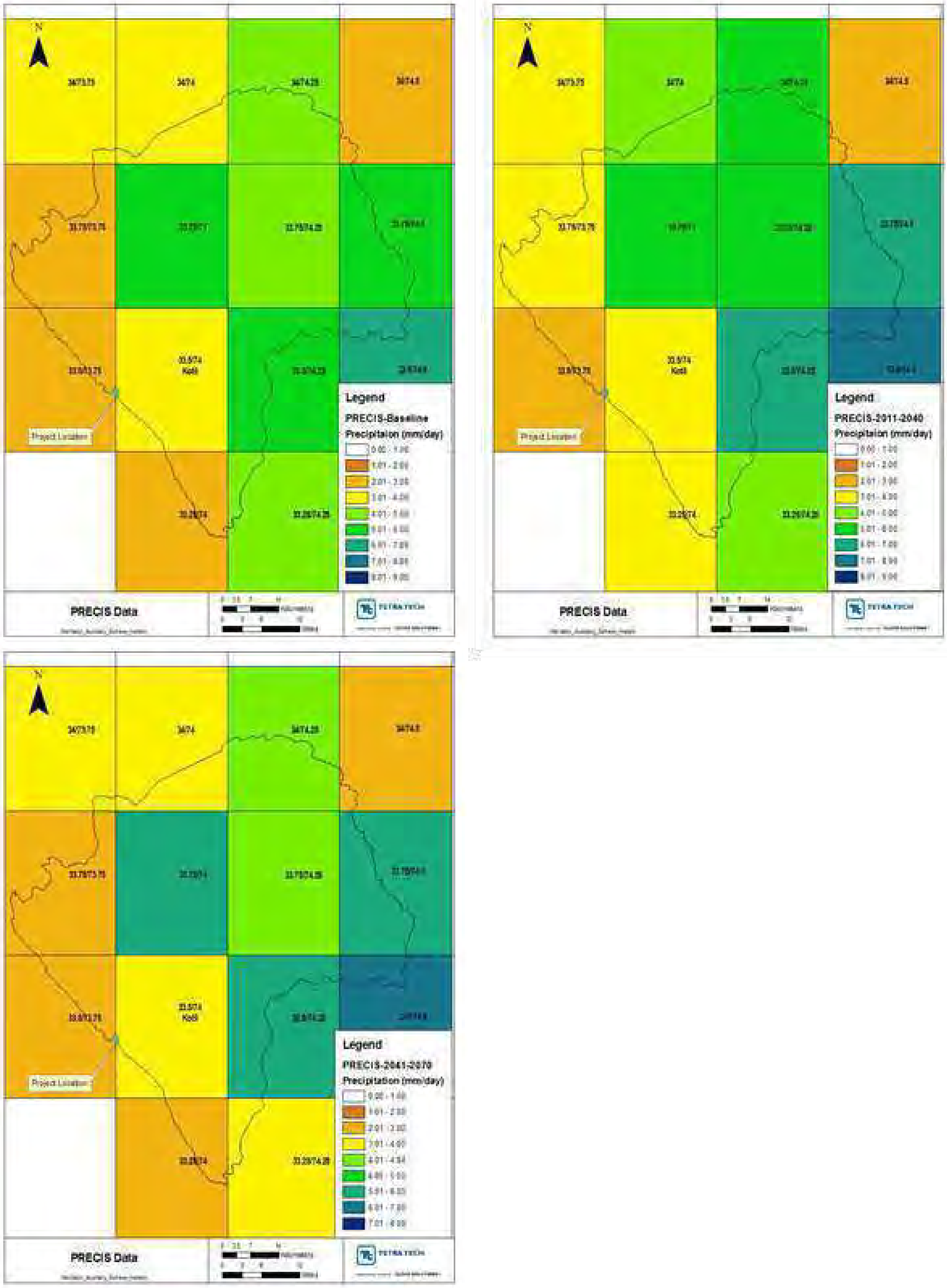


Figure 2-10: PRECIS Watershed Maps of Projected Precipitation per Time Horizon

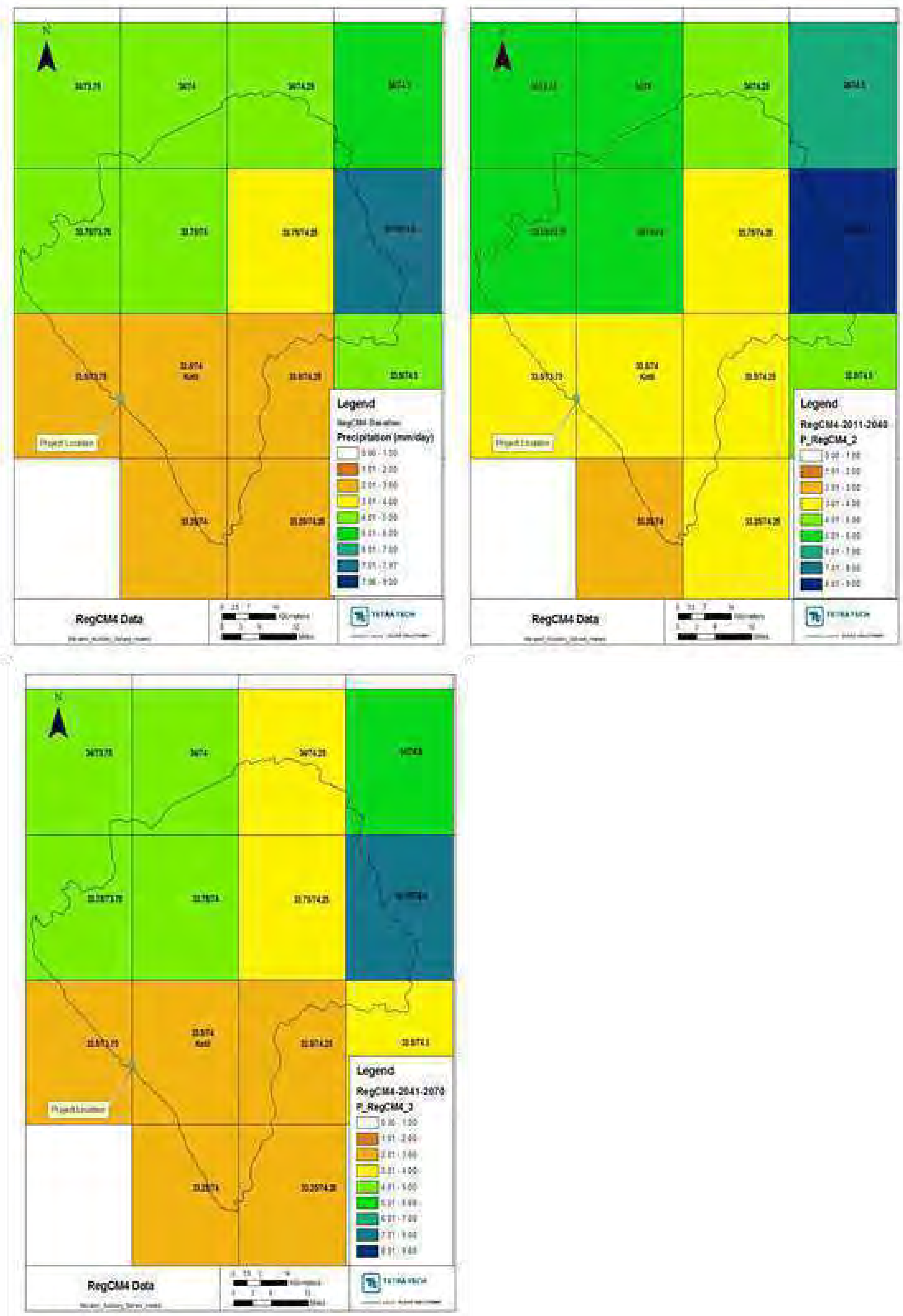


Figure 2-11: RegCM4 Watershed Maps of Projected Precipitation per Time Horizon

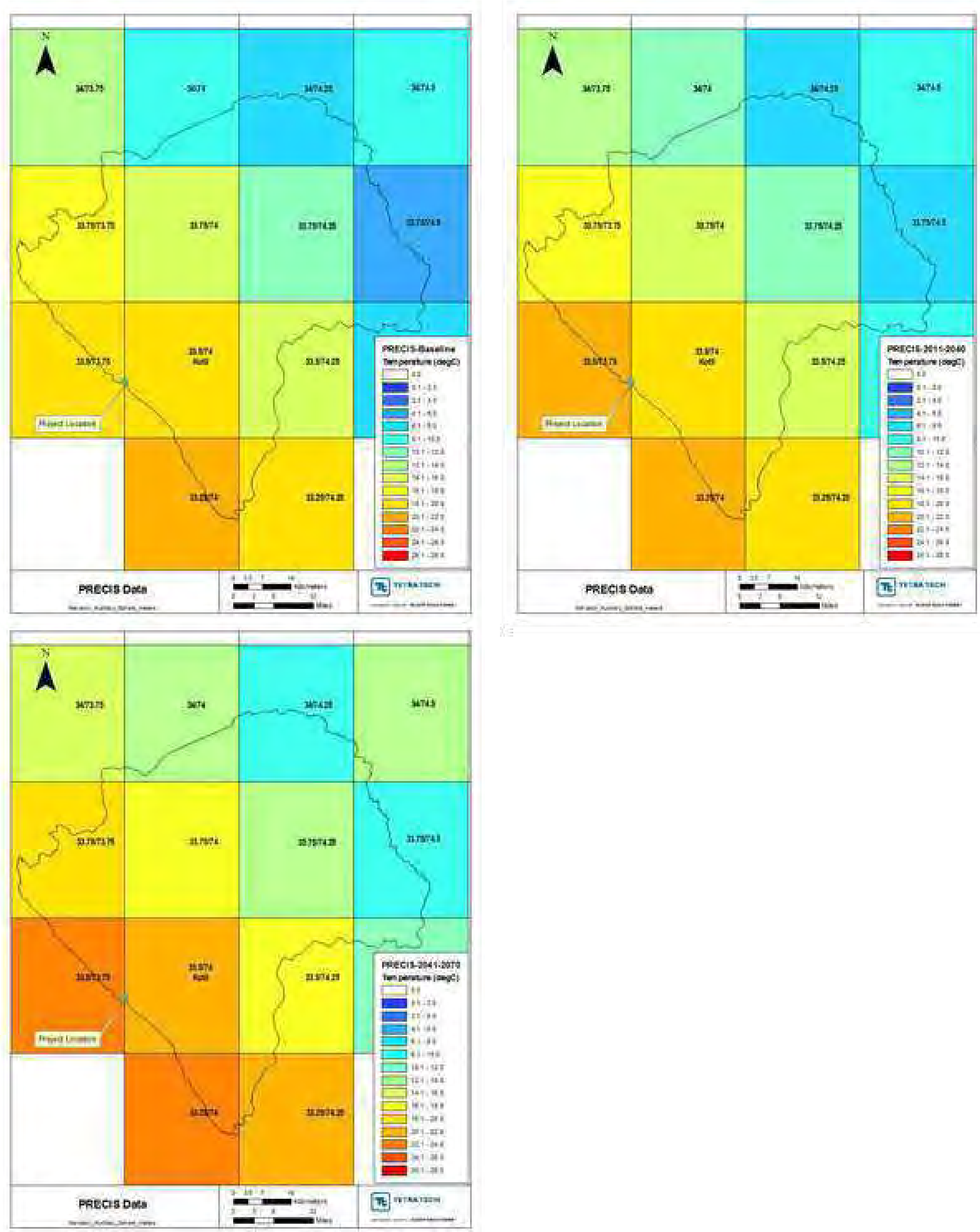


Figure 2-12: PRECIS Watershed Maps of Projected Temperature per Time Horizon

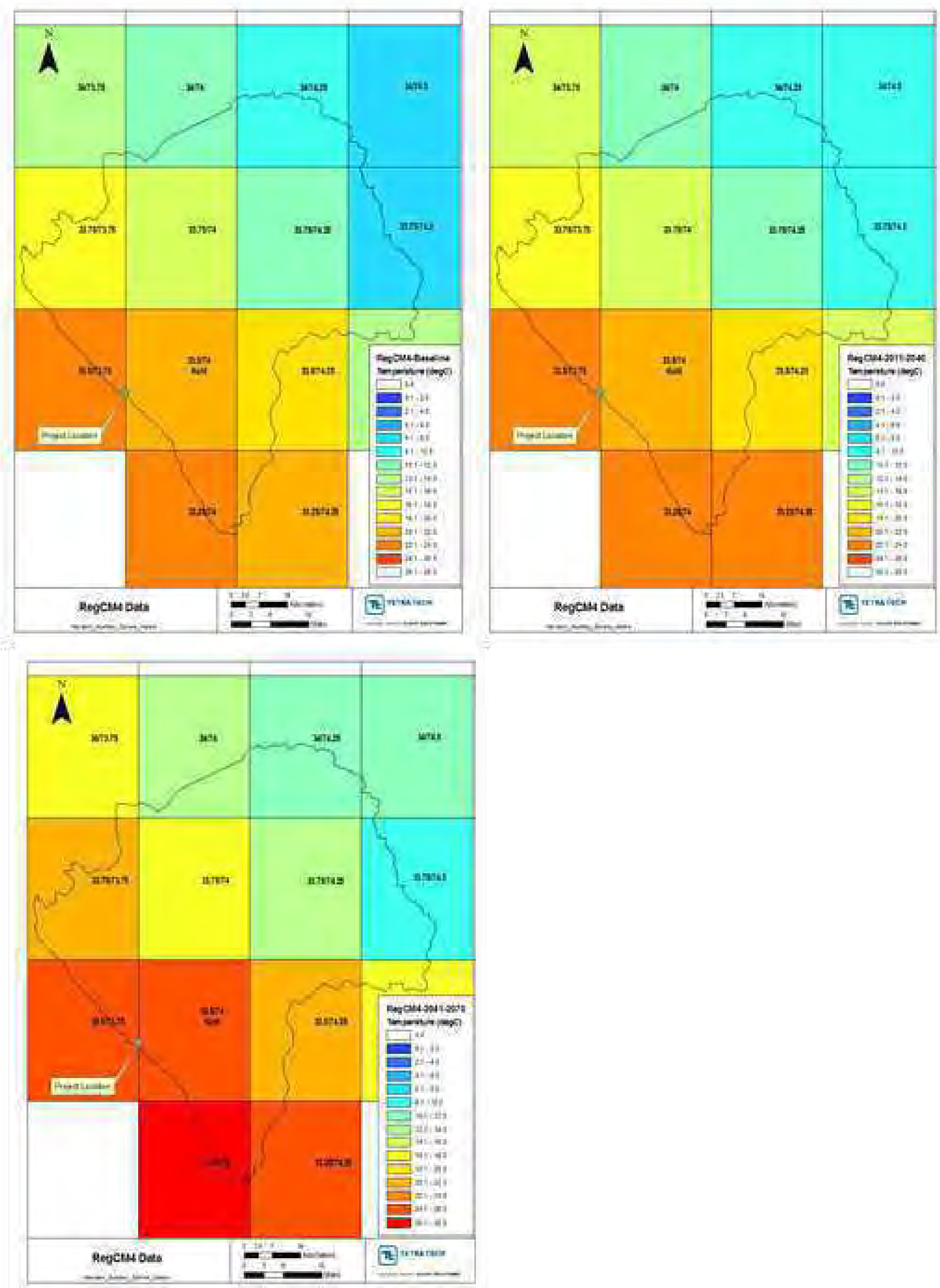


Figure 2-13: RegCM-4 Watershed Maps of Projected Temperature per Time Horizon

2.4 Corroborating Evidence

Different GCMs are reasonably consistent in their predictions of changes in annual average temperature, while the different emissions scenarios vary by only a small amount in temperature predictions through the mid-21st century. In contrast, precipitation predictions vary markedly among different climate models and emissions scenarios. To get a sense of the potential range of the PMD projections, they were compared to the projected results for the 2050s of 16 statistically downscaled GCMs under three different emissions scenarios from the IPCC 4th reassessment (Girvetz et al., 2009). The spread among individual GCMs is large, ranging from -17 percent to +19 percent relative to the average annual precipitation of 1951-2002 at 74°N 33.5 °W (near Kotli). However, the central tendency of the 16 models suggests little overall change, consistent with the analysis presented above. Specifically, the median change in precipitation for the A1B scenario is +0.5 percent, while the median changes for the B1 and A2 scenarios are +1 percent and -0.5 percent, respectively.

Annex I of IPCC (2013) also presents ensemble results from AR5 graphically by subregion. These figures suggest that the project area will likely experience an air temperature increase of around 1°C by the 2020s and more than 2°C by the 2050s, while precipitation changes are likely to be small.

2.5 References

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3. Hydrologic Assessment of Potential Climate Change Impacts: Daily Precipitation and Flooding

3.1 Introduction

A considerable body of literature suggests that climate extremes, not just averages, will be modified as a consequence of climate change in the 21st century, as described in the IPCC summaries (Special Report on Extremes, 2012; Assessment Report 5, 2013). In both documents, special mention is made of the major floods along the Indus River in 2010. Although it is not established that the 2010 flood was a consequence of climate change, it is an example of a major extreme event with large economic consequences, whose probabilities are expected to increase in the future. In the context of a new dam, the flooding risk is a major concern and is the subject of this chapter. The analysis was conducted using two approaches. The first approach addresses the probable maximum flood directly from global model discharge values for different time points in the future. The second approach involves the estimation of a probable maximum precipitation event for the future, and then applies a hydrologic model of the watershed to compute the discharge. This latter approach replicates the analysis methodology applied in the current design of the dam's spillway flow (Mira Power, Hydrological Analysis). However, the original analysis uses the current estimate of the probable maximum precipitation event, and does not consider climate change. In addition to the flood analysis, the change in sediment loading under climate change was also computed. This was done in light of the major sediment loads transported in the Indus basin and the need for frequent flushing of the proposed Gulpur HPP to maintain operations.

3.2 Updating the Probable Maximum Flood Using Climate Scenario Data

The flood flows as a result of climate change were estimated by evaluating daily discharge data computed using a GCM (Hadley Centre Model, HadGEM2-ES), coupled with the VIC model (Liang et al., 1994) applied at the global scale. HadGEM2-ES was selected because it predicts a wetter future climate for Pakistan than most other GCMs in the CMIP ensemble. Model output was available from 1970-2100. GCMs are also run with different emission scenarios, with different extents of warming potential, labeled as representative concentration pathways (RCPs), ranging from RCP2.6 to RCP8.5 corresponding to different levels of greenhouse warming gases in the atmosphere and associated radiative forcing due to the presence of these gases. RCP6 constitutes a mid-range emission scenario, excluding the upper and lower emission extremes. Where multiple climate scenarios were available, this analysis focuses on the RCP6 calculated values in this analysis, and did not focus on the high or low extreme emissions. A general goal of the present analysis was to understand how key dam-related design properties might change under future scenarios, and to thus improve decision making in the near term and the long term. Although presented in a quantitative manner below, it is important to emphasize the significant unknowns involved in projections many decades into the future (driven by emission and model uncertainty). Given the wide range of emission futures that are possible, it is reasonable to consider a mid-range value of emission at the current stage of risk assessment. It is possible that a different emission scenario results in a different estimate of the quantities presented here. However, in the subsequent use of this analysis, it is more important to consider the direction of the projected change, and the approximate magnitude of the change, rather than the specific numerical value.

Model output values at the global scale were downloaded from the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) archive (Warszawski et al., 2013). Data were reported at the 0.5^{o} by 0.5^{o} grid scale (latitude by longitude), and were extracted for the nearest cell corresponding to the project location in Gulpur, Pakistan, and corresponding to the basin outflow (33.25 N, 73.75 E).

The following factors were used to select this model for this aspect of the analysis:

- Availability of daily discharge data for the most recent of climate projections, performed as part of Coupled Model Intercomparison Project (CMIP) Phase 5, or CMIP5, effort. CMIP5 model results are the basis of the most recent IPCC reports being released in phases in 2013 and 2014.
- Previous versions of the Hadley Center Model suggest projections of wetter conditions in Pakistan than the ensemble average of models, as evaluated in the CMIP Phase 3 (CMIP3). For comparison, the ensemble average for Pakistan for CMIP3 models and for the Hadley Centre Model are shown in Figure 3-1.
- Other analysis of daily precipitation intensity for CMIP5 models, besides HadGEM2-ES, suggest lower reduced rainfall intensity and/or no statistically meaningful change.
- For estimating flooding characteristics into the future, therefore, the HadGEM2-ES model may represent more conservative conditions.

The available discharge data for HadGEM2-ES data was used to estimate changes in probable maximum floods (PMFs) for periods 30 years and 60 years into the future (2040 and 2070 for this evaluation). Further, each of the future time points was associated with a 30-year climatology, represented by data from 2025-2055 and 2055-2085.

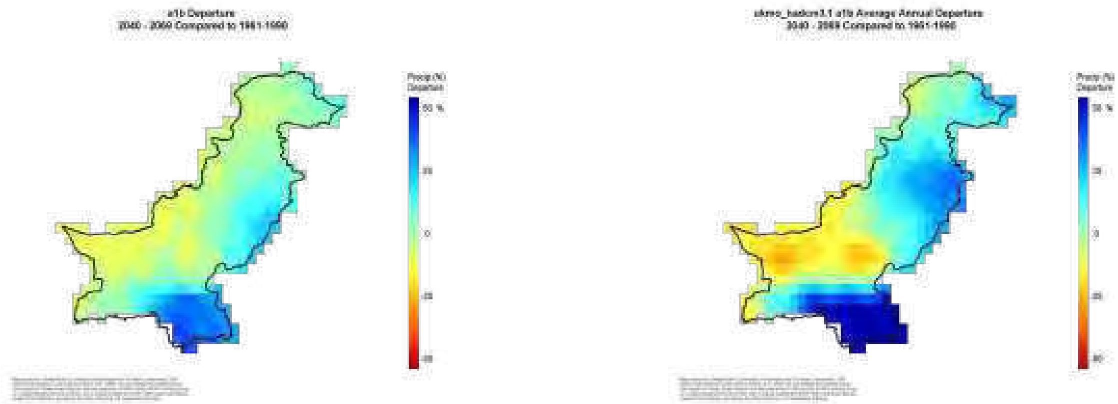

Figure 3-1: Change in Precipitation from CMIP3 Models

Note: Change is for the mid-21st century compared to 1961-1990). Left panel, ensemble average; right panel: Hadley Centre Model. Source: http://www.climatewizard.org/.

Discharge computations were based on the VIC model applied at the global scale. VIC is a macroscale hydrologic model that balances both energy and water over a grid mesh, typically at resolutions ranging from a fraction of a degree to several degrees latitude by longitude. In contrast to most hydrologic, or rainfall-runoff models, the VIC model includes a full energy balance formulation, and a comprehensive, physically-based representation of snow dynamics. The VIC model has been successfully applied to watersheds around the world for many years. The global VIC model performs flow routing as an approximation on a 0.5°C grid using the method of Lohmann et al. (1996). Because of the coarse scale it is not expected to provide an exact estimate of flow volume in a single small catchment, such as the Poonch River. However, the *relative* changes between scenarios in VIC model predictions should provide a good indication of the relative changes expected in actual catchment flows.

The above model data were divided into three groups: (1) the historical HadGem2 run (“HadGem hist”), (2) years 2025-2055 of the HadGem2 RCP6P0 run, corresponding to a mid-point period of 2040 (“HadGem 2040”), and (3) years 2055-2085 of the RCP6P0 run, corresponding to a mid-point period of 2070 (“HadGem 2070”). For comparison, the results include the data of Table 1.4-1 of the Gulpur HPP Hydrological Report (“Observed”) as another group. The annual maxima of each group were plotted as a time series as well as the empirical cumulative distribution factor (CDF). The annual maxima of each model were then fit to both the Gumbel and Generalized Extreme Value (GEV) distributions by maximum likelihood (a GEV fit to the observed group is included for comparison — similar to the boxed column of Table 1.4-4 in the Hydrological report).

Return levels for each fitted distribution were calculated out to 10,000 years and plotted. Four diagnostic plots for each fit were developed, consisting of:

1. A probability plot: empirical CDF of the data vs. CDF of fitted distribution
2. A quantile plot: quantiles of the data vs. corresponding quantiles of the fitted distribution
3. A return level plot: empirical and modelled quantiles on the scale of return periods
4. A density plot: fitted distribution overlaid on histogram of the data

The calculated 10,000 year extreme flow event using the different sources is summarized in Table 3-1 below.

Data Source and Probability Distribution	Calculated 10,000 Year Return Period Event (m^3/s)	Change from Historical (%)
GEV, observed	26,724	
Gumbel, observed	21,294	
GEV, Historical, HadGEM	7,993	
Gumbel, Historical, HadGEM	5,526	
GEV, 2040 climatology	20,601	158
GEV, 2070 climatology	11,350	42
Gumbel, 2040 climatology	6,166	12
Gumbel, 2070 climatology	8,040	45

Table 3-1: Summary of 10,000 Year Discharge Events from Different Models (m^3/s)

Note that these results correspond to PMF estimates. The future projections are based on the VIC model, and the percent change from historical for future time periods are based on a model-to-model comparison, i.e., VIC model for historical values versus VIC model for future values.

Discharge for different return periods (2-years and 100-years) is shown in Table 3-2. In addition, the discharge time series from the different data sources is shown in Figure 3-2. Note that the observed values of discharge are higher than modeled historical values, and estimates of future change are based on a model comparison (historical modeled compared to future modeled).

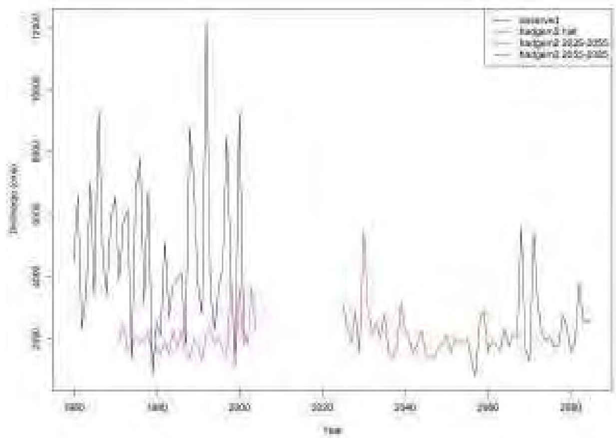

Figure 3-2: Time series of discharge

Note that the data are calculated using the HadGEM2-ES model for climate with RCP6 and the VIC model for hydrology, for the historical period, and for the two 30-year time periods centered around 2040 (2025-2055) and 2070 (2055-2085). Also shown, for comparison, is the observed discharge over the historical period. Data were downloaded from ISI-MIP.

3.3 Updating the Probable Maximum Precipitation

Computation of the PMP involved an approach widely recommended for use in hydrologic planning (Koutsoyiannis, 1999; Chin, 2005). Typically, PMP estimates are based on the maximum possible rainfall that can occur over a specific location, and based on meteorological evaluations. Where data are limited, statistical approaches may be used. The available daily precipitation time series from the different data sources is shown in Figure 3-3.

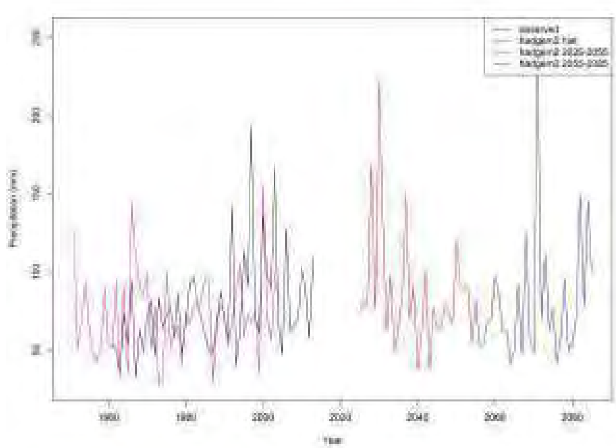

Figure 3-3: Time Series of Precipitation, Calculated Using the HadGEM2-ES Model

Note that this is for the historical period and for the two 30-year time periods centered around 2040 (2025-2055) and 2070 (2055-2085). Also shown, for comparison, is the observed precipitation over the historical period. Data downloaded from ISI-MIP.

The CDF of daily precipitation is presented in Figure 3-4, and shows how the higher end daily precipitation values are more extreme in the 21st century periods compared to historical values (model to model comparisons; observed values are higher than modeled).

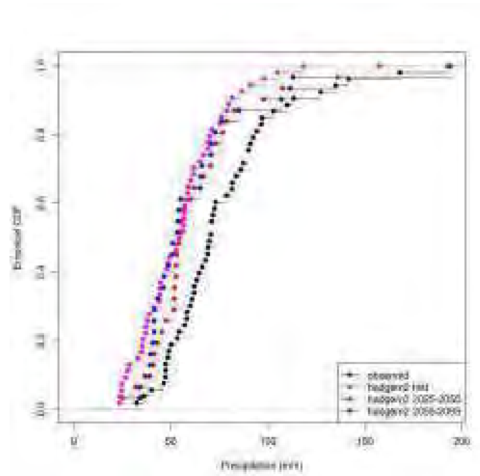

Figure 3-4: Cumulative Distribution Function (CDF) of Daily Precipitation

Note: This is calculated using the HadGEM2-ES model (RCP6), for the historical period, and for the two 30-year time periods centered around 2040 (2025-2055) and 2070 (2055-2085). Also shown, for comparison, is the observed precipitation over the historical period. Data downloaded from ISI-MIP

The approach employed was to use the daily precipitation averaged over the four grid cells that span the extent of the project watershed over the historical and 21st century periods to estimate the PMP as

$$P_m = \bar{P} + k_m \sigma_P,$$

where $\bar{P}$ and σ_m are the average and standard deviation, respectively, of the annual maxima of a precipitation series. The coefficient k_m is considered to be a GEV-distributed random variable with parameters $\mu = 0.44$, $\sigma = 0.60$, and $\xi = 0.13$, and specific return periods m are associated with the upper $\frac{1}{m}$ point of that distribution (Koutsoyiannis, 1999; Chin, 2005).

There is no specific return period for the PMP, and given its extreme nature, return periods from tens to hundreds of thousands of years have been used in the literature. For this study, the relevant factor is the potential change in PMP for climate change scenarios, given a fixed, and large, value of the return period. The calculated PMP changes for $m = 100{,}000$ years using the different data sources are summarized in Table 3-2. The magnitude of the PMP is expected to increase by 30 percent and 47 percent for the 2040 and 2070 climatology, respectively.

Data Source	Calculated 100,000 Year Return Period Event (mm)	Change from Historical (%)
Observed	598	
Hadgem, Historical	409	
Hadgem, 2040 climatology	533	30
Hadgem, 2070 climatology	599	47

Table 3-2: Summary of Statistically Estimated PMP (Koutsoyiannis, 1999 Approach)

In addition to the PMP, the daily precipitation data were fit via maximum likelihood estimation (MLE) to distributions and used to compute the 2-year and the 100-year events. Daily precipitation values for these return periods are shown in Table 3-3.

Data Source and Probability Distribution	Calculated 2-year Return Period Event (mm)	Calculated 100-Year Return Period Event (mm)
Gumbel, observed	72	165
GEV, observed	71	188
GEV, Historical, Hadgem	52	118
Gumbel, Historical, Hadgem	52	126
GEV, 2040 climatology	58	163
GEV, 2070 climatology	52	260
Gumbel, 2040 climatology	59	138
Gumbel,2070 climatology	57	133

Table 3-3: Summary of 2- and 100-year Events from Different Models for Daily Precipitation (mm)

3.4 Discussion of Daily GCM Output Analysis

In addition to the uncertainties in the climate model and discharge model projections, it is important to highlight that this report also presents the extrapolation of the probability distribution function (either GEV or Gumbel) to a return period with very little data. This adds uncertainty but is inherent in extreme event projections, which by their nature, have very few observations associated with them. This analysis does not address uncertainty bounds on these distributions because the ratio of the change is more relevant and the impact models cannot resolve the actual flow routing of the project. In this case, when the watershed-specific analysis and the PMF values derived from the GEV distribution, are compared with the regional estimates, the upper end changes for the 10,000 year return periods appear not to be supported. For this reason, the Gumbel estimates for PMF are considered more reasonable (10.1 percent and 36.6 percent increase for 2040 and 2070), and in line with the independent estimates of PMP (30 percent and 47 percent increase for the 2040 and 2070).

3.5 Summary of Previous Estimates of Extreme Flows

Previous estimates of peak flow and PMF used for design of dam and associated infrastructure are summarized in this section; these have been compiled using the following documents provided by Mira Power:

- Basic Design Report
- Design Option Comparison

The values utilized for design of the dam are reproduced in Table 3-4. In previous analyses (see Basic Design Report), PMP was routed through the catchment to estimate PMF using the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS). The parameters utilized for estimation of the PMF are provided in Table 3-5.

	Average Recurrence Interval (years)	Peak Discharge (m^3/s)	Estimation Method	Source
Diversion Works	1	1,761	Flood Frequency Analysis	Design Option Comparison
Spillway	100	13,334	Flood Frequency Analysis	Design Option Comparison and Basic Design Report
Weir	Probable Maximum Flood	22,191	Probable Maximum Precipitation converted to Probable Maximum Flow using HEC-HMS and relevant parameters (see Table 2)	Design Option Comparison and Basic Design Report

Table 3-4: Previous Estimates of Peak Flow

Parameter	Value	Source
Probable Maximum Precipitation	459.23 mm	Basic Design Report
Catchment Area	3,625 km^2	Basic Design Report
Lag	372.6 min	Basic Design Report
Rainfall Temporal Pattern	Pattern associated with 1992 flood (see Table 3)	Basic Design Report
Unit Hydrograph	SCS Standard Unit Hydrograph	Basic Design Report; used as part of HEC-HMS model
Loss Model and Parameters	SCS Method with Curve Number 83 and 0% impervious	Basic Design Report; used as part of HEC-HMS model

Table 3-5: Parameters for Estimation of Probable Maximum Flow (PMF)

The temporal pattern of the PMP was based on the 1992 floods in Pakistan and is reproduced in Table 3-6.

Hour	1	3	6	12	24	36	42
Cumulative Percent Rainfall (%)	3.91	13.69	48.88	66.47	87.00	97.23	100.0

Table 3-6: 1992 Storm Temporal Distribution (Source: Basic Design Report)

The hydrograph for the PMF generated using a HEC-HMS model is reproduced in Figure 3-5 . The associated peak flow is 22,191.2 m^3/s and an infiltration loss of approximately 10 percent is estimated by the model. The loss parameter ("curve number" or CN = 83) is considered conservative in relation to flood modelling for the current catchment.

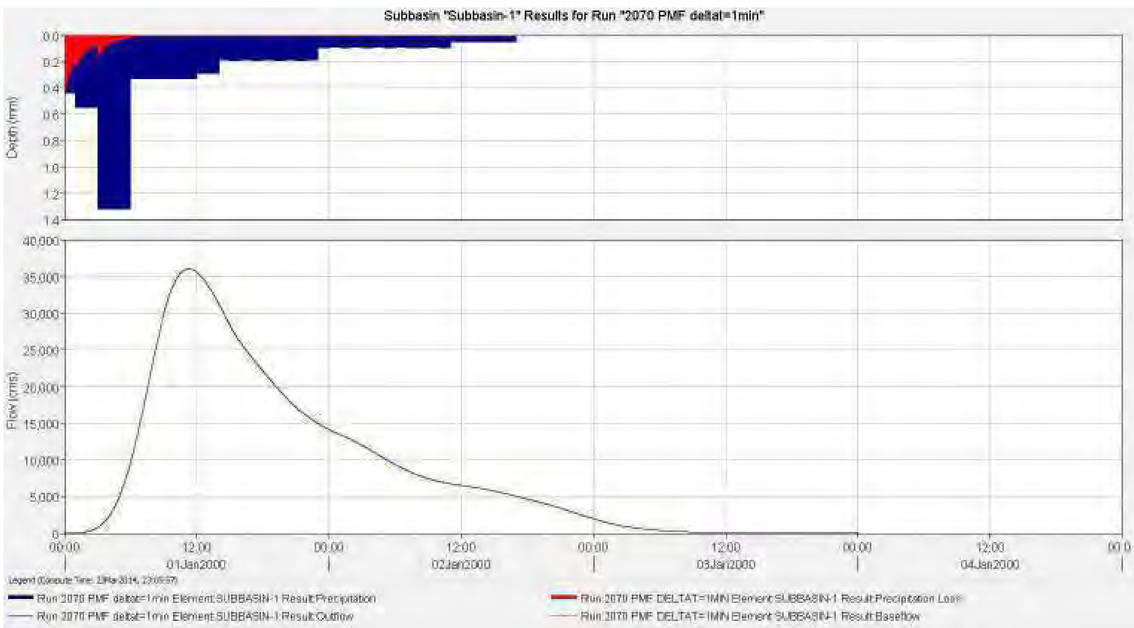

Figure 3-5: Probable Maximum Flood Hydrograph (Source: Basic Design Report)

3.6 Calculation of PMF Using a Modeling Approach

This section provides the PMF hydrograph and 100-yr average recurrence interval (ARI) peak flows under future climatology. The 10,000-yr peak flow is also calculated for an independent comparison to the peak PMF. Time horizons of 30 and 60 years were used as described above. The 30 year and 60 year time horizons correspond to years 2040 and 2070.

Note that the PMP, associated PMF and the 100-yr ARI peak flow, used to design the weir and spillway, are critical parameters for design.

The diversion tunnel for the Gulpur HPP is designed for a 1-yr ARI peak flow. It is understood that this is a temporary tunnel, utilized only during construction. Therefore future climate projections have not been carried out for the 1-yr ARI peak flow.

The observed 100-yr peak flow values used for design were estimated using a Flood Frequency Analysis (FFA) (see Basic Design Report). A summary of the key values for this analysis (using values from preceding sections) is shown in Table 3-7.

Parameter	Value	Source
Observed GEV 100-yr peak Flow (m^3/s)	13,334	Basic Design Report
Percent Change from historical GEV, 2040 climatology (%)	38.2%	This Study
Percent change from historical GEV, 2070 climatology (%)	37.0%	This Study
2040 100-yr GEV Peak flow (m^3/s)	18,427	Calculated
2070 100-yr GEV Peak flow (m^3/s)	18,273	Calculated
Observed Gumbel 100-yr peak Flow (m^3/s)	12,887	Basic Design Report
Percent Change from historical Gumbel, 2040 climatology (%)	10.1%	This Study
Percent change from historical Gumbel, 2070 climatology (%)	36.6%	This Study
2040 100-yr Gumbel Peak flow (m^3/s)	14,188	Calculated
2070 100-yr Gumbel Peak flow (m^3/s)	17,607	Calculated

Table 3-7: Updated 100-yr Peak Flows for GEV and Gumbel Distributions

An important disadvantage of the FFA approach is that any subsequent analysis cannot be adjusted for changing catchment parameters; e.g., unit hydrograph and losses cannot be adjusted. Therefore, it is important to note that reported peak flows for 2040 and 2070 are not adjusted for changes in catchment characteristics. Catchment specific sub-daily data is not available for the alternate intensity-frequency-duration (IFD) analysis which allows adjustment of catchment parameters.

The 10,000-yr peak flows for 2040 and 2070 are provided in Table 3-8. These are compared to independent estimates of the peak PMF in the preceding section.

Parameter	Value	Source
Observed Gumbel 10,000-yr Peak Flow (m^3/s)	22,302	Basic Design Report
Percent change from historical Gumbel, 2040 climatology (%)	12.0%	This Study
Percent change from historical Gumbel, 2070 climatology (%)	45.0%	This Study
2040 10,000-yr Gumbel Peak flow (m^3/s)	24,979	Calculated
2070 10,000-yr Gumbel Peak flow (m^3/s)	32,338	Calculated

Table 3-8: Updated 10,000-yr Peak Flows for Gumbel Distribution

Updated peak flows used in the design are provided in Table 3-9. The PMP is adjusted using multipliers based on the 100,000-yr ARI precipitation for 2040 and 2070 climatology using the Koutsoyiannis (1999) approach.

Parameter	Value	Source
Design PMP (mm)	459.23	Basic Design Report
Percent change from 100,000-yr historical rainfall, 2040 climatology (mm)	30%	This Study
Percent change from historical rainfall, 2070 climatology (mm)	47%	This Study
2040 PMP (mm)	597.0	Calculated
2070 PMP (mm)	675.1	Calculated

Table 3-9: Probable Maximum Precipitation

The PMF hydrograph is estimated by routing the PMP through the catchment using relevant parameters in Table 3-9. A HEC-HMS model is used for this calculation. The loss parameters, unit-hydrograph and storm-temporal pattern are the same as analysis carried out for the design (see Gulpur HPP Basic Design Report). A note on uncertainty of the PMF, as related to the parameters used, is provided in the next section.

The estimated peak flow associated with the PMF for 2040 and 2070 are 31,449.8 m^3/s and 36,041.6 m^3/s respectively.

While the estimation methods are independent, note that the estimated 2040 and 2070 peak PMF corresponds reasonably well to the 10,000-yr peak flows (see Figure 3-7). For 2040 and 2070, the result is similar to that used for validation of the PMF in the Basic Design Report. The modelled hydrographs for these periods are shown in Figure 3-6 and Figure 3-7.

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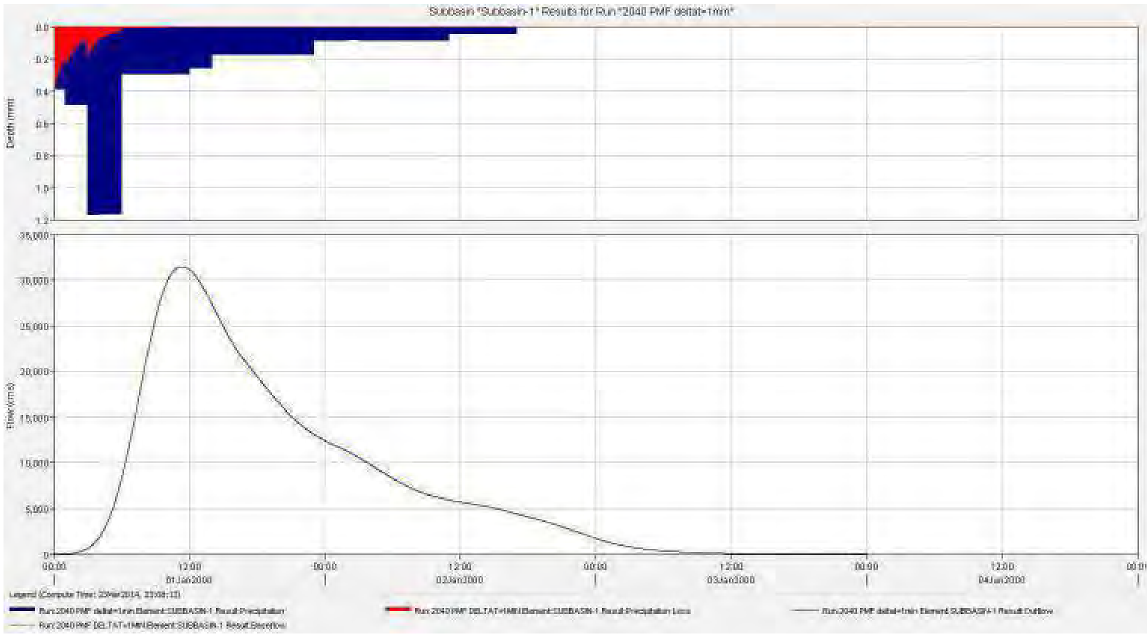

Figure 3-6: 2040 PMF Hydrograph

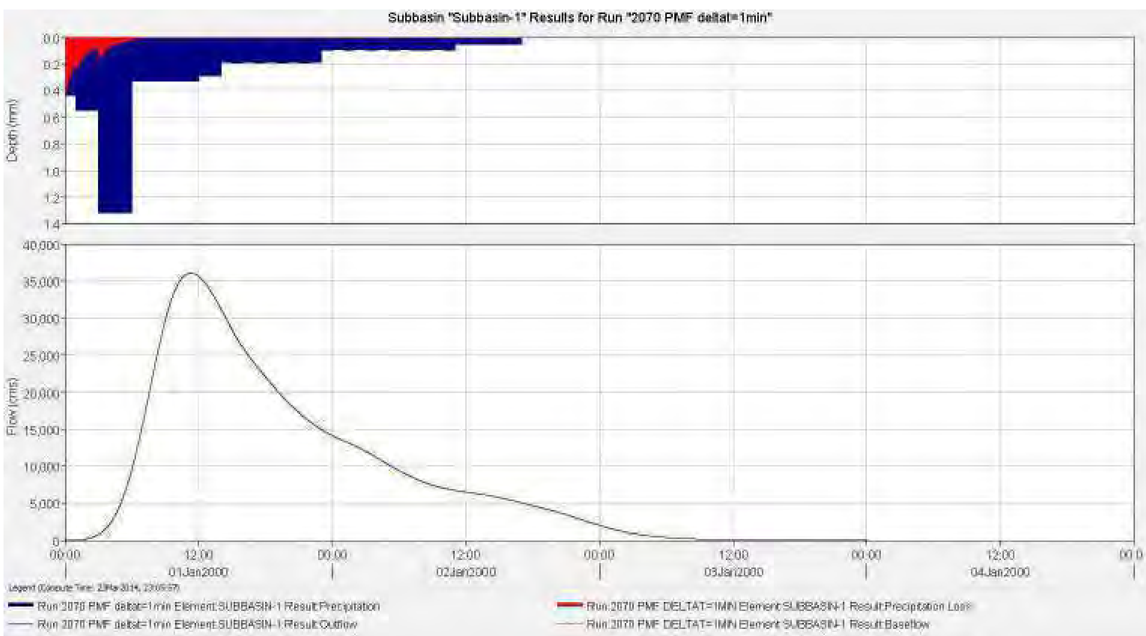

Figure 3-7: 2070 PMF Hydrograph

3.7 PMF Uncertainty

Besides the PMP, the parameters used to estimate the PMF include:

- Unit hydrograph
- Loss Model
- PMP temporal pattern

Uncertainty in these parameters is discussed below.

The unit hydrograph utilised for design and the current projected PMF is a U.S. Soil Conservation Service (SCS) standard unit hydrograph. The unit-hydrograph is not catchment specific and, for lack of historical sub-daily precipitation and flow data, estimation of catchment-specific unit-hydrographs is not possible. It is also expected that the unit hydrograph will change over time.

It is worth noting that the 1992 storm occurred in September and WMO (2009) states that mid-August to September is the most likely period for PMP in the Indus in Pakistan (WMO, 2009). Additionally, global climate change models cannot predict changes sub-daily patterns with reasonable accuracy and historical sub-daily precipitation data is not available to extract additional temporal patterns. Recommendations on addressing these data gaps to reduce uncertainty as part of the detailed design are provided in the Summary section.

The SCS loss model used (curve number (CN) = 83) for previous PMF estimates (see Basic Design Report and Table 6) is considered extremely conservative given current catchment conditions. These have been utilised for 2040 and 2070 PMFs. However, a sensitivity analysis is carried out to determine percent change in peak flow with increasing CN (i.e. degrading catchment). Results of the sensitivity analysis show that the maximum increase in 2040 peak PMF is 11 percent where no losses are considered (Table 3-10).

CN	% Change in Peak PMF in 2040 with CN 83	% Change in Peak PMF in 2070 with CN 83
83	0	0
90	4%	9%
95	8%	13%
99	11%	15%

Table 3-10: Sensitivity of PMF Peak Flow to CN

Similarly, the maximum increase in 2070 peak PMF is 15 percent. Updating loss parameters should be considered if additional data are available for calibration during detailed design. In the case additional data are not available, it is recommended to use the peak flows associated with CN of 99, as this is most conservative in terms of peak flow estimation for dam design.

3.8 Global and Regional Analyses of Flood Risk

Besides the watershed-level analysis performed with values from a small number of grid cells, larger regional-scale estimates can also be considered because of the spatially broad nature of climate change and associated modeling. For the two variables of interest - discharge and PMP – this analysis refers to recent analysis of CMIP5 data for flood frequencies (Dankers et al., 2013, Davie et al., 2013) and for PMP estimation (Kunkel et al., 2013). Relevant data from these analyses are reproduced in Figure 3-8 through Figure 3-10. The Dankers et al. work supports an increase of the 30-year flood frequency over the area of the project computed by a majority of 45 models evaluated (albeit not all) (Figure 3-10). For the HadGEM2-ES model as the GCM driver, the Dankers et al., 2013 and Davie et al. work shows an increase in runoff in the South Asian region across all hydrologic models considered. Independent of these efforts, the Kunkel et al. analysis suggests a 30 percent to 40 percent increase over the project region in a quantity they term maximum precipitable water, which is the primary driver for PMP.

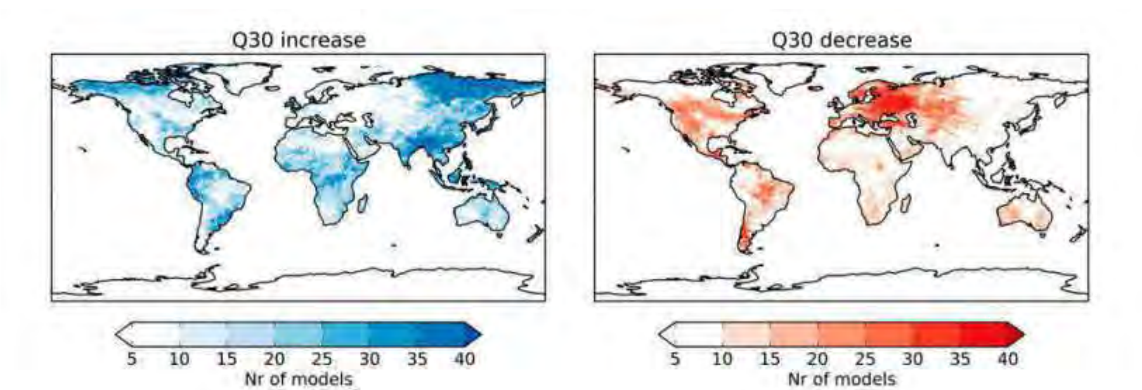

Figure 3-8: Change in 30-year Flood: 45 Models

Note: these represent changes (increase or decrease) in a suite of 45 models (combinations of 5 GCMs and 9 impact models). Reproduced with permission from Dankers, R., Arnell, N. W., Clark, D. B., Falloon, P. D., Fekete, B. M., Gosling, S. N et al. (2013). First look at changes in flood hazard in the Inter-Sectoral Impact Model Intercomparison Project ensemble. Proceedings of the National Academy of Sciences, 201302078.

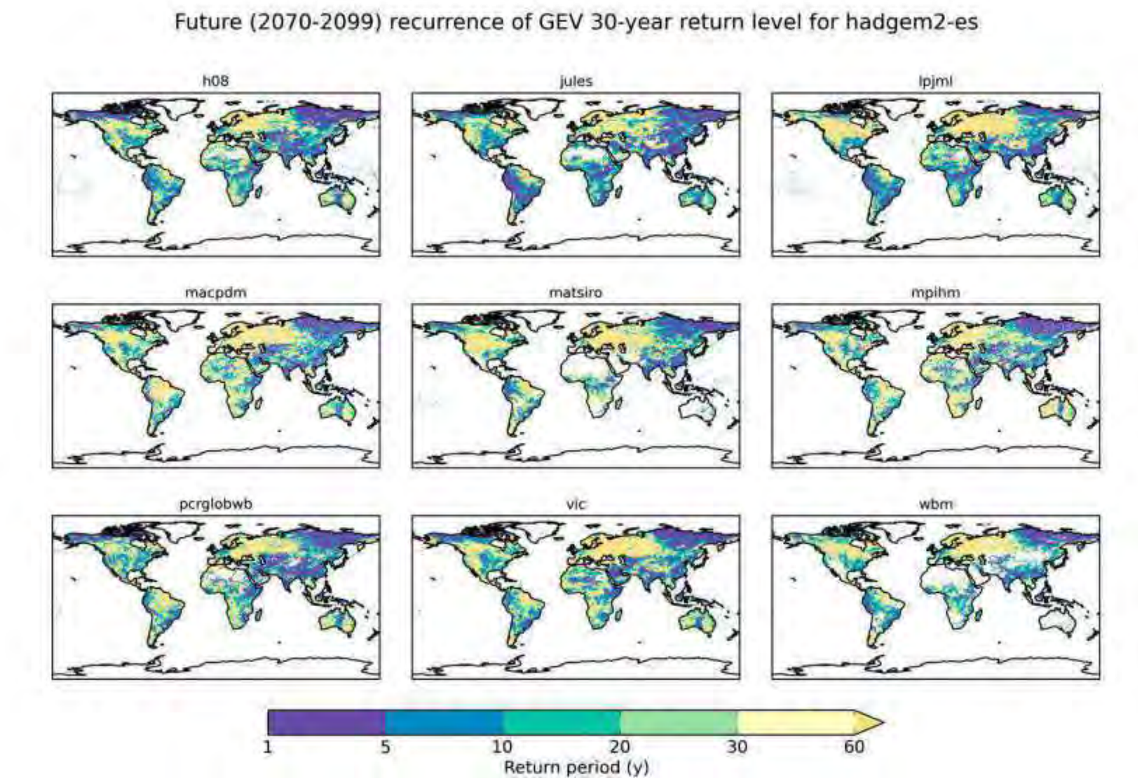

Figure 3-9: Change in 30-year Flood: 9 Impact Models

Note that these show changes (increase or decrease) in a suite of 9 impact models (using the HadGEM2-ES model). Reproduced with permission from Dankers, R., Arnell, N. W., Clark, D. B., Falloon, P. D., Fekete, B. M., Gosling, S. N et al. (2013). First look at changes in flood hazard in the Inter-Sectoral Impact Model Intercomparison Project ensemble. Proceedings of the National Academy of Sciences, 201302078.

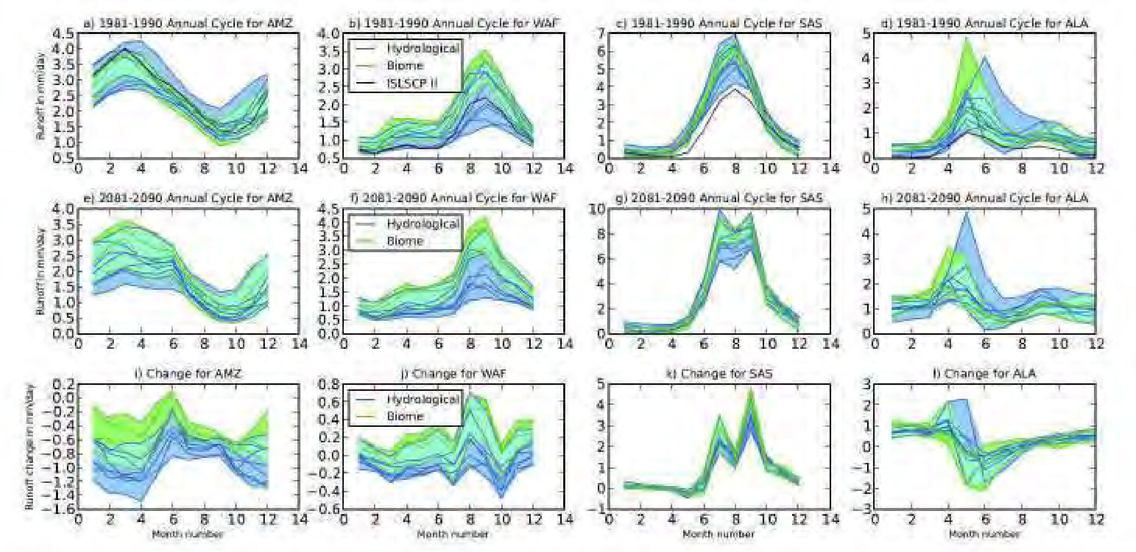

Figure 3-10: Annual Cycles of Runoff for Different Regions

Note: these are computed using different hydrologic or biome models, driven by output from the HadGEM2-ES model. SAS corresponds to the South Asian Region. Reproduced under a Creative Commons 3.0 license from Davie, J. C. S., Falloon, P. D., Kahana, R., Dankers, R., Betts, R., Portmann, F. T et al. (2013). Comparing projections of future changes in runoff from hydrological and biome models in ISI-MIP. Earth System Dynamics,4(2).

3.9 Effect of Climate Change on Sediment Transport

Daily discharge data from the VIC model, coupled with the HADGEM2-ES GCM, were used to estimate changes in suspended sediment load entering the Gulpur HPP reservoir. These are the same discharge data as shown in Figure 3-2. The changes in discharge data and in the sediment load estimates (between historical and future periods) are considered to be relative, in that we are comparing a historical period *modeled* value to a future period *modeled* value. The appropriate expression of future sediment loads is not as absolute values, but as changes from the historical. This is the same approach as used for evaluating the projected discharge data in Section 3.6.

As in Section 2.3 of the Sedimentation Studies report from Mira Power, daily suspended sediment load is computed from the discharge quantity using the following rating curve:

$$Q_s = 5.913 \times 10^{-3} Q_w^{2.6261}, \quad \text{for } Q_w < 92;$$
$$Q_s = 5.252 \times 10^{-6} Q_w^{4.1788}, \quad \text{for } 92 < Q_w < 275;$$
$$Q_s = 2.749 \times Q_w^{1.8342}, \quad \text{for } Q_w > 275,$$

where Q_s is the suspended sediment load in tons per day and Q_w is the discharge quantity in cubic meters per second. The above set of equations, along with the discharge data, were used to estimate the sediment loading for each day for the period of interest (not just the loads associated with peak flows).

The aggregated the daily suspended sediment loads were applied to the monthly and annual levels and summarized the data across three climatologies: baseline, as defined by the historical run from 1971 to 2004; 2040, using years 2025-2055 from the RCP6P0 run; and 2070, using years 2055-2085 of the RCP6P0 run. Monthly and annual values represented as boxplots for each climatology are shown in Figure 3-11 and Figure 3-12 below.

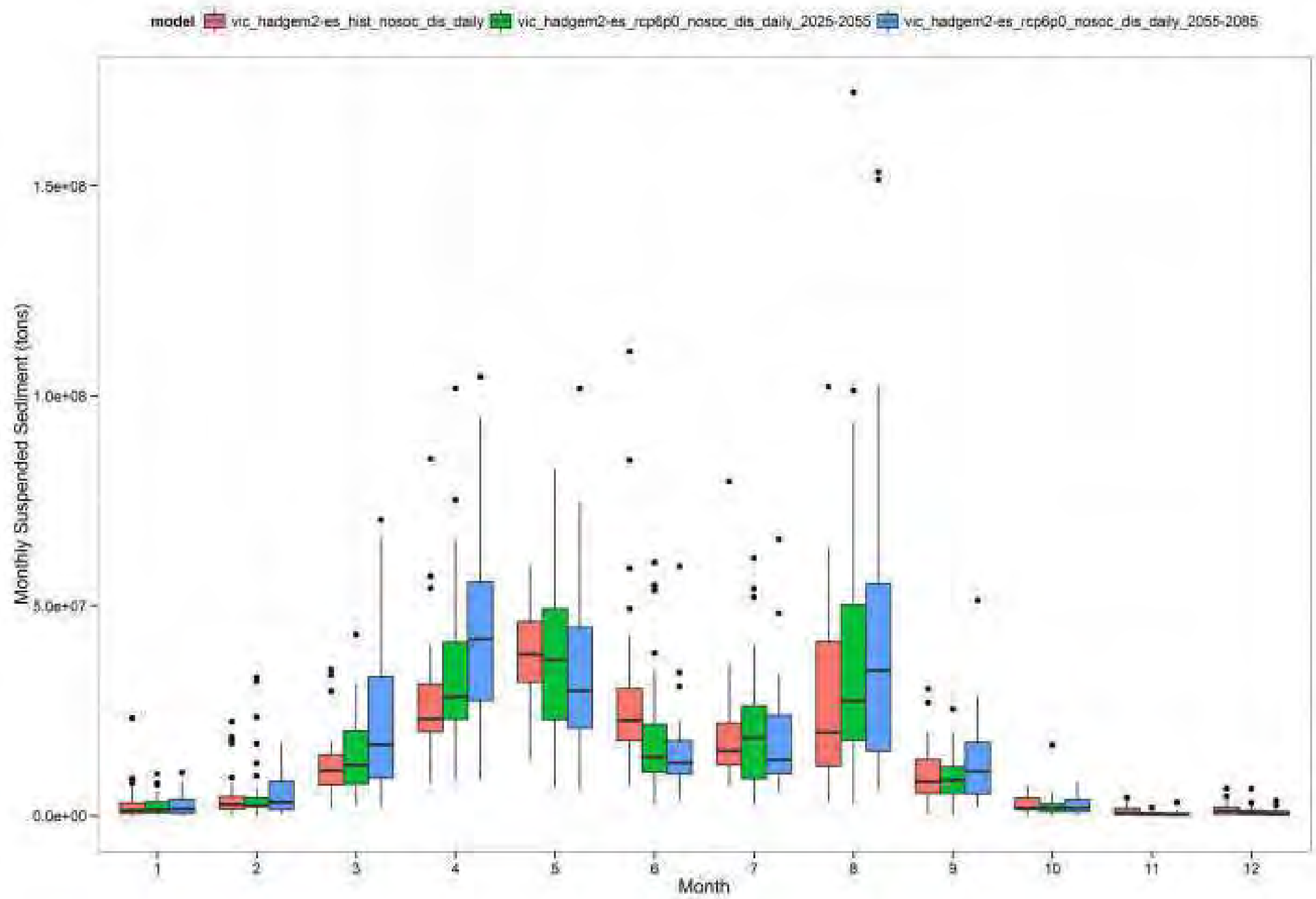

Figure 3-11: Monthly Suspended Sediment Loads

Note that these are summarized across the baseline, 2040 and 2070 climatologies. All values are based on modeled discharge for historical and future periods. These are best applied for evaluating relative change over different periods.

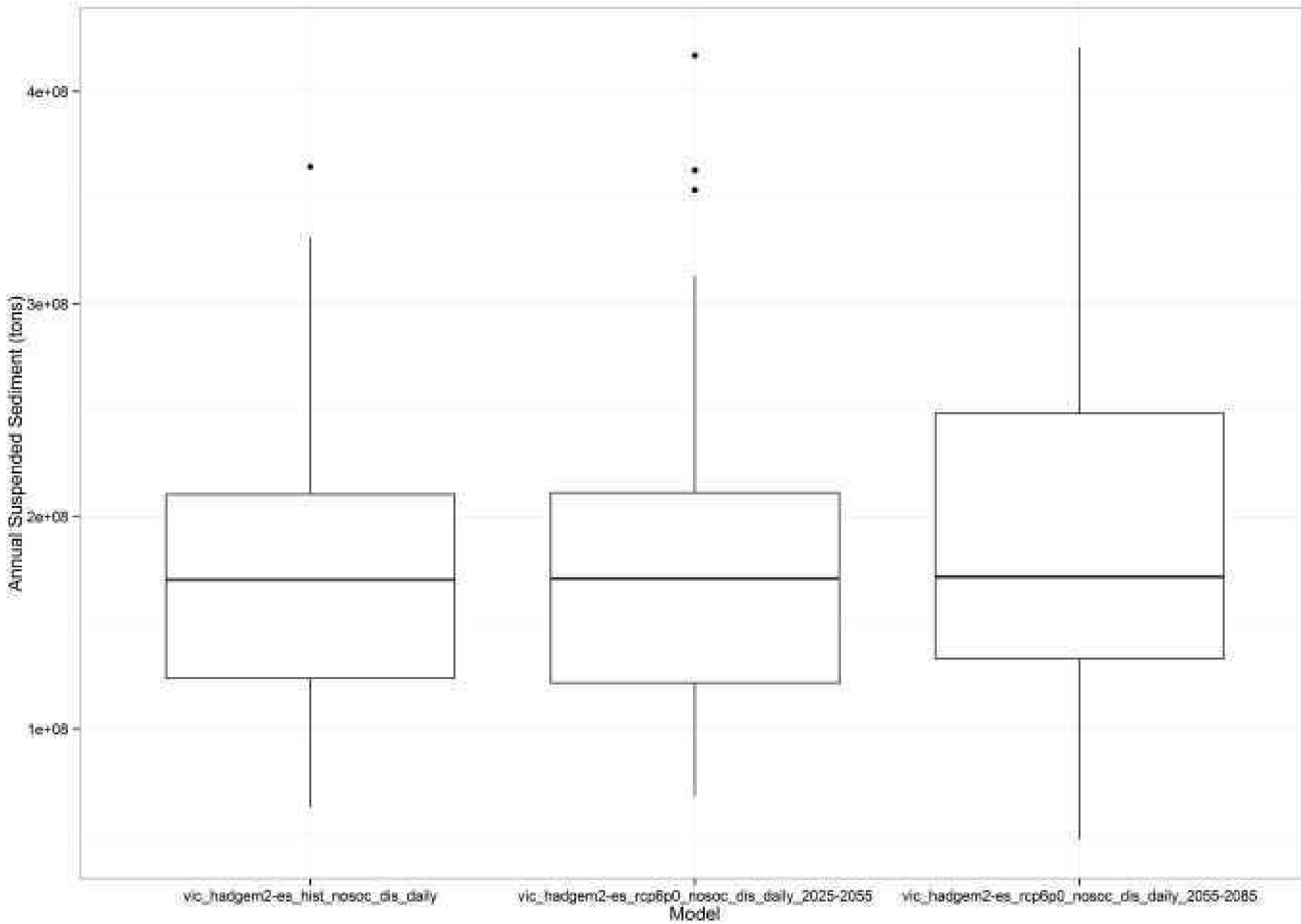

Figure 3-12: Annual Suspended Sediment Loads

Note that the data are summarized across historical, 2040, and 2070 climatologies, in each case based on modeled discharge data. These are best applied for evaluating relative change over different periods.

The changes in monthly suspended sediment loads display a non-uniform seasonal pattern. Future projections are larger than baseline values in March, April, and August but generally smaller in May and June. The 2040 and 2070 climatologies generally display increased variability relative to the baseline period as well.

At the yearly level of aggregation, the baseline and 2040 climatologies display a very similar distribution. The suspended sediment load data for the 2070 climatology have a median value comparable to the other two periods, but the variability of the data is increased with more instances of large annual loads relative to the baseline and 2040 periods. Mean values are slightly higher in the 2040 and 2070 periods (Table 3-11). In addition, changes in single-day sediment loading for peak flow events defined earlier are presented in Table 3-12 and Table 3-13. Because the peak event flows are higher, and the exponential nature of the flow and sediment load relationship, the single-day events generally result in larger loads compared to historical values. Based on these analyses, , both annual and single-day peak values, it appears that the risks of substantial increases in reservoir sedimentation rate due to climate change over the course of long-term operations are small, especially given the design feature of regular sediment flushing. However, single day extreme events can result in larger changes from historical values. From the perspective of long-term sediment accumulation in the dam, the single day event are less consequential (unlike for flooding risk discussed above, where the single day values are of great consequence).

Period	Annual Mean Sediment Load (tons/year)	Change from Historical (%)
Historical, modeled	177,575,398	
HadGEM2-ES, 2040	186,122,561	4.8
HadGEM2-ES, 2070	204,249,394	15.0

Table 3-11: Change in Mean Sediment Loads.

Note: All values are based on modeled discharge for historical and future periods. These are best applied for evaluating relative change over different periods.

Data Source and Probability Distribution	Calculated 100 year return period event (m^3/s)	Change in sediment loading from historical (%)
GEV, observed	13,456	
Gumbel, observed	12,399	
GEV, Historical, HadGEM	4,079	
Gumbel, Historical, HadGEM	3,634	
GEV, 2040 climatology	5,637	81
GEV, 2070 climatology	5,590	78
Gumbel, 2040 climatology	4,001	19
Gumbel, 2070 climatology	4,965	77

Table 3-12: Summary of 100-Year Events from Different Models

Note: These reflect discharge (m^3/s) and sediment loading.

Data Source and Probability Distribution	Calculated 10,000 Year Return Period Event (m^3/s)	Change From Historical (%)
GEV, observed	26,724	
Gumbel, observed	21,294	
GEV, Historical, HadGEM	7,993	
Gumbel, Historical, HadGEM	5,526	
GEV, 2040 climatology	20,601	468
GEV, 2070 climatology	11,350	90
Gumbel, 2040 climatology	6,166	22
Gumbel, 2070 climatology	8,040	99

Table 3-13: Summary of 10,000-Year Events from Different Models

Note: This reflect discharge (m^3/s) and sediment loading.

3.10 Future Precipitation and Landslide Risk

There are various reasons to expect increases in extreme precipitation, if and when, significant warming occurs. There will be more moisture in the atmosphere and probably greater thermodynamic instability (Kunkel, 2003). There is also evidence that rainfall events have become more intense during recent warm decades in some locations in the United States, Canada, Australia, Japan, South Africa, and Europe (Goudie, 2006). Since the 1990s, a number of studies have been implemented around the world to assess and quantify the impacts of climate change on water resources (Leavesley, 1994; Arnell, 1998). The focus of these studies generally projects the change in climate primarily for rainfall and temperature parameters.

Under projected climate conditions with higher temperatures, it may be expected that convective, high intensity precipitation may occur more frequently (Middelkoop, et al., 2001). In addition to the impact of temperature changes and annual average precipitation changes, climate change will also cause changes in the amount, intensity, duration, type, and timing of precipitation, which will affect river flows (http://www.libraryindex.com/pages/3394/Rivers-Impacts-Climate-Change.html).

As discussed, some climate models show increases in precipitation and some show decreases. However, local data can also serve as a useful complement to climate models. The PMD has collected data for several decades from 43 weather stations throughout Pakistan. Their locations are shown in Figure 3-13 below.

Figure 3-13: PMD Weather Stations in Pakistan

Of the 43 stations, 19 stations were modeled due to their data completeness from 1960 to 2007. Their data were used for several analyses in this study, one of which involves calculating the consecutive wet days (CWD).

A study was conducted in 2009 by the PMD and Climate Research Unit to analyze regional changes to precipitation and temperature including frequency of CWD. The number of CWDs was calculated using daily data for 19 meteorological stations from 1960 to 2007. A wet day is considered any day when precipitation is greater than or equal to 1 mm. Significant increases can be seen in Quetta and Peshawar (west of the site). The change in the number of CWDs is shown in Table 3-14 below.

Station	CWD	Station	CWD	Station	CWD	Station	CWD
Chitral	0.47	**Hyderabad**	-0.19	**Karachi**	0.56	**Quetta**	1.79
D.I. Khan	-0.24	**Islamabad**	0.00	**Lahore**	0.00	**Saidu Sharif**	0.42
Dalbandin	0.05	**Jacobabad**	-0.09	**Multan**	0.14	**Zhob**	-0.24
Faisalabad	0.05	**Jhelum**	0.71	**Parachinar**	-1.13		
Gilgit	0.38	**Jiwani**	-0.66	**Peshawar**	2.16		

Table 3-14: Changes in Consecutive Wet Days

The frequency of very heavy precipitation days (HPD) was also analyzed in the study where a day with 20 mm or greater of rain was considered heavy. Islamabad, west of the hydropower site, has a very significant rise in HPDs of the 19 areas with data. The results of the change in HPDs are shown in Table 3-15 below.

Station	HPD	Station	HPD
Chitral	-0.66	**Karachi**	-2.12
D.I. Khan	1.32	**Lahore**	3.43
Dalbandin	0.05	**Multan**	0.19
Faisalabad	0.28	**Murree**	4.14
Gilgit	0.28	**Parachinar**	-1.36
Hyderabad	-1.03	**Peshawar**	4.65
Islamabad	5.41	**Quetta**	0.66
Jacobabad	0.61	**Saidu Sharif**	1.65
Jhelum	2.44	**Zhob**	1.08
Jiwani	-0.61		

Table 3-15: Changes in Number of Heavy Precipitation Days

For the project site, the PMF was calculated in the Gulpur HPP Basic Design Report for the GEV and the Gumbel value as 13,334 m^3/s and 12,887 m^3/s respectively. This chapter describes the process for assessing the PMF for two time horizons of 2040 and 2070. The PMF increases 38.2 percent and 37.0 percent for the GEV and increases 10.1 percent and 36.6 percent for the Gumbel value. In this case, climate change model results show the conditions exist for more frequent or larger floods resulting in direct economic losses to the hydropower facilities and utility lines, and the suspension of hydropower operations. The flood events also may cause substantial impacts to customers which could indirectly affect Mira Power.

For the risk screening, the results support a flood frequency ranking of "high" both for the country as a whole and locally. Based on hydraulic modeling results for the location, future flood magnitudes should also be rated as high.

Flood-induced landslide events are tied to the flood analysis above. Reviewing the future hazard screening, the conditions exist for a rise in frequency and magnitude of landslide events, as shown in Table 3-16. The future vulnerability conditions, shown in Table 3-17 look similar since development will probably occur as it has in the past. The landslide could directly impact Mira Power facilities or the sediment produced by the landslide could be transported into the reservoir, also impacting Mira Power, as shown in Table 3-18. With wetter conditions and the potential for more extreme events, there is a greater risk of landslides.

Hazard	*Current* Frequency	*Future* Frequency	*Current* Magnitude Range	*Future* Magnitude Range
Flood	H	H	M	H
Landslides	M	H	M	M

Table 3-16: Hazard Screening Table

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Exposure	*Future* Exposure	*Current* Sensitivity	*Future* Sensitivity	Adaptive Capacity
Flood	M (L*)	M (L*)	H (L*)	H (L*)	L (M)
Landslides	L (M*)	L (M*)	H (M)	H (M)	L (M)

Table 3-17: Vulnerability Screening Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Potential Loss			*Future* Potential Loss		
	Social	Economic	Environ-mental	Social	Economic	Environ-mental
Flood	M (L)	H (M*)	M (L)	H (M)	H (M*)	H (M)
Landslides	L (L)	L (M*)	L (L)	L (L)	L (M*)	L (L)

Table 3-18: Risk Findings Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low.

3.11 Summary

Use of the HadGEM2-ES model is considered to be conservative from the perspective of calculations relating to flooding, because it generally predicts wet conditions for Pakistan compared to historical values. When a multi-model analysis for flood return events is also considered, there is a reasonable basis to propose that extreme flood volumes in the basin may be higher than historical.

As the Gulpur HPP is currently designed there is no provision for adding spillway capacity in the future. If the design flood were to be larger in the future we would expect some small overtopping. The project engineers do not expect significant damage from a small amount of overtopping.

Sediment loading may be expected to increase for the discharge scenario considered here, and may also involve a change in the timing of delivery. Given that the dam operation is proposed to include periodic flushing to reduce sediment buildup, this change is expected to through operational changes in the future.

To address uncertainty in flood risk estimates and improve calibration of models it is recommended that the following monitoring be carried out:

- continuous flow measurements at selected dam site
- sub-daily precipitation in upstream locations within the catchment

Data from monitoring will allow more accurate estimates of PMF using catchment-specific unit hydrographs and storm temporal patterns, particularly if a flood event is observed. Additionally, sub-daily storm temporal patterns associated with the 2010 floods could be utilised and combined with storm temporal patterns associated with the 1992 floods.

3.12 References

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4. Evaluation of Potential Climate Change Impacts on Water Demand

4.1 Introduction

As part of the climate change evaluation of the Gulpur HPP, it is important to evaluate the water demands in the project region, both in the watershed upstream of the dam and in the region downstream. Downstream of the project site is the irrigation system of the Indus River Basin, which supports one of the largest and most intensively irrigated areas in the world, and one of the most important sectors in Pakistan's economy (Archer et al., 2010). Thus, changes in the water demands and water supply of the Indus River system, of which the Gulpur HPP will be a part, are of interest downstream. The analysis presented here is framed on the following two key points: (1) Irrigation water use, which constitutes the major water withdrawal in Pakistan, is the primary demand sector of interest. (2) The Gulpur HPP is focused solely on hydropower generation and is not intended for any water supply function for irrigation. Any impacts of climate change on water demands may potentially affect inflows *into* the dam, but other large-scale demand changes *downstream* of the Gulpur HPP are likely to be addressed through the major multipurpose dams in the system that are downstream (such as the Mangla Dam on the Jhelum River, with a reservoir capacity of 7.4 million acre-feet or 9.1 km^3).

Limited local-scale water demand data were available; therefore, this analysis is based on larger, national scale or global scale data that were available. The global scale data that are used below are from a 0.5° by o.5° (latitude by longitude) grid-based dataset, similar to what was employed in the flood calculations in Chapter 3. Although local data would be preferred for such as analysis, the grid based data for the region provide a reasonable basis for estimating relative change.

Based on data presented by the United Nations Food and Agriculture Organization (FAO, 1997), total water withdrawal in Pakistan is 155,600 million m^3/year, of which agricultural withdrawals are 150,600 million m^3/yr, and domestic and industrial withdrawals are both 2,500 million m^3/year each. In the larger area of the Gulpur HPP and downstream, and in the absence of local data on water demands, the assumption of irrigation constituting more than 95 percent of the withdrawal is consistent with the national pattern. An approximate estimate of non-irrigation demands in the region is also presented below for confirmation.

Irrigation demand is assumed to be driven by changes in temperature and precipitation, with other factors such as the irrigation efficiency, the area irrigated and the crop mix assumed to remain constant. In reality, these other factors will continue to evolve in response to changes in climate, but these should be considered to be an adaptation factor rather than a direct impact of climate change. The focus of this section is to assess the direct impacts of climate change on demand: warmer temperatures increase evapotranspiration, and thus more water is needed for crop growth. Similarly, lower precipitation means a larger portion of plant growth must be aided by irrigation. Population growth is an additional driver, directly through the need for water for human use, plus the additional need for food. However, the interaction between population and water demand is more complex, and there is not a one-to-one relationship between a region's aggregate water demand over multiple sectors and its population. This section focuses on the increase in water demand for irrigation as a function of climate change, while also acknowledging that population growth clearly has the potential to further exacerbate the problem. Given Pakistan's unique situation as a country with low rainfall in the lower elevations and with intensive irrigation, the focus on changes in irrigation demand is appropriate.

In addition to the water demand changes across the larger region, changes in irrigation in the Gulpur HPP watershed and evaporation from the watershed are also considered for their significance compared to the river flows and reservoir volumes.

The analysis approach used here includes evaluation of climate change model results for evapotranspiration at different points in time, for periods two to six decades into the future. Large-scale analyses of changes been reported in the literature provide a strong basis for this assessment. The climate change analysis presented in Chapter 2 supports this evaluation and is complemented by local scale GCM output where available. The data sources for these climate models include the CMIP, which have been reported in two phases, CMIP3 in 2007 and CMIP5 in 2012/2013. The CMIP5 effort is the basis of the soon-to-be-published IPCC AR5 (regional assessments expected in 2014). Specifically, the model output assembled and archived as part of the ISI–MIP (Warszawski et al., 2014) was a source of data and analysis for this chapter. The CMIP5 model runs are driven by RCP emission scenarios, ranging from RCP2.6 to RCP8.5 corresponding to different levels of GHGs in the atmosphere and associated radiative forcing due to the presence of these gases. RCP6 constitutes a mid-range emission scenario, excluding the upper and lower emission extremes. Where multiple climate scenarios were available, similar to the analysis in Chapter 3, this evaluation focuses on the RCP6 calculated values in this analysis, and did not focus on the high or low extreme emissions. For periods spanning the current period to a little past the mid-century point, RCP6 emissions roughly correspond to the midrange scenario labeled A1B in the previous iteration of the CMIP3. Sources of uncertainty in any future projection include the GCM used, the hydrologic model used, and the emission scenario used.

4.2 Assessment of Water Demand Changes at the Global Scale

Analyses focusing on water demand and supply have been performed for a wide variety of GCMs and hydrologic models and reported in the recent literature. However, not all of the raw output data from these studies are available in the public domain, and it is more straightforward to compare the global scale maps that have been published, focusing on the project area. Importantly the large differences across models require that multi-model evaluations be performed to develop robust assessments.

In an analysis highly relevant to this work, Wada et al (2013) show the impact of climate change on future IWD, using a set of seven GHMs to quantify the impact of projected global climate change. They also assessed the resulting uncertainties arising from both the GHMs and climate projections. The resulting ensemble projections generally show an increasing trend in future IWD, but the increase varies substantially depending on the degree of global warming and associated regional precipitation changes. In Pakistan, the irrigation water demand is expected to increase by more than 20 percent for warming by 2°C or more.

Uncertainties arising from GHMs and GCMs are both large, with hydrological model uncertainty dominating throughout the century and with GCM uncertainty substantially increasing from the mid-century, indicating the choice of hydrological model outweighs the uncertainty arising from the choice of GCM and associated emission scenario.

Using an ensemble of 14 GCMs, Dai (2013) report a change in the global drought severity computed using the Palmer drought severity index (PDSI) with potential evapotranspiration estimated using the Penman-Monteith equation. The PDSI is calculated from a water-balance model forced with observed precipitation and temperature and has been widely used in monitoring drought development in many regions of the world. The global results from multiple models show a decrease in the drought index, indicative of more aridity in Pakistan, with most models agreeing that an increase in drought is expected in Northern Pakistan.

Globally, the percentage changes from 1980–1999 to 2080–2099 in the multi-model ensemble mean soil-moisture content in the top 10 cm layer (broadly similar for the whole soil layer) simulated by 11 CMIP5 models under the RCP4.5 emissions scenario. Stippling indicates at least 82 percent (9 out of 11) of the models agree on the sign of change. (Source: Dai, 2012.)

Using a suite of seven global hydrological models, forced with multiple climate projections, Haddeland et al. 2013 estimated irrigation water consumption with and without taking into account impacts of human interventions such as dams and water withdrawals on the hydrological cycle. Model results were analyzed for different levels of global warming. It was shown that irrigation water consumption is generally projected to increase with higher global mean temperatures. Irrigation water scarcity was found to be particularly large in parts of southern and eastern Asia, including Pakistan, and is expected to become even larger in the future. Results from this analysis in map form and box plot form showing regional summary statistics are presented in Figure 4-1 and Figure 4-2.

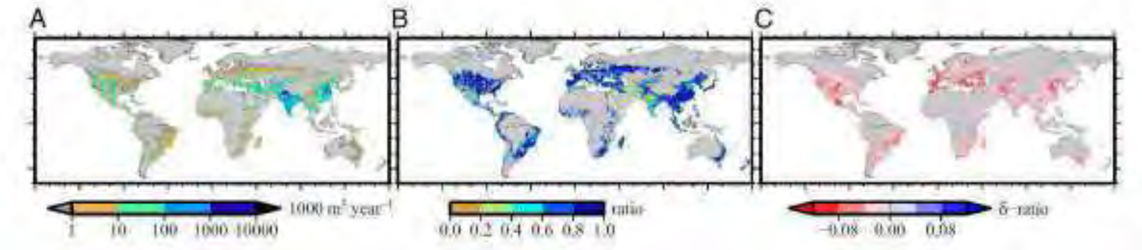

Figure 4-1: Irrigation Water Consumption and Cumulative Abstraction-to-Demand (CAD) Ratio at the Grid Cell Level.

Note: CAD = cumulative abstraction-to-demand; (A) Ensemble median potential irrigation water consumption, control period (1971–2000). Light gray color represents areas where there is no, or very little, irrigation. (B) Ensemble median CAD for the control period. (C) Differences in CAD between the control period and for an increase of 2°C. Negative numbers mean the CAD ratio decreases. Image reproduced with permission from Haddeland, I., Heinke, J., Biemans, H., Eisner, S., Flörke, M., Hanasaki, N. et al. (2013). Global water resources affected by human interventions and climate change. Proceedings of the National Academy of Sciences, 201222475.

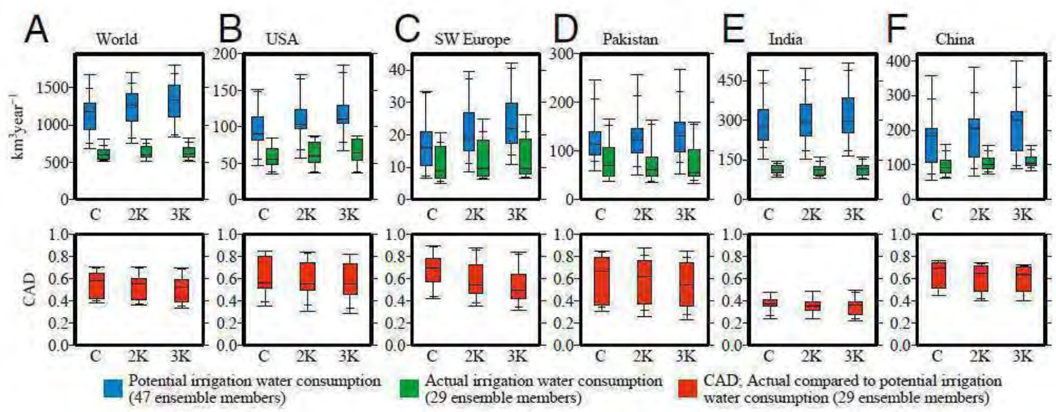

Figure 4-2: Ensemble Statistics on Irrigation Water Consumption

Note that this information is for the control period (C) (1971–2000), 2 and 3 K GMT increases for (A) the world, (B) United States, (C) southwest Europe (here comprising Portugal, Spain, and France, (D) Pakistan, (E) India, and (F) China. The upper panels show annual potential and actual irrigation water consumption. The lower panels show CAD, i.e., the relationship between the actual and potential irrigation water consumption. The boxes illustrate the 25th, 50th, and 75th percentiles of the ensemble. The whiskers represent the total sample spread, and in addition the 5th and 95th percentiles are marked. Image reproduced with permission from Haddeland, I., Heinke, J., Biemans, H., Eisner, S., Flörke, M., Hanasaki, N. et al. (2013). Global water resources affected by human interventions and climate change. Proceedings of the National Academy of Sciences, 201222475.

Prudhomme et al (2014) assessed the impact of climate change on hydrological droughts in a multimodel experiment including seven hydrologic models driven by bias corrected climate from five global climate models under four RCPs. Drought severity was defined as the fraction of land under drought conditions. Results showed a likely increase in the global severity of hydrological drought at the end of the 21st century, with systematically greater increases for RCPs describing stronger radiative forcings. A summary of the results across different global regions from this analysis is shown in Figure 4-3. (The South Asia region has the code SAs.)

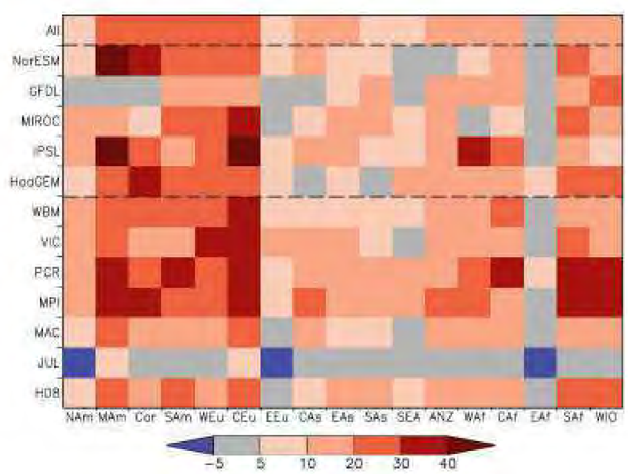

Figure 4-3: Mean Percentage Changes in Regional Deficit Index
Note that these changes are between 30-y simulations of reference (1976-2005) and future (2070-2099) under RCP8.5 for 17 world regions. The South Asia region is identified with the code SAs. Image reproduced with permission from Prudhomme, C., Giuntoli, I., Robinson, E. L., Clark, D. B., Arnell, N. W., Dankers, R. et al. (2013). Hydrological droughts in the 21st century, hotspots and uncertainties from a global multimodel ensemble experiment. *Proceedings of the National Academy of Sciences*, 201222473.

4.3 Assessment of Water Demand Changes at the Watershed Scale

As a representative example, this analysis uses water balance information at the country scale from the HadGEM2-ES model, a credible and widely used GCM developed by the United Kingdom Meteorological Office and global-scale water balance modeling using two hydrologic models: WaterGAP (Döll et al., 2003) and VIC (Van Vliet et al., 2013). Model output values at the global scale were downloaded from the ISI-MIP server at esg.pik-potsdam.de/esgf-web-fe/. Data are available at the 0.5° by 0.5° grid scale (latitude by longitude), and were extracted for cells corresponding to the project location in Gulpur, Pakistan, and corresponding to the overall Indus Basin.

The actual irrigation levels in 2005, computed using the VIC model, are shown in Figure 4-4 and illustrate that the withdrawals in the project region are low, and that the highest irrigation withdrawals occur downstream.

More specifically, these grid-based data can be used to estimate irrigation water demands across the watershed and compared against other potential demands, such as human withdrawals and evaporation losses from the reservoir water surface. The average irrigation through the VIC model, for the grid cells overlying the watershed is 50.2 mm/yr (average of 1971-2004). Note that this is a relatively low value, particularly compared to other parts of Pakistan, and related to the mountainous terrain of the project region with limited irrigation. This corresponds to a flow of 5.8 m^3/s over the watershed area. Similarly, the regional estimate of the watershed population (1.5 million) and a basic water withdrawal of 50 liters per capita per day (Gleick, 1996), corresponds to an approximate human use withdrawal of 75 million liters per day, or 0.9 m^3/s. Finally, given a reservoir area of 325.4 hectares, and an water surface evaporation of 1,427 mm/year (Hydrological Analysis, Mira Power), the evaporative loss is 0.15 m^3/s. Thus, the irrigation demand is estimated to be the dominant component of the other demands (85% of total estimated demands of 6.8 m^3/s), and all demands combined are about 5% of the average discharge of the Poonch River at Kotli of 125.4 m^3/s (Hydrological Analysis, Mira Power). These numbers allow estimates of changes in irrigation demands. It is important to highlight that the far greater change due to climate change upstream of the dam is not the human demands, but changes in evapotranspiration from natural lands and changing patterns in snowmelt. These will have a more consequential impact on the inflows to the dam and are separately below.

The VIC model produces projected changes in evaporation using the output variable "evspsbl", described in the CMIP5 standard output documentation as "evaporation at surface; flux of water into the atmosphere due to conversion of both liquid and solid phases to vapor (from underlying surface and vegetation)". VIC model output with comparable human impact boundary conditions across historical and future periods was not available at this time. Changes in evaporation from a year 2000 baseline are shown in Figure 4-5 and Figure 4-6 for 2040 and 2070 respectively, with the Gulpur HPP watershed identified on the grid-level data (HadGEM2-ES plus VIC model).

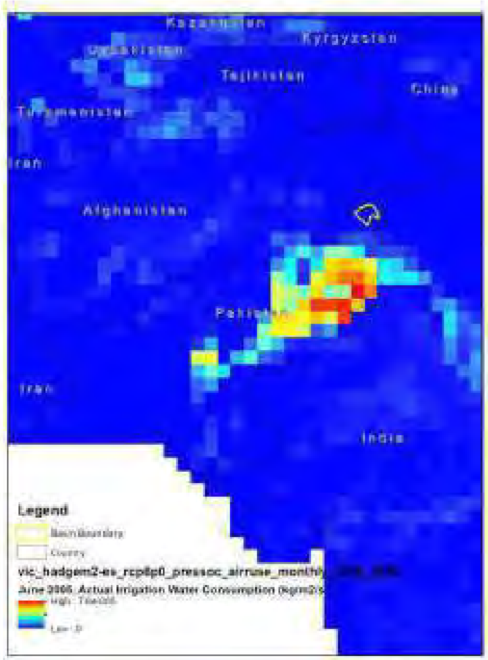

Figure 4-4: Actual Irrigation in the Project Region and Pakistan
Note that this is as calculated by the VIC model.

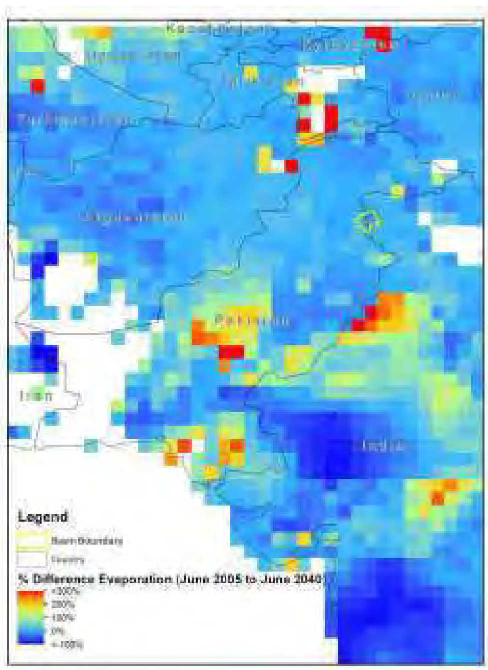

Figure 4-5: Projected Difference in Irrigation Between 2000 and 2040
Note: HadGEM2-ES model with WaterGAP for hydrological modeling. Based on data downloaded from ISI-MIP.

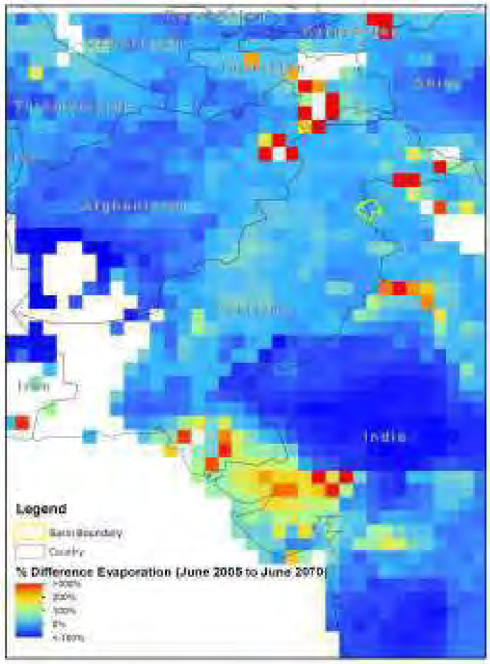

Figure 4-6: Projected Difference in Irrigation Between 2000 and 2070
Note: HadGEM2-ES model with WaterGAP for hydrological modeling. Based on data downloaded from ISI-MIP.

Two alternative baseline climatologies based on subsets of the 2005-2099 RCP6.0 (rcp6p0) climate scenario with year 2000 human impact ("pressoc" in the ISI-MIP terminology) were considered: (1) years 2005-2010, and (2) years 2005-2025. The first subset corresponds to years strictly representative of historical conditions, but the amount of data is very limited. The second subset has an improved sample size but includes projections of near-future conditions. The projected "evspsbl" data is compared from these baseline periods with data for periods 30 and 60 years into the future, represented by data from 2025-2055 and 2055-2085, respectively.

Figure 4-7 and Figure 4-8 show comparisons across the four climatologies for monthly and annual totals, respectively, for the grid cells that span the watershed upstream of the Gulpur HPP.

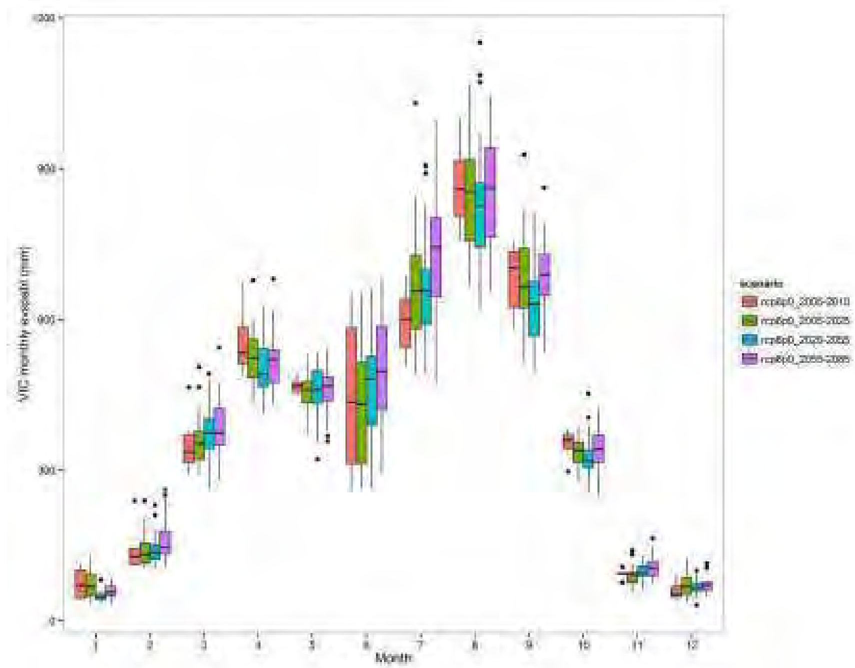

Figure 4-7: Comparison of monthly evaporation in the Gulpur HPP watershed

Note: Data is for four grid cells that span the watershed for baseline and future climatologies. Based on data downloaded from ISI-MIP.

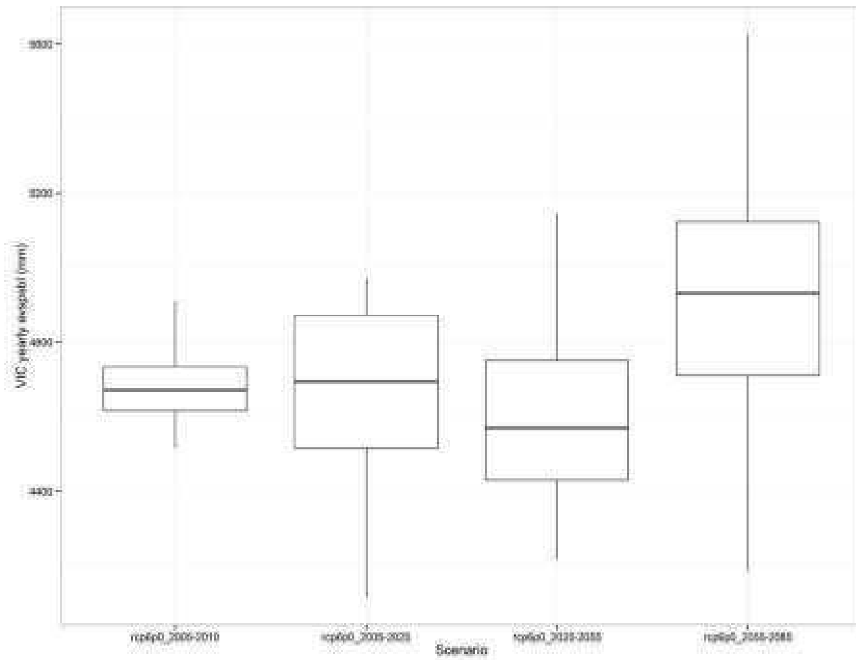

Figure 4-8: Comparison of annual evaporation for baseline and future climatologies.
Note: Based on data downloaded from ISI-MIP.

4.4 Analysis of Irrigation Demand

The variable "PIrrWW**"** from the WaterGAP model is described in the ISI-MIP documentation as "Irrigation water withdrawal, assuming unlimited water supply." Comparable human impact scenarios (*pressoc*) across historical (*hist*, 1970-2004) and future (rcp6p0, 2005-2099) climate scenarios were available. The *hist* run was used as the baseline climatology and the same windows of the rcp6p0 run as above for climatologies 30 and 60 years in the future.

Figure 4-9 and Figure 4-10 show comparisons across the three climatologies for monthly and annual totals, respectively, over the four 0.5 ° by 0.5 ° grid cells that span the Gulpur HPP watershed.

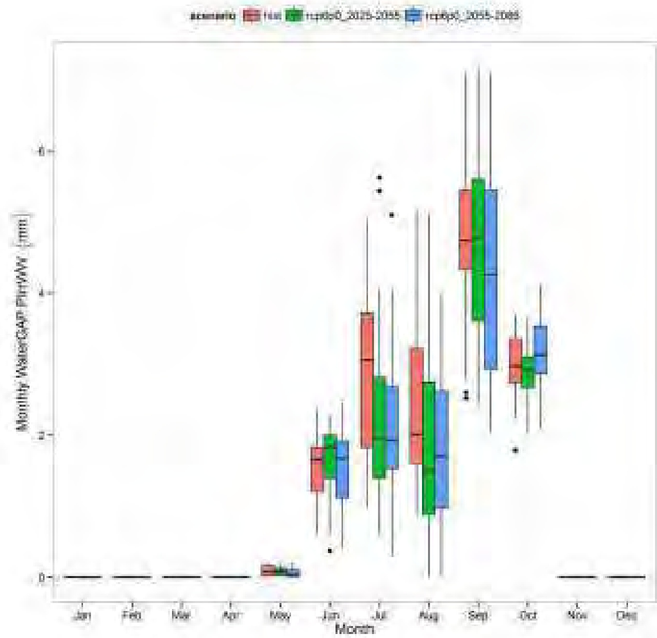

Figure 4-9: Comparison of Monthly Irrigation Demand Across Climatologies
Note: Based on data downloaded from ISI-MIP.

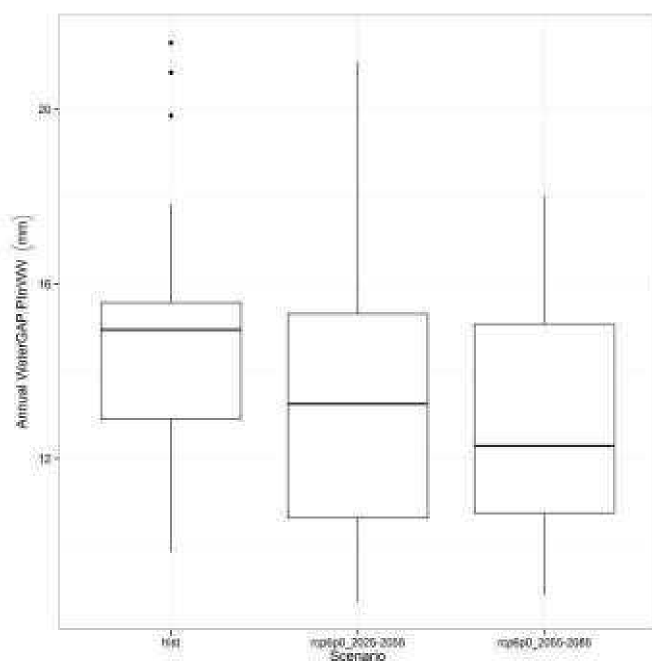

Figure 4-10: Comparison of Annual Irrigation Demand Across Climatologies
Note: Data are averaged over the 4 grid cells that span the Gulpur HPP watershed.
Based on data downloaded from ISI-MIP.

4.5 Discussion of Gulpur Watershed Data Analysis

VIC model-predicted evaporation in the project region has a non-uniform pattern of projected change between baseline and future climatologies. The annual totals exhibit a predicted decrease in evaporation during the 2040 period relative to both baseline periods. Conversely, the annual evaporation in the 2070 period is predicted to have larger central tendency and variability compared to the baseline periods.

WaterGAP model-predicted irrigation demand is again non-uniform on the monthly level, with the relative change between historical and future periods ranging from slight increases to moderate decreases. Annual demands are projected to decrease for the 2040 window relative to baseline and continue to decrease further for the 2070 window. Note that the projected decrease is larger for the middle and lower parts of the distributions than for the high parts, highlighting the projected increase in variability. Importantly, for the Gulpur watershed, the irrigation requirements are a small fraction of the evaporation, thus indicating that much of the local water need in this area is met through rain, or that the irrigated area is small. Note that this is clearly not the case in irrigated areas downstream in the Indus River Valley, where much of crop water growing needs are met through irrigation.

For both periods, *for these model combinations*, there is minimal or no increase in evaporation and a slight decrease in potential irrigation requirements. This observation is consistent with the summary of irrigation through a multi-model ensemble that suggests the HadGEM2-ES model is a relatively wet model suggesting wetter conditions over South Asia in general. However, considered in isolation, this set of results does not provide the full picture provided by the global assessments in the previous section, and does not represent worse-case conditions that would be needed to make the local-scale analysis conservative. A similar analysis of all model combinations was beyond the scope of the present work, and not all model data are available for public access at this time. These results at the local scale are presented here to demonstrate the methodology, should more ensemble analyses be desired in future work.

Using the above maps and quantitative analysis at the project location, it can be seen that the Gulpur HPP watershed itself is not a major user of irrigation water and irrigation demand change upstream is unlikely to reduce inflows into reservoir. Evaporation changes in the Gulpur HPP basin may occur as a result of climate change, even in the absence of irrigation demand. For the HadGEM2-ES model presented here the evaporation changes are small. Other warmer, and drier models, may result in greater changes in evaporation, and the loss of flow volume to the reservoir and consequent reduction of hydropower generation is a climate risk although it has not been fully quantified here. In general warming temperatures will result in earlier snowmelt and earlier peak discharge, with a greater likelihood of low flows in the late summer months. For the Gulpur watershed, as computed from the HadGEM2-ES and the WaterGAP model, this change in the monthly discharge patterns are shown in Figure 4-11. The change in the timing and seasonality of the discharge as shown here is of much greater consequence to the future operation of the dam in comparison to the potential human demands upstream which constitute about 5% of the discharge in the Poonch River at Kotli. Thus, flows in February and March are higher and flows in May and June are lower, both as a result of earlier snowmelt. This change is an important consideration for future hydropower operations, because some of the peak demand months in May and June also correspond to low flows. A similar response has been computed by Sharma et al. (2013) for the Jhelum River basin in Kashmir using a more detailed snow melt model and local data. A better understanding of precipitation, evaporation and watershed outflows are needed, with additional data collection across the watershed – not just the downstream outflow – to better characterize this risk.

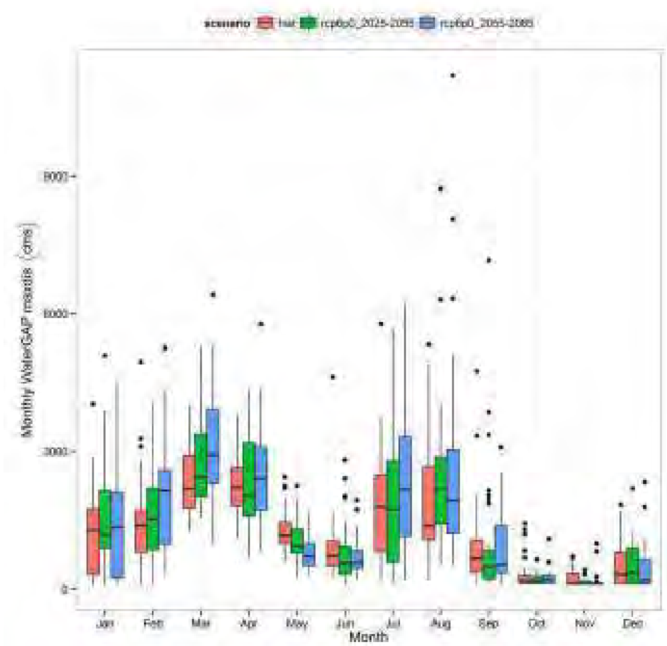

Figure 4-11: Comparison of monthly maximum discharge from the WaterGAP model

Note: Data is across climatologies (historical, 2025-2055, and 2055-2085), shown for the grid cell that corresponds to the outflow from the Gulpur watershed. Based on data downloaded from ISI-MIP.

4.6 Indus Basin Study on Climate and Agricultural Risk

The World Bank recently completed a study focused on the Indus Basin that is pertinent to the current work (Yu et al. 2013), and involved the evaluation of future climate scenarios, impacts to agriculture, and to the economy of Pakistan. To generate a wider range of potential climate scenarios, the World Bank study used combinations of corresponding inflow and crop water requirement parameters: Inflow was varied from 10 percent to 90 percent exceedance probability, and the crop water requirement was varied to correspond to a 1° to 4.5°C temperature increase (possibly occurring around the 2020s and 2080s, respectively). Thus, the work was not limited to models but also extended the record independently to generate extreme cases.

Climate change impacts (using corresponding temperature and precipitation changes) on snow and ice on the basin flows were considered. In most cases, negative impacts were estimated under these climate risk scenarios. In the most extreme future scenario — when inflow is at 90 percent exceedance probability and the temperature increases 4.5°C — GDP, and agricultural GDP were estimated to decrease annually by 2.7 percent and 12.0 percent. Total crop production is estimated to decrease up to 13 percent. The change in hydropower generation varies the most, from a 22 percent increase to a 34 percent decrease, with increases as a result of more snowmelt water becoming available. In order to assess the likelihood of low probability but high impact climate changes ("surprises"), possible "worst" case climate futures were considered. The worst case was defined as 90 percent exceedance inflow, a forward monthly hydrograph shift, 20 percent less rainfall, 20 percent more water requirement (consistent with a +4.5°C change), and groundwater table depths that are 20 percent deeper throughout the basin. In the worst case, there is a GDP decrease of 3.1 percent and an agricultural GDP decrease of 13.3 percent annually. There was also a best case considered, with modestly increased flows, and could result in a GDP increase of 1.0 percent and an agricultural GDP increase of 4.2 percent annually. This highlights the wide range of future outcomes possible given modeled climate and some extensions to the extremes as discussed above. The specific actions are not prescriptive, but clearly elucidate the risks to Pakistan's agricultural economy, and the need for continued refinement of analytical tools to support better decision-making.

4.7 Future Drought Risk

As discussed earlier in this chapter, some climate models show increases in precipitation and some show decreases. The average monthly and annual changes have been calculated but these changes are not always indicative of drought conditions. Another analysis which may be undertaken involves calculating the consecutive dry days.

A study was conducted in 2009 by the PMD to analyze regional changes to precipitation and temperature including frequency of consecutive dry days (CDD). For the frequency of CDD analysis, a dry day is considered any day when the precipitation was less than 1 mm. The 19 stations shown in Table 4-1 below were modeled due to their data completeness from 1960 to 2007. The results of the analysis are shown in Table 4-1 below.

Station	CDD	Station	CDD
Chitral	-8.08	**Jiwani**	53.39
D.I. Khan	-22.18	**Multan**	-7
Dalbandin	63.4	**Murree**	-18.61
Faisalabad	-4.98	**Parachinar**	7.76
Gilgit	-3.62	**Peshawar**	1.74
Hyderabad	15.89	**Quetta**	27.21
Islamabad	4.28	**Saidu Sharif**	6.91
Jacobabad	-36.43	**Zhob**	-14.71
Jhelum	7.38		

Table 4-1: Changes in Consecutive Dry Days

A review of future precipitation values and consecutive dry days indicate conditions exist for an increase in frequency of future drought events.

The models show the temperature changes due to climate change will increase. This may exacerbate drought conditions (e.g., by increasing water needs for crop maintenance).

Given anticipated changes in temperature and precipitation, there is on average an expected increase in irrigation water demands, other factor remaining constant (irrigated area, irrigation efficiency, crop types). This means the sensitivity could get worse in the future due to climate change. Furthermore, increases in population will also add pressures for water directly in cities and villages, and for food production through irrigation. It is well understood in current water balance studies, even in the absence of climate change, that Pakistan is a water stressed country with no known sources of new water to address future growth needs. Climate change, combined with development pressures, population growth, and conservation needs may increase the risk of this hazard in the future.

Hazard	*Current* Frequency	*Future* Frequency	*Current* Magnitude Range	*Future* Magnitude Range
Drought	L	M	M	M

Table 4-2: Hazard Screening Table

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Exposure	*Future* Exposure	*Current* Sensitivity	*Future* Sensitivity	Adaptive Capacity
Drought	H (H)	H (H)	H (L*)	H (M*)	L (M*)

Table 4-3: Vulnerability Screening Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Potential Loss			*Future* Potential Loss		
	Social	Economic	Environ-mental	Social	Economic	Environ-mental
Drought	M (L)	M (L)	M (L)	H (L)	H (M)	H (M)

Table 4-4: Risk Findings Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low.

4.8 Summary

Water demands for irrigation are the most important consideration in the broader region of the Gulpur HPP. However, the largest demands occur downstream of the project, and flows and water supplies that address these demands are modulated by other larger dams on the Jhelum River that is downstream of the proposed project. Given the relatively large storage capacity of Mangla Dam that is downstream of the Gulpur HPP, and given that the Gulpur project is to be run as a run-of-the river hydropower power project, with no diversions for irrigation, it is unlikely that the project will affect flows and releases from Mangla Dam.

Given anticipated changes in temperature and precipitation, on average there is an expected increase in irrigation water demands, other factors remaining constant (such as irrigated area, irrigation efficiency, crop types). Furthermore, increases in population will also add pressures for water directly in cities and villages, and for food production through irrigation. It is well understood in current water balance studies, even in the absence of climate change, that Pakistan is a water stressed country with no known sources of new water to address future growth needs. Although surface water resources are used extensively for irrigation, there is also a major concern with groundwater overdraft. These issues go well beyond the design and operations of the Gulpur project, and will continue to be addressed through various adaptive measures in the coming decades.

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5. Evaluation of Potential Climate Change Impacts on Reservoir Emissions

5.1 Introduction

The "Environmental and Social Impact Assessment and Environmental and Social Impact and Environmental and Social Management and Monitoring Plan" addressing Mira Power's proposed Gulpur HPP and produced for the IFC in September, 2013, presents in Volume I a brief discussion of GHG emissions associated with hydropower projects as compared to sources of electricity fueled by other sources.[2] The discussion correctly presents the recent understanding of relative GHG emissions among different fuel types, comparing the relative GHG emissions of hydropower to fossil fuel-fired power plants, but does not address the possible GHG emissions from the Gulpur project itself. It is widely acknowledged among scientists and policymakers that the scientific community has not reached agreement regarding the methodology that is appropriate for projecting GHG emissions from a proposed hydropower project (IPCC SRRES). Therefore, the objective of this chapter is to provide further insight into the factors that are relevant to the calculation for the Gulpur HPP and to provide an initial estimate of these emissions based upon a review of relevant literature. Detailed data collection from the Gulpur HPP and its analysis will further improve upon these estimates. Ongoing coordination with international efforts to improve these calculations will improve the understanding of potential GHG emission impacts of the Gulpur HPP reservoir.

5.2 Background

The inundation of forests and vegetation required to create a reservoir changes the primary decomposition of the affected organic material from aerobic to anaerobic, converting a portion of the organic carbon into methane (CH_4) and carbon dioxide (CO_2). In the absence of the reservoir, the organic material would have experience aerobic decomposition, producing CO_2 only. Methane's impact on climate change is about 25 times greater than that of CO_2; therefore, the creation of the reservoir can be expected to yield an increase in GHG emissions.[3]

Diffusion of GHGs through the impounded water into the ambient air is a significant pathway for the release of GHGs from the reservoir. Therefore, the surface area of the reservoir is a key variable for GHG emissions. In addition, the conversion efficiency of water to electricity at the hydroelectric plant also affects the amount of GHGs released per unit of electricity (kWh) created; therefore, the turbine technology affects GHG estimates.

The reservoir will be located in a humid subtropical zone, where temperatures will accelerate the decomposition of biomass in the reservoir and contribute to higher GHG emissions from

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[2] IFC ESIA and ESMMP ("ESIA") for Mira Power Gulpur Project, page 7-4.

[3] For ease of comparison of total GHG emissions among projects, methane is often presented as a "carbon dioxide equivalent" (CO_2e) using the factor of 25 as the conversion. Therefore, one unit of methane is equal to 25 units of CO_2, and could be added to 25 units of CO_2, with the sum expressed as 50 CO_2e.

the Gulpur HPP as compared to other hydropower projects located in temperate or boreal climate zones. The forest profile for the area is characterized by Subtropical Broadleaved Forest, and Subtropical Pine Forest.[4] The release of carbon from soil and other vegetation will contribute to GHG emission levels in the first few years after inundation, followed by additional years of emissions from the decomposition of the affected forest species. The reservoir will be located at an elevation of 542 meters.[5] The flooded area for the reservoir is projected to equal 325.4 hectares.[6] Central to estimation of GHG emissions from the reservoir is the fact that the lowest monthly mean minimum temperature is 4.8 °C in January, ensuring that meaningful ice cover is unlikely to accumulate on the reservoir.

The amount of these GHGs that is released from the reservoir changes over time due to a variety of factors that include climate, water flow through the reservoir, and the composition (i.e., carbon content) of the submerged biological matter. In the absence of data to support oxygen levels in the reservoir and the carbon content of the biomass, climate is the best single basis for the estimate of GHG emissions. Plant material is decomposed primarily in the first three years after flooding. The complete decomposition of trees can require many decades, depending on the species. The oxygen levels in the reservoir affect the production of methane. Relatively still water yields highly stratified layers of water within the reservoir that encourage anaerobic decomposition at lower levels, while the diffusion of oxygenated water from upstream or from thermal mixing of water at different depths provides for increased levels of aerobic decomposition.

In addition to the GHG calculation methodology itself, current assessments of GHG emissions from HPPs vary in their approach, reflecting different objectives. In some cases, the purpose of the GHG assessment is to compare the “pre-project” GHG emissions with “post-project” emissions. Alternatively, some assessments seek to compare operational emissions from an HPP with operational emissions from power plants fueled by other sources (i.e., renewable, nuclear and fossil fuel). Finally, a more comprehensive comparison of HPPs with GHG emissions from other sources of electricity requires a lifecycle analysis (LCA) to capture annual emissions from construction (e.g., GHGs associated with electricity use and equipment/vehicle fuel consumption) throughout the useful life of the project, including decommissioning. Estimates of GHG emissions in this chapter will be limited to projected emissions from the reservoir itself.

5.3 Approach

Review of relevant literature confirms that a reliable set of calculations and emission factors are not available for estimating GHG emissions for a potential reservoir. Collected data from existing reservoirs do not provide the basis for reliable estimates.[7] The analyses from five key

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[4] ibid, p 5-7

[5] Ibid, 3-2

[6] Gulpur HPP Basic Design Report Civil, Hydrological Analysis, page 21

[7] See statistical analysis in “Greenhouse Gas Emissions from Hydropower Reservoirs,” Kumar, Amit, M.P.Sharma; *Hydro Nepal* Issue No. 11 July, 2012, page 37.

resources provides some useful insight into the likely range of GHG emissions from the Gulpur HPP reservoir:

1. The Special Report on Renewable Energy Sources and Climate Change Mitigation ("SRRES") produced by the IPCC. Chapter 5 includes hydropower, and further detail is provided in Annex II, which also refers to prior work completed by the U.S. Department of Energy's National Renewable Energy Laboratory.
2. Appendices 3 and 4 from the IPCC's Fourth Assessment Report (AR4), addressing CO_2 and CH_4 emissions (respectively) from hydropower plants.
3. Hydropower Developments in Canada: Greenhouse Gas Emissions, Energy Outputs and Review of Environmental Impacts; authored by Peter G. Lee, Ryan Cheng, and Catherine Scheelar.
4. Addressing Biogenic Greenhouse Gas Emissions from Hydropower in LCA, published in Environmental Science Technology, 2013, by Hertwich et al.
5. "Hydropower Greenhouse Gas Emissions: State of the Research" produced for the Conservation Law Foundation (CLF), a U.S. non-governmental organization, by Synapse Energy Economics.

In addition, two multi-stakeholder efforts to improve an internationally accepted approach to estimating GHG emissions from reservoirs are also worth noting:

6. Guidelines for Quantitative Analysis of Net GHG Emissions from Reservoirs - Volume 1: Measurement, Programs and Data Analysis, developed by the International Energy Association (IEA) as Annex XII of their IEA Hydropower Implementing Agreement on Hydropower Technologies and Programmes (IEA Hydro).
7. The United Nations Educational, Scientific and Cultural Organization/International Hydropower Association (UNESCO/IHA) Greenhouse Gas Emissions from Freshwater Reservoirs Research Project

These two multi-stakeholder efforts advance the understanding of GHG estimation for hydropower projects with improved methodologies, decision trees and best practices for quantifying GHG emissions.

Taken together, these resources highlight the difficulties of estimating GHG emissions from hydropower projects. Emissions are sometimes expressed as an annual average in terms of capacity or electricity produced, the size of the reservoir or a combination of these features. None of the literature directly addresses the humid sub-tropical climatic zone; instead, they provide estimations for the broader climate categories of boreal, temperate and tropical. This adds to the limited ability to provide estimates for the Gulpur HPP within reasonable ranges of uncertainty. The findings for each of these studies are summarized below.

1. SRRES Chapter 5. Annex II of the SRRES analysis summarizes the results of the National Renewable Energy Laboratory's (NREL) literature review of peer-reviewed reports assessing GHG emissions from 18 hydropower projects internationally, using an LCA approach. Results

are reported as a function of annual electricity generation (in kWh). Specifics for each project are not provided; however, NREL applied a screening process to the original pool of 225 studies to ensure comparability among the results. Of the final set, the median result is 7.8 g/kWh of CO_2e emissions. Applied to the Gulpur HPP, this would yield an annual value of 3,348 tons of CO_2e. Chapter 5 of the SRRES presents a range of 4 g/kWh to 14g/kwh but under certain scenarios there is potential to emit much larger quantities of GHGs, as shown by the outliers. In light of the fact that the Gulpur HPP is located in a humid, subtropical zone, the higher value of 14 g/kwh may be reasonable. This would yield annual GHG emissions from the reservoir of 65,100 tons per year, assuming that the Gulpur HPP operates at its expected capacity to produce 465 GWh of electricity per year.

2. Variables from Appendices 3 and 4 of the IPCC's AR4, can be applied to the Gulpur HPP. In this case, a hydropower project located at an elevation of 542 meters with a flooded area of 326.37 hectares with zero ice-free days per year, annual metric tons of emissions vary from 1,407 tons in a warm, temperate-moist climate to over 27 million tons in a tropical-wet climate.

3. Hydropower Developments in Canada. This analysis for Global Forest Watch Canada, a Canadian non-governmental organization, focuses on an evaluation of GHG emissions from hydropower projects in Canada, but provides a global context of GHG emissions from other countries. As with other international studies, this report acknowledges the average annual GHG emission values used by the IPCC, but also highlights the fact that GHG emissions in the early years after the formation of reservoir can be substantially higher. This report presents average GHG results from hydropower in the form of a "decay curve", shown as Figure 1 below, illustrating the change in GHG emissions over time. This report also acknowledges that although project-specific measurements and analysis of GHG emissions for specific HPPs have been undertaken, no acceptable formula or methodology exists that contains "an acceptable degree of error".

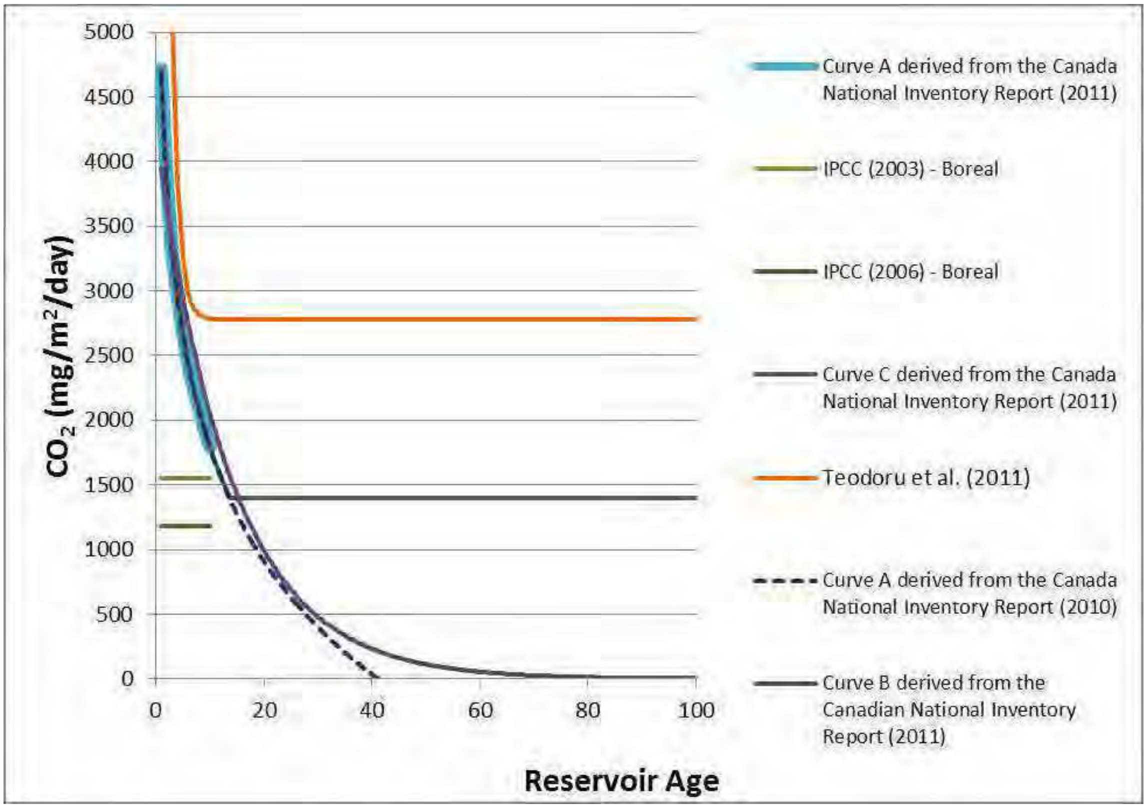

Figure 5-1: Projected Emission Curves for CO_2 Emissions from Hydropower Projects

Note: Used with permission from Global Forest Watch Canada.

Figure 5-1 shows projected emission curves for hydropower projects.[8] Note that the two lines derived from IPCC calculations are not decay curves, but are constant values that apply only for the first 10 years of operation. An estimation of annual emissions for the Gulpur HPP in its first year of operation, based upon this figure, would suggest a value on the y-axis in excess of the upper range shown by the existing curves. This is based on the fact that a humid sub-tropic zone would facilitate emissions in the early years of reservoir impoundment. Using 4,500 mg as an approximation of a maximum value, the corresponding annual emissions for the Gulpur HPP would equal 4,700 tons of CO_2e. While this study does not provide values that apply to the Gulpur HPP, calculations for projects located in a humid sub-tropic zone will yield values that are much higher and that are likely to decay substantially within the first 10 years.

4. Addressing Biogenic Greenhouse Gas Emissions from Hydropower in LCA, Hertwich, et al.

[8] Figure 5 from Lee P.G., R. Cheng, and C. Scheelar. 2012. Hydropower Developments in Canada: Greenhouse Gas Emissions, Energy Outputs and Review of Environmental Impacts. (Hydropower Report #2). Global Forest Watch Canada. International Year of Sustainable Energy for All Publication No. 3. Edmonton, Alberta. 101 pp.

This study uses a review of the literature, as well as data collection, and statistical analysis of CH_4 and CO_2 emissions from a sample of 82 measurements, and finds methane emissions per kWh unit of power generated to be log-normally distributed, ranging from micrograms of methane per unit to tens of kilograms. The authors use a multivariate regression analysis to determine that reservoir area per kWh of electricity generated is the most important explanatory variable. This yields an estimate of global average emissions from hydropower of 85 grams (g) of CO_2/kWh and 3 g CH_4/kWh, with an uncertainty factor of two. For the Gulpur HPP, these results equate to annual emissions of 74,400 metric tons with a high degree of uncertainty.

The study acknowledges that IPCC values for hydropower projects are held constant for each of the first 10 years after flooding but notes that recent statistical analyses worldwide reveal that emissions stabilize only after initial high levels following inundation. The report cites other studies to support the idea that the rate of post-flooding emission decline may depend on the region in which the reservoir is located.

5. Hydropower Greenhouse Gas Emissions: State of the Research, Synapse

While the focus of this analysis is on boreal HPPs located in Canada, the report includes information relevant to temperate and tropical climates. Although no data or discussion is provided that is specific to sub-tropic zones, the GHG emission values included for tropical locations range from 1,300 kg of CO_2e per MWh of generation to 3,000 kg CO_2e/MWh. Adjusting for the projected annual activity level at the Gulpur HPP, this would equate to 604,500 metric tons and 1,395,000 tons respectively.

6. IEA Hydro's Guidelines for Quantitative Analysis of Net GHG Emissions from Reservoirs ("Guidelines")

This comprehensive document provides an approach for the quantification of net GHG emissions, by providing formulas for the quantification of the pre-impoundment GHG emission baseline and subtracting it from post-impoundment emissions from the reservoir. The Guidelines provide decision-trees, suggested best practices and formulas for the quantification of CO_2, CH_4 and N_20. Because the Gulpur HPP reservoir has not yet been created, this document does not provide the basis for an estimation for the Gulpur HPP. It also includes an appendix which explains GHG emission measurement techniques from the reservoir itself, sediment, unflooded soil and from water downstream of the dam. As development of the Gulpur HPP procedes, it will be possible to apply these Guidelines to estimate GHG emissions. Examples of the information needed to support the equations in the Guidance are provided in Annex 2.

7. The IHA GHG Research Project, undertaken in collaboration with the International Hydrological Programme (IHP) of UNESCO evaluates GHG emissions from freshwater reservoirs. In the absence of an existing rigorous approach, their goal is to find definitive answers regarding GHG emissions and build consensus for an accepted approach. This goal

acknowledges key challenges, including the facts that data have not been obtained according to a standardized procedure; a representative sample of existing and planned reservoirs has not been collected; and there is not yet a consensus about the best procedure for estimating the net emissions of reservoirs.

To support their process, the recommendation was also made to develop a Measurement Specification Guidance, which would then be applied to a set of representative reservoir schemes. This would enable the collection of universally comparable data sets to be used for the development of predictive modelling tools and mitigation guidance for vulnerable sites. In conjunction, the IHA process began development of a predictive model for evaluating GHG emissions from reservoirs. The relationships among key inputs was developed based upon data collected from 169 reservoirs. The model remains in a "beta" form, but is available for public use and comment. The process of improving the quality and rigor of the model is on-going, with guidance available for the submission of compatible from new reservoirs.

The model requests four data inputs to predict gross emissions of CO_2 and CH_4: reservoir age; mean annual air temperature (in Celsius), mean annual runoff (in mm), and mean annual precipitation (in mm). The inputs for the Gulpur HPP are shown in Table 5-1 below.

Input Parameter	Value
Reservoir Age (years)	0
Mean Annual Air Temperature (Celsius)	13.5
Mean Rainfall (mm)	1090
Mean Annual Runoff (mm)	1279

Table 5-1: IHA GHG Risk Assessment Model (*beta*) Inputs

Model results are presented as milligrams (mg) of carbon (C) per square meter (m^2), per day. Results can be provided for any year of reservoir life, up to 100 years. Further, results are provided as average values, as well as the low and high boundaries representing the 67% confidence range for both CO_2 and CH_4. The model results are summarized in Table 5-2.

Predicted 67% Confidence Range for Gross CO_2e Flux For First Year of Operations			
	Low	Average	High
CO_2e	822	2176	6083

Table 5-2: Predicted CO_2e Emissions, in Tons, for Gulpur HPP for First Year of Operation

The model further provides graphs showing the 100- year emission curve for CO_2 and CH_4, including the low, expected and high values that define the 67% confidence interval. These are shown in Figure 5-2 and Figure 5-3 below.

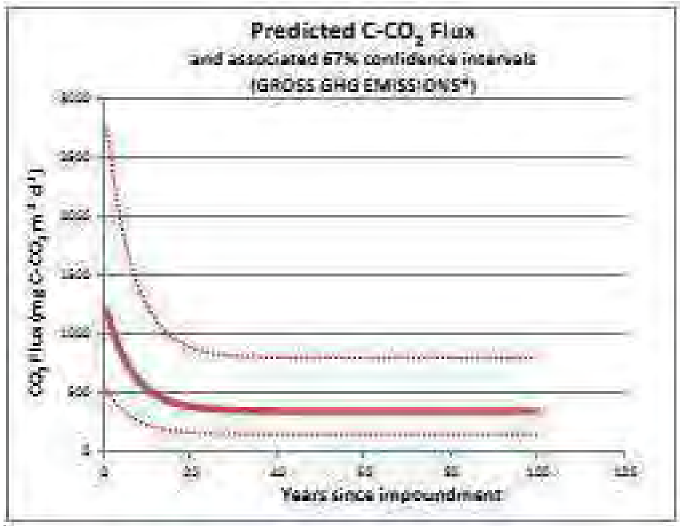

Figure 5-2: IHA Model Estimate of Carbon from CO_2 Over 100 Years

Note: The model's projections are in units of per m^2 per day. They do not equate directly to the values shown in Table 5-2.

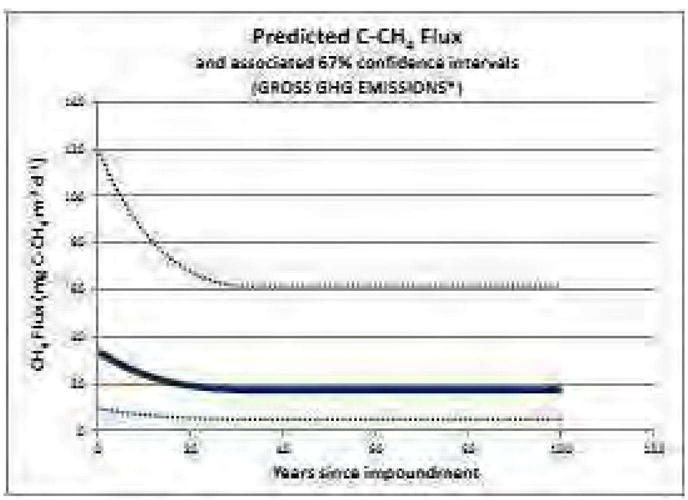

Figure 5-3: IHA Model Estimate of Carbon from CH_4 Over 100 Years

Note: The model's projections are in units of per m^2 per day. They do not equate directly to the values shown in Table 5-2.

5.4 Discussion

Of the studies presented, the range of annual emissions of a HPP similar in size and location to the Gulpur HPP could be between 1,407 tons and 27 million tons. They are summarized in Figure 5-4 below.

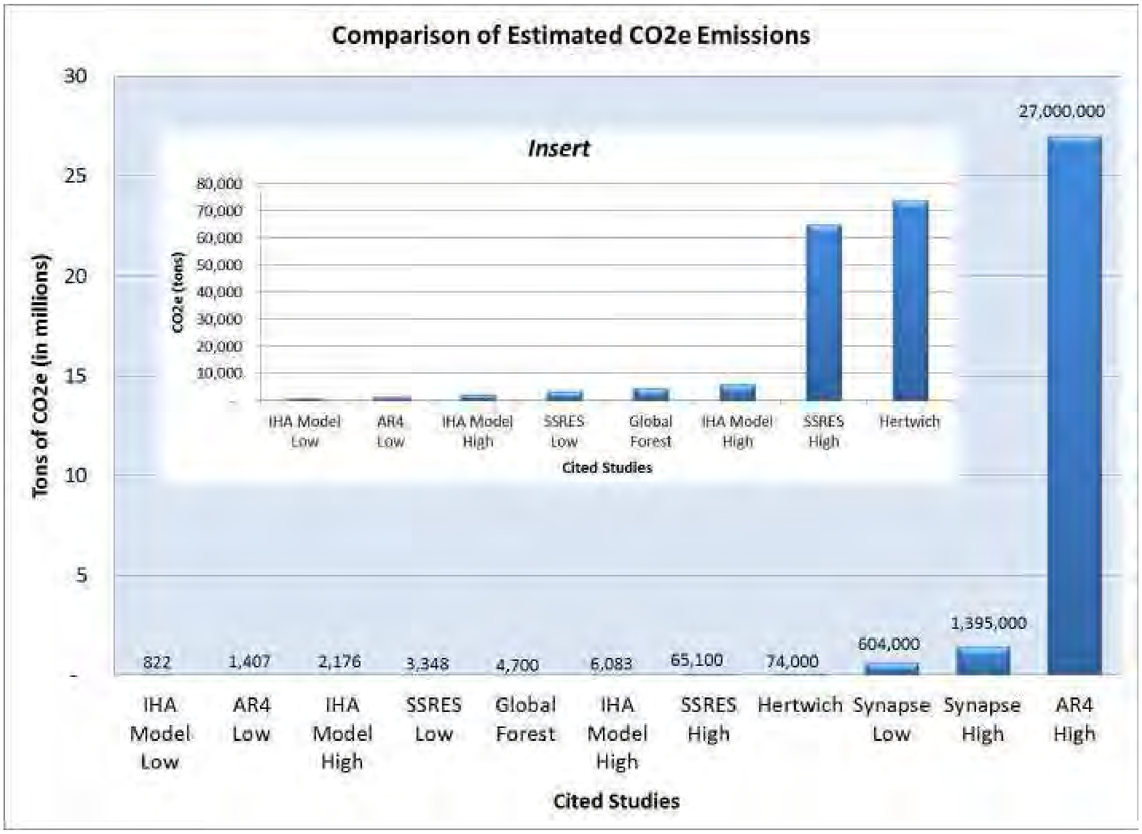

Figure 5-4: Comparison of CO2e Emission Estimates for Gulpur HPP Based on Selected Studies

Note: the “insert” provides a more detailed graph for the first eight results.

In light of the acknowledged inability to apply existing data to new reservoirs, the value to the Gulpur HPP of this wide estimate range can be further called into question. The two international efforts to standardize emission measurement and projections for reservoirs represent important advances in the future ability to develop meaningful estimates for reservoir GHG emissions.

5.5 Conclusion

As noted in the IPCC’s SRRES, variability in reported estimates for GHG emissions from hydropower is due to several differences among studies (e.g., climate, carbon stock of flooded area), technological performance of the HPP (e.g., turbine efficiency, lifetime, residence time of water) and quantification methods. Completion of additional analysis is needed to increase the number of estimates and the breadth of their coverage in terms of climatic zones, technology types, dam sizes etc. At the same time, improved international consistency for the quantification of the inputs is needed to allow for reliable estimates. Among stakeholders concerned about climate change, hydropower projects are routinely cited as having clear GHG benefits compared to fossil-fuel-fired power plants due to the carbon content of fossil fuel.

However, it is increasingly understood that GHG emissions from hydropower reservoirs can be substantial – especially in tropical climates – to the degree that they may emit more GHGs than a comparably sized fossil fuel plant, particularly in the first 10 years or so.

As presented in the preceding chapters, the impacts of climate change are likely to result in higher average annual temperatures and less annual precipitation distributed in fewer, more extreme precipitation events. This will have a complex set of impacts on the Gulpur HPP reservoir, including changes to the reservoir water levels, which will affect surface area and depth, as well as changing oxygenation of the reservoir through changes in flow of water through the reservoir and the extent of stratification. Realistic emission estimates from the Gulpur HPP will require direct study of the reservoir, including seasonal monitoring, of the ecology, technology and climate issues affecting it. Annex 2 provides an example from the Guidelines of the information that is widely agreed to be needed for reliable estimates. The application of this approach to the Gulpur HPP should allow for a more reliable estimate of its annual GHG emissions. Participation in these multi-stakeholder efforts, coordinated by respected bodies (i.e., the IHA and the IEA), may provide a dual benefit to Gulpur HPP project proponents – such participation could allow issues of importance for the Gulpur HPP to be acknowledged and incorporated into these international efforts; at the same time, Gulpur HPP representatives may gain useful insight into their quantification efforts for the Gulpur HPP.

5.5 References

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6. Evaluation of Disease Risks

6.1 Introduction

The IPCC has concluded that climate change is likely to expand the geographical distribution of several vector-borne diseases, including malaria, dengue and leishmaniasis to higher altitudes (high confidence) and higher latitudes with limited public health defenses (medium/low confidence), and to extend the transmission seasons in some locations (medium/high confidence) (IPCC, 2001). For some vector-borne diseases in some locations, climate change may decrease transmission by reductions in rainfall or temperatures creating conditions that are not conducive to vector transmission (medium/low confidence) (IPCC, 2001).

Climate-induced increases in mean temperature and precipitation levels could increase the distribution and abundance of vector organisms, such as mosquitoes, that transmit malaria. Although the full ramifications for many diseases are not well understood, this section will evaluate the disease risk to the project area based on available data and studies. The infectious diseases that were identified for evaluation in this section were (1) determined as having a quantified climate-epidemic relationship by the World Health Organization (WHO, 2005)[9] and (2) identified as affecting the project area.

Malaria is a leading cause of death in many tropical developing countries, and has been relatively well studied compared to other endemic diseases (CDC, 2014). Therefore, quantitative data and modeled results will also be used to evaluate malaria risk.

6.2 Future Disease Hazard Assessment

A changing climate will alter physical and ecological conditions for a variety of disease-carrying insects and parasites. Mosquitoes and ticks are sensitive to physical conditions, such as humidity, daily high and low temperatures, rainfall patterns, and winter snowpack. The distribution and growth-rate of vector populations have been correlated with ambient temperature. Numerous studies have concluded that an increase in ambient temperature will lead to net increases in the geographical distribution of many vector organisms, including several species of mosquitos that carry malaria and dengue fever (Bouma et al., 1996; WHO, 2003; WHO, 2005).

The following sections present the potential effect of climate change on the hazard conditions of the three key epidemic-prone diseases.

6.2.1 Malaria

Climate change was linked to an increased malaria rate from *P. falciparum* in Khyber Pukhtunkhwa (formerly the Northwest Frontier Province) by Bouma et.al. (1996). Khyber Pukhtunkhwa is one of the northernmost areas worldwide where seasonal malaria

[9] Refer to Table 2 in WHO 2005 for a summary of diseases that have had a climate epidemic relationship quantified.

transmission occurs. The province has experienced a spike in malaria rates since 1983, a trend which continues. Bouma et al. evaluated the monthly temperature and precipitation patterns in the provincial capital and found:

- A more than 100 percent increase in October precipitation since 1875;
- An increase of approximately 2 ^{o}C and 1.5^{o}C in November and December temperatures, respectively, since 1875;
- A significant increase in average (8:00 am) humidity ($t=4.58$, $P < 0.0001$) since 1950

When evaluated against other factors (such as the national malaria control strategy), the authors concluded that the striking increase in *P. falciparum* in the province is likely related to more favorable climatologic conditions for *P. falciparum* (Bouma et al. 1996). Because Khyber Pukhtunkhwa boarders AJK to the West, these study results are considered relevant to the project area.

The PRECIS model dynamically downscaled climate results (based on the ECHAM5 GCM simulations under the A2B emissions scenario) discussed in Chapter 2 indicate that the average annual temperature in the project area will increase from the baseline of 13.5^{o}C by approximately 1^{o}C for 2025 and by approximately 3^{o}C for 2055. Area-weighted precipitation values showed an overall 14 percent increase for 2025 and 2 percent decrease 2055. These results suggest a similar trend in temperature patterns as found in the Bouma et al. study; but yields a variance in precipitation patterns. A broader survey of ensemble averages under the various RCPs discussed in Chapter 3 also suggests continued increases in air temperature and possible increases or decreases in precipitation across Pakistan as a whole. Increased air temperature and possibly increased precipitation could both increase malaria risk.

The Liverpool Malaria Model (LMM) was used to better determine malaria risk to the project area under future climate conditions. The LMM is a mathematical-biological model of malaria parasite dynamics using daily temperature and precipitation data. While there are several different malaria models that have been developed, LMM was chosen based on data availability for the project area. Malaria models that have been developed to date, including LMM, are based partly on qualitative assumptions and models are usually not extensively validated against entomological and parasitological field observations. Thus, there is inherent uncertainty associated with these modeled results.

Figure 6-1 through Figure 6-3 show the LMM results for the HadGEM2-ES scenario, which indicates climate suitability for malaria transmission for the Poonch River Basin (2040, 2055, and 2070).

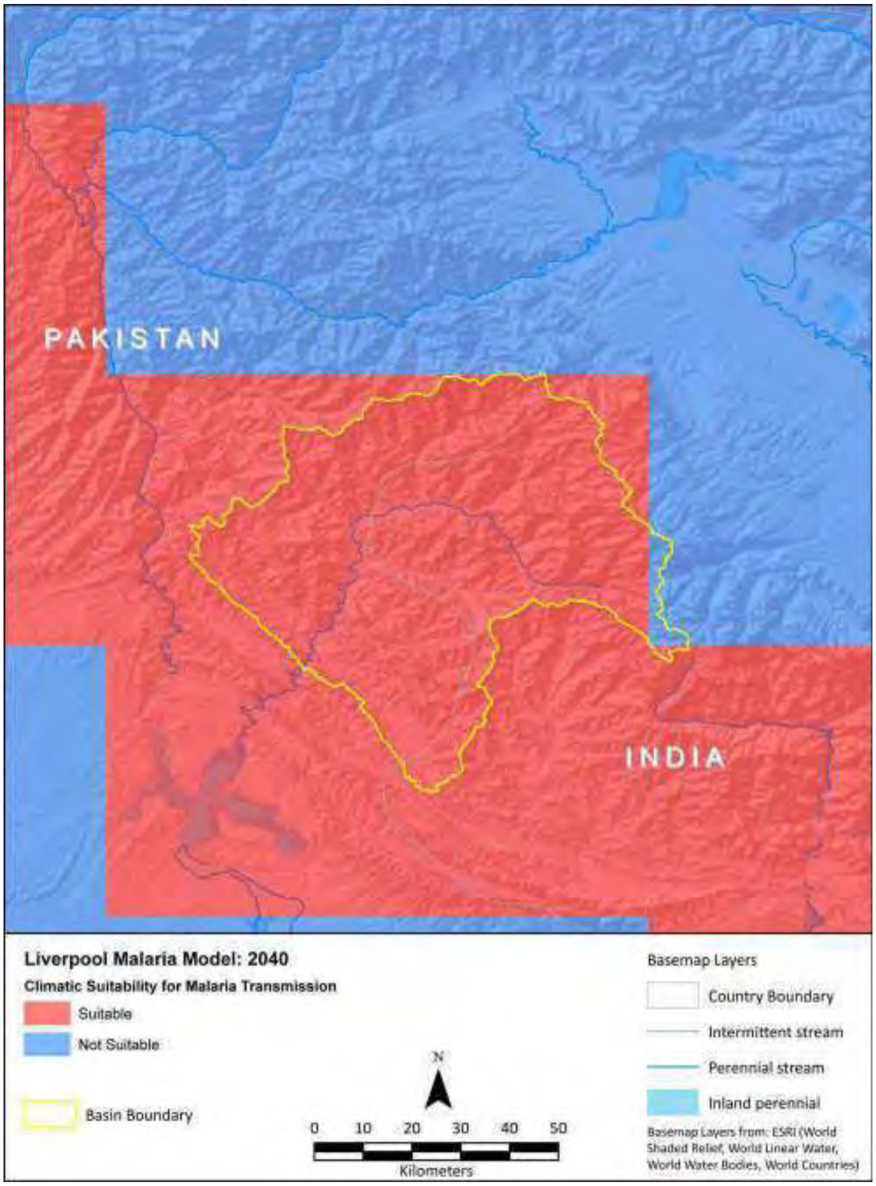

Figure 6-1: Climatic Suitability for Malaria Transmission - 2040

Note: (LMM model output from ISI-MIP Fasttrack Phase (http://www.pik-potsdam.de/isi-mip/ToU)

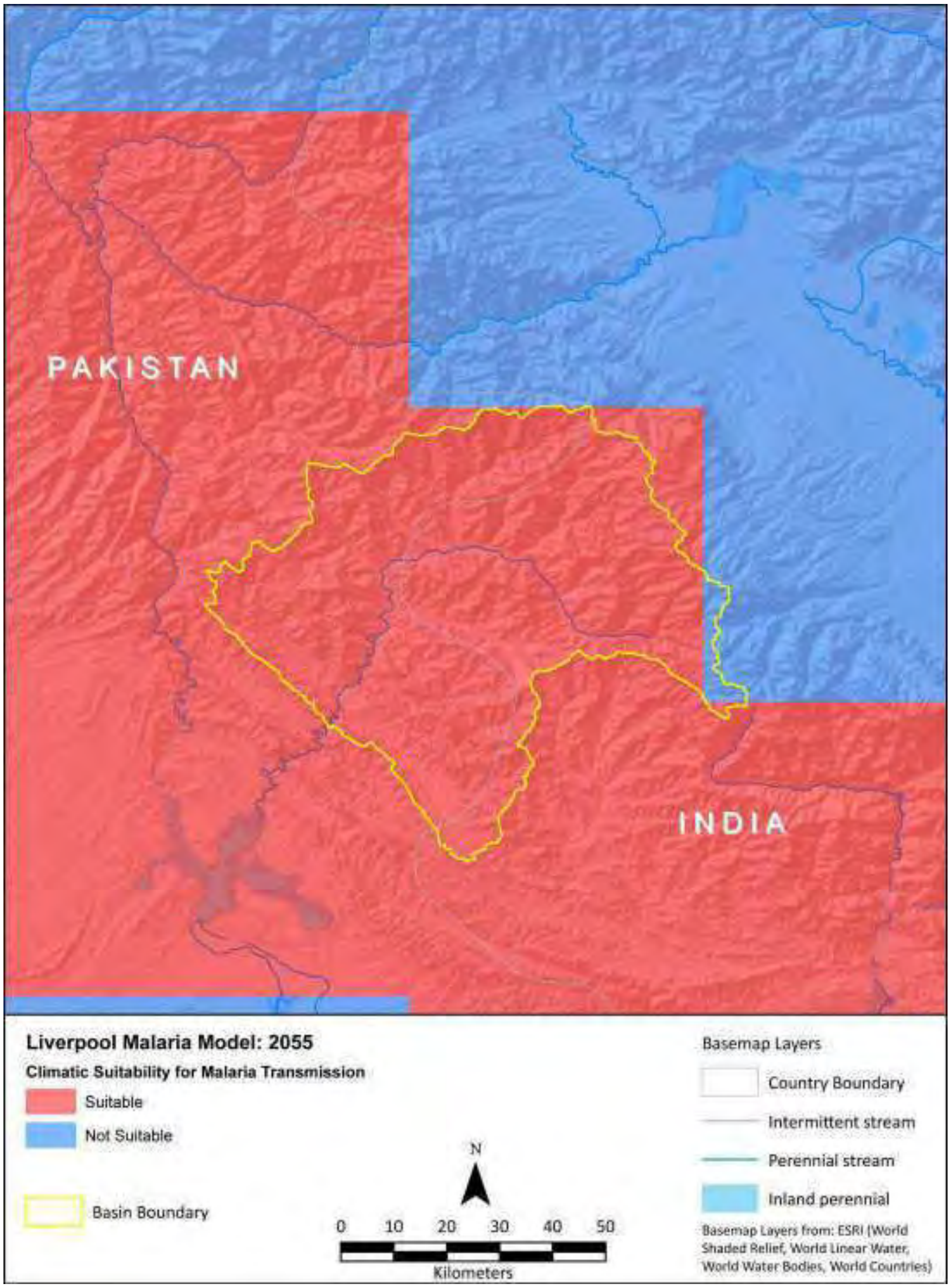

Figure 6-2: Climatic Suitability for Malaria Transmission – 2055 (LMM model output from ISI-MIP Fasttrack Phase (http://www.pik-potsdam.de/isi-mip/ToU)

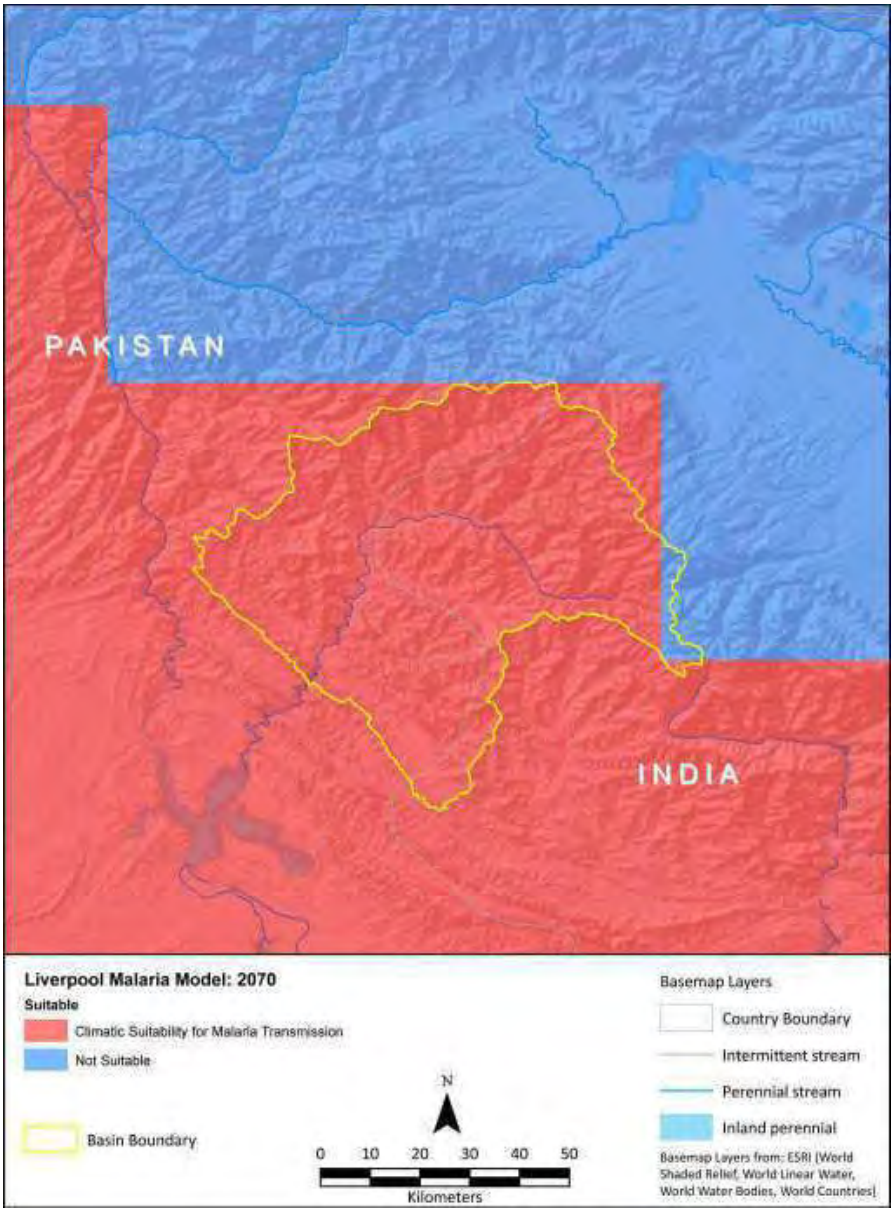

Figure 6-3: Climatic Suitability for Malaria Transmission – 2070 (LMM model output from ISI-MIP Fasttrack Phase (http://www.pik-potsdam.de/isi-mip/ToU)

HadGEM2-ES was selected as a conservative basis for malaria risk as it predicts wetter conditions in the project area than most other GCMs. As illustrated in these figures, the majority of the river basin will be at risk to malaria over the three time horizons. The eastern portion of the river basin is at a higher elevation (refer to the basin elevation map Figure 6-4), and the colder temperatures at those elevations are below the optimal range for mosquitos. The climate suitability for malaria transmission of the surrounding areas shows some degree of variance, with both the northwest and southwest quadrants exhibiting more suitable conditions in 2055 relative to 2040, and the southwest exhibiting more suitable conditions in

2070 relative to 2040. These changing conditions are likely due to the fluctuating precipitation patterns predicted for the basin for those time horizons (refer to the PRECIS results above).

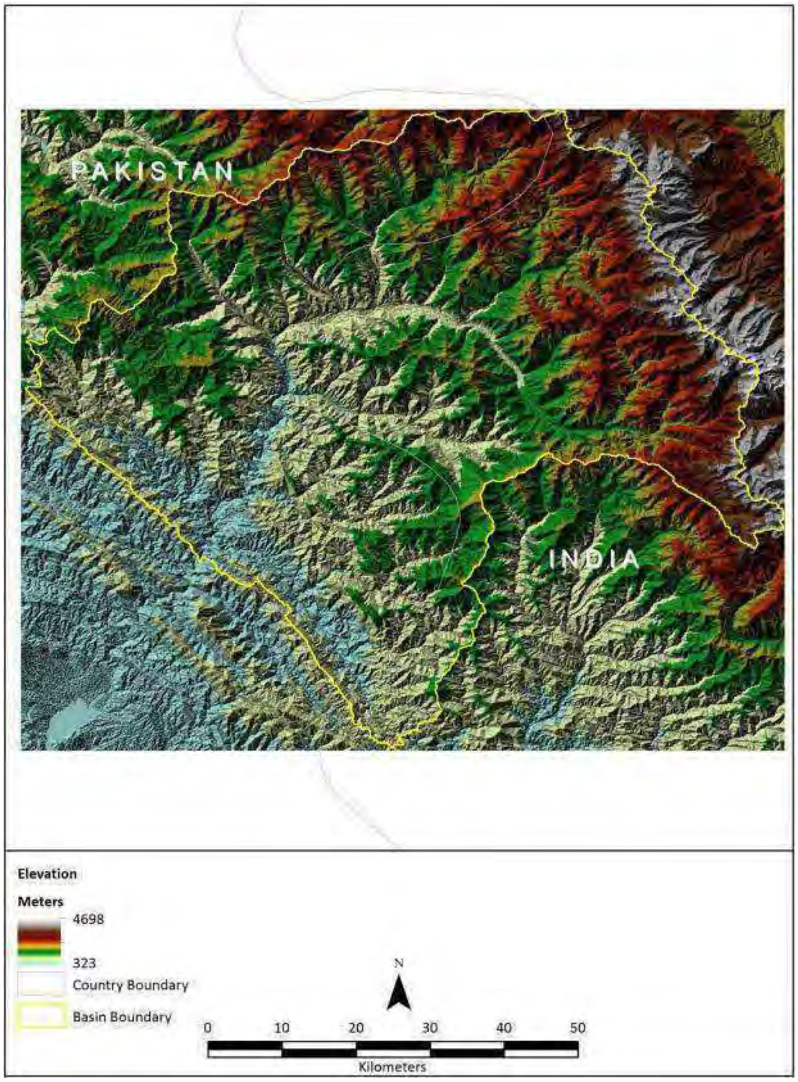

Figure 6-4: Elevation of the Project Area

6.2.2 Dengue Fever

Studies compiled by the WHO have linked outbreaks of dengue fever with high rainfall, elevated temperatures and humidity, as well as to other intrinsic factors such as population immunity. Based on these findings, the WHO (2003) concluded that climate change could increase the *Aedes aegypti* range and rates of transmission. A review of existing literature conducted by Morin et al. (2013) found that temperature is a major regulator of *Aedes aegypti* development; for viral replication, mosquito survival, and the reproductive behavior of mosquitoes. As illustrated in Figure 6-5, a range of 20 to 35^{o}C is considered optimal, with the temperature range and number of consecutive days dependent on the specific life-cycle requirements. The Morin et al. (2013) review showed that climate variables strongly influence dengue fever incidence; although there is still significant uncertainty in the connections to predict disease occurrence.

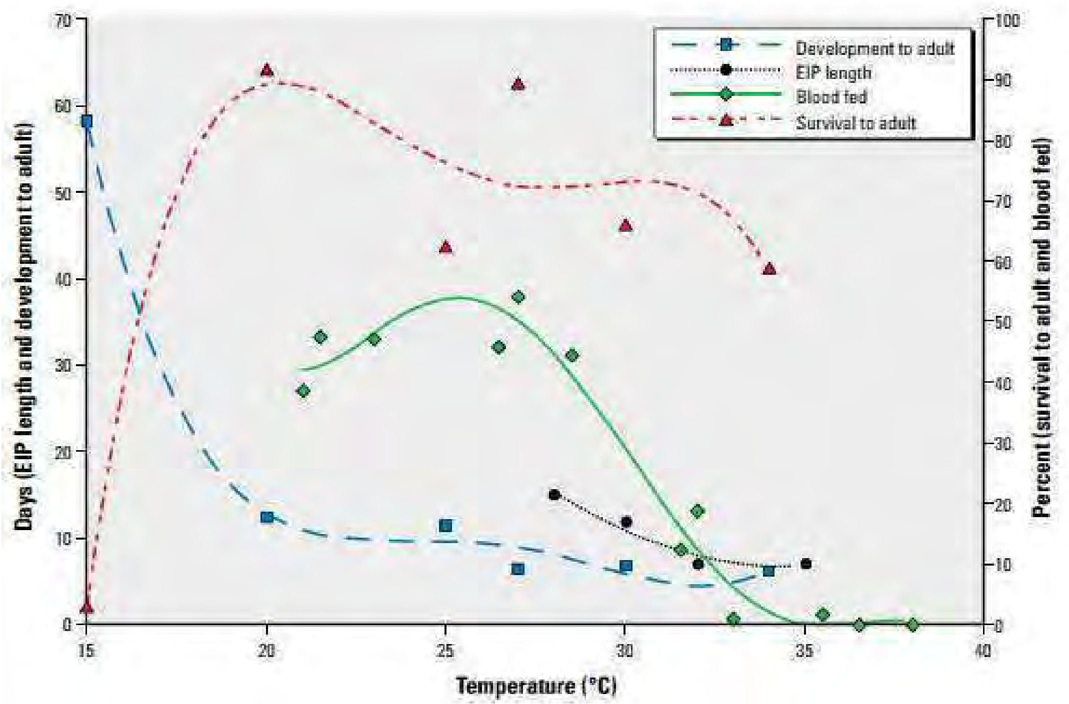

Figure 6-5: Effects of Temperature on Variables Associated with Dengue Fever Transmission

Note: Days required for immature Ae. aegypti development to adult, length of extrinsic incubation period, percent of Ae. aegypti mosquitoes that completed a blood meal within 30 min after a blood source was madeavailable, and percent of hatched Ae. aegypti larvae surviving to adulthood. (Morine et al. 2013).

6.2.3 CCHF

Similar to mosquitoes, tick life cycles depend on a complex combination of variables. Climate affects tick development and mortality, as well as their activity rates. In addition to climate factors, host availability and vegetation significantly impact tick populations. Estrada-Peña et al. (2010) have identified a worldwide increase in tick-borne infections worldwide, including for CCHF. While Estrada-Peña link warmer climate conditions and increases in humidity to changes in distribution of other tick species, the study is more cautious regarding CCHF, noting "the complex enzootic cycles of CCHF are made up of a combination of interactions resulting is a seemingly geographic distribution range that does not appear to currently match that of competent vector species" (Estrada-Peña, 2010). Instead, studies indicate that the highest CCHF rates in humans are in areas with high landscape fragmentation, compatible with conditions of high tick population movements, and a high number of hosts. Thus, while warmer than current climate conditions with adequate humidity levels would favor the presence of permanent populations of *Hyalomma marginatum* living across the northern temperate zone, it is not yet possible to predict how future climate will impact CCHF rates in the project area.

6.3 Disease Risk Assessment

Pakistan's vulnerability to climate change depends not only upon its ecological exposure but also on the socio-economic conditions and adaptive capacity of its population. Pakistan is a developing country with poor human health indicators. Pakistan's health profile includes high fertility, low life expectancy, high maternal and child mortality, high incidence of infectious and communicable diseases, and wide prevalence of malnutrition among children and women (WHO, 2014).

Prevention and response programs have been in place for malaria in Pakistan since 1961 (Directorate of Malaria Control, 2013). Pakistan requested assistance from the WHO to develop programs and provide emergency response targeted at dengue fever and CCHF in 2010 (WHO, 2010). Despite these programs, the national rates of malaria, dengue fever, and CCHF have each seen recent increases. Due to these factors, the adaptive capacity of Pakistan is considered low.

The Gulpur HPP's exposure to disease risk is considered moderate since diseases occur in the project area, but only seasonally. Although diseases risk could increase in the project area in the future, the Gulpur HPP's risk is considered lower than that of the average population since the personnel will not include children and personnel will have access to health care.

6.4 Risk Screening Results

The analysis shows that the project area is currently impacted by endemic malaria, and experiences sporadic cases of dengue fever and CCHF. Climate change temperatures and precipitation will provide a more suitable habitat for malaria in the project area, particularly in the 2050 time horizon. It is possible that warmer temperatures will also extend the range and incidence rate of dengue fever and CCHF. In the case of CCHF, other factors such as landscape and number of domestic animals are also important.

Current models provide a measure of changing exposure to disease, rather than a complete measure of infection incidence or disease burden. If the latter are required, it will be necessary to make an assumption about the relationship between changes in exposure and in disease burden. The simplest method, applied in the national analysis is to assume that proportional changes in exposure (e.g., proportion of people livening in areas climatically suitable for malaria), are directly related to proportional changes in disease burden. For example if climate change in a particular region is estimated to cause a 20% increase in the number of people living in areas that are defined as climatically suitable for malaria transmission, then this is most likely to lead to a 20% increase in the disease burden, compared to the situation if climate change did not occur. This proportional change can be applied to the estimated disease burden in the absence of climate change. Estimates of current burden of malaria at the national level are usually available from national statistics, or from the World Health Organization. For estimates of future impacts, it is necessary to apply these proportional changes to projections of what is likely to happen to malaria in the absence of climate change. The simplest assumption is that the disease burden will remain at current levels. It is more realistic, however, to take account of other likely changes in other determinants of malaria, such as population size and structure, as well as socioeconomic changes and technological advances.

Hazard	*Current* Frequency	*Future* Frequency	*Current* Magnitude Range	*Future* Magnitude Range
Disease	M	H	M	H

Table 6-1: Hazard Screening Table

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Exposure	*Future* Exposure	*Current* Sensitivity	*Future* Sensitivity	Adaptive Capacity
Drought	M (M)	H (H)	M (L)	H (L)	L (M)

Table 6-2: Vulnerability Screening Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low

Hazard	*Current* Potential Loss			*Future* Potential Loss		
	Social	Economic	Environmental	Social	Economic	Environmental
Disease	M (L)	M (L)	M (L)	H (M)	H (M)	M (L)

Table 6-3: Risk Findings Table, Pakistan (Mira Power)

Notes: Acronyms - H = High; M = Medium; L = Low.

6.5 References

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7. Conclusions

As with other infrastructure projects, the Gulpur HPP can benefit from an understanding of the potential risks to it that are posed by climate change. While the future remains uncertain with regard to a precise projection of the nature and extent of these risks for specific locations, the general scientific relationships are increasingly well understood and strongly suggest that each major project stakeholder should continue to anticipate and evaluate the effects of a changing climate, particularly the potential for adverse effects.

The potential future effects of climate change on four key issues have been addressed in this report:

1. Temperature and precipitation
2. Water supply and demand
3. Hazard threat of flood (including extreme flood magnitudes), landslide, drought, disease
4. Reservoir GHG emissions

This study provides an initial review of these issues, including summaries of relevant literature and assessment of local impacts. Downscaled climate data for the project region were obtained for the IPCC's A1B scenario from the ECHAM GCM, using the PRECIS and REgCM4 regional climate models. Climate change effects were developed for two future 30-year time periods, with mid-points of 2025 and 2055, respectively. Additional data on projected 21st century daily discharge were obtained for analysis of extreme flood risks.

1. Temperature and precipitation. In general, the effects of climate change by the year 2100 for Pakistan and the Poonch River watershed are consistent with more global trends: temperature is expected to increase by about 1° to 3°C; average annual precipitation is expected to remain similar to past experience. Of critical importance for precipitation, however, is the fact that average annual values fail to reveal potentially large intra-annual changes. This report suggests that the timing of the seasonal monsoon may be delayed by up to one month by 2100 and that annual precipitation may be delivered in fewer, larger events. Combined with increased evaporation levels due to higher temperatures, and the potential for increased sedimentation at the dam, these climate effects could have important impacts on the operation and performance of the Gulpur HPP.
2. Relatively small changes in annual temperature and precipitation estimates from the GCMs and RCMs tend to mask larger extremes – especially in precipitation – that can occur within a year. Other analyses suggest increases in both flooding and drought due to fewer, high precipitation events. Some studies show that as a result, irrigation water demand in Pakistan is expected to increase by more than 20 percent with temperature increases of 2 degrees or more. Although the Gulpur HPP watershed is not a major user of water that might otherwise be needed for irrigation, Pakistan has historically

been a water-stressed country and has no known sources of new water to address future growth. Climate change, development pressures, population growth and environmental conservation needs could increase the risk of drought and drought-related stresses in the future. Daily discharge and precipitation data from the HadGEM2-ES and coupled VIC models were used to estimate extreme flood and precipitation events. This information, as well as global studies spanning multiple models, support the likelihood of greater magnitudes of extreme floods in future decades.

3. An assessment of the hazards in the Poonch watershed includes consideration of flood, landslide, drought and disease. The results support a flood frequency ranking of *high risk* both for the country as a whole and locally. Based on reviews of historic events and corresponding water depths, future flood magnitudes should also be rated as *high risk*. Flood-induced landslide events are related to the flood analysis. Reviewing the future hazard screening, the conditions exist for a rise in frequency and magnitude of landslide events (ranked as a *medium* risk). A review of future precipitation values and consecutive dry days indicate conditions exist for an increase in frequency of future drought events (ranked as a *medium* risk). Of the four diseases in Pakistan addressed by this report, the projected temperature and precipitation impacts of climate change could increase the future risk of malaria, dengue fever and CCHF (ranked as a *medium* risk).

4. Among stakeholders concerned about climate change, hydropower projects are routinely cited as having clear GHG benefits compared to fossil-fuel-fired power plants due to the carbon content of fossil fuel. However, it is increasingly understood that GHG emissions from hydropower reservoirs can be substantial – especially in tropical climates – to the degree that they may emit more GHGs than a comparably sized fossil fuel plant, particularly in the first 10 years or so. The impacts of climate change will have a complex set of impacts on the Gulpur HPP reservoir, including changes to the reservoir water levels, which will affect surface area and depth, as well as changing oxygenation of the reservoir through changes in flow of water through the reservoir and the extent of stratification. Realistic emission estimates from the Gulpur HPP will require direct study, including seasonal monitoring of the ecology, technology, and climate issues affecting the reservoir. Annex 2 provides an example from the Guidelines of the information that is widely agreed to be needed for reliable estimates. The application of this approach to the Gulpur HPP should allow for a more reliable estimate of its annual GHG emissions. Participation in these multi-stakeholder efforts, coordinated by respected bodies (i.e., the IHA and the IEA), may provide a dual benefit to Gulpur HPP project proponents – such participation could allow issues of importance for the Gulpur HPP to be acknowledged and incorporated into these international efforts; at the same time, Gulpur HPP representatives may gain useful insight into their quantification efforts for the Gulpur HPP.

For each of these key issues, it is important to note that published climate impact studies are of global and regional scale, and often do not clearly address local impacts for the Poonch River watershed and the Gulpur HPP project specifically. The present analysis serves to highlight the most important climate-related issues for the project based on the most current scientific data (including data that are being used to develop the regional studies for the upcoming IPCC report, expected later in 2014). As the Gulpur HPP is developed and becomes operational, additional local data collection, on meteorological, socioeconomic, and ecological metrics will no doubt improve these analyses, and are strongly recommended to better understand and manage future risks in coming years.

Appendix J: Stakeholders Consultations

See following pages.

Environmental and Social Assessment of Gulpur Hydropower Project
Mira Power Ltd (MPL)

Record of the Consultation Meeting

Stakeholders:	World Wide Fund for Nature (WWF-P) Himalayan Wildlife Foundation (HWF) Private Power Infrastructure Board (PPIB) Snow Leopard Foundation Independent Ecologists
Date:	February 19, 2014
Time:	3:00 pm
Meeting Venue:	Mira Power Limited Office
Attended by:	Uzma Naureen (UN), WWF-P Sohail Naqvi (SN), WWF-P Dr Anis ur Rehman (AR), HWF Abrar ul Haq (AH) (PPIB) ZB Mirza (ZBM) (Ecologist) Hafeez Buzdar (HB) Snow Leopard Foundation Jahanzeb Murad (JM) Mira Power Ltd
Conducted by:	Vaqar Zakaria (VZ), HBP
Recorded by:	Fareeha Ovais (FO), HBP
Language:	Urdu, English
Preamble:	Information Document (English) on the Project Impacts on Biodiversity. Power Point presentation on the Impact Assessment of the Project on the aquatic ecological resources of designated section of Poonch River.

No.	*Issues Raised*	*By*	*Response Provided*
1.	PPIB awarded the contract for the development of Gulpur Hydropower Ltd in 2005 and the Poonch River was declared a national park in 2010 without consulting the PPIB or their counterpart in AJK (Azad Jammu and Kashmir). In view of the ongoing electricity shortages and load shedding, power generation is very important for the economy.	AH	The Poonch River provides habitat for two fish species, Mahaseer (*Tor putitora*) and Kashmir Catfish (*Glyptothorax kashmirensis*) listed as Endangered and Critically Endangered respectively in the IUCN Red List 2013. Therefore, the Poonch River is a Critical Habitat according to IFC Guidelines whether or not it is declared a national park. Communication gaps between PPIB and AJK Government is not a Project concern. If EIAs were done on time then PPIB and developers would have known the environmental concerns.
2.	How far back will the reservoir extend upstream of the Project location?	AR	The Project is a run of river (RoR) type hydropower project so no reservoir like the Mangla reservoir will be created. The water level in the River will rise but will not go beyond the flood line. No houses will be submerged and no agricultural land will be lost
3.	The Poonch River is an ecologically sensitive river, and provides habitat for fish of conservation and socio-economic importance. So PPIB should not authorize any more projects on this river.	AR	The Cumulative Impact Assessment of the planned hydropower projects on the Poonch river is being investigated. Only when this is done, we can determine if there is room for any more projects. Keeping in view the ecological sensitivity of the Poonch River, it seems unlikely that more hydropower projects can be built and can achieve the net gain for conservation as proposed in the IFC guidelines. *If* any more Projects are to be sanctioned on the Poonch River at all, it is recommended that they be considered first downstream of the Gulpur Hydropower Project. This will avoid blocking the important fish breeding areas located in the Ban Nallah and Rangar Nallah
4.	The information document provides information only about baseline biodiversity assessment surveys done in October. How will seasonality be captured?	UN	In addition to literature reviews, field surveys have been conducted in June (for the ESIA), October and December (fish survey). Spring surveys are scheduled for April 2014. So seasonal variations in biodiversity will be captured. Full details are available in the Baseline Biodiversity Assessment Report that can be shared with the stakeholders upon request.

No.	Issues Raised	By	Response Provided
5.	Local communities in the Poonch River basin will be affected by decline in fish resources. They are also dependent on sand and gravel extraction from the river bed for construction. How will this be dealt with?	AR	A draft Biodiversity Management Plan has been developed and work is in progress for the Biodiversity Action Plan. Measures to conserve the fish resources include reactivation and rehabilitation of the Mangla hatchery and stocking the fish like Mahaseer upstream of the Project location. If the protection measures outlined in the Pro 2 scenario are implemented and the Biodiversity Action Plan is implemented, a net gain for conservation can be achieved. However, the 0.7 km stretch of the River that will experience low flows due to Project operations is likely to suffer negative ecological impacts. But this is only 0.7% of the total length of the Poonch River in Pakistan. As for sand and gravel extraction, a sand and gravel extraction plan will be developed and locals will be allowed to extract the sand and gravel trapped upstream of the weir (of the Project).
6.	Have fish ladders been incorporated in to the Project design	ZBM	According to the feedback provided by local and international fish experts, fish ladders are seldom successful, and are not going to be useful for protecting the fish species of the Poonch River especially considering the gradient of the landscape.
7.	We are depending on the AJK Fisheries and Wildlife department to implement the environmnetal conservation and protection measures while we know that they are inefficient. The Poonch River is already a national park yet conservation measures are presently inadequate.	AR	Subject to agreement with government of AJK on the Biodiversity Action Plan (BAP) for the project, The AJK Fisheries and Wildlife Department will have to sign an agreement for effective implementation of the conservation and protection measures outlined in the BAP. In addition, there will be external third party monitoring to ensure that goals are being met. Training and capacity building measures for the AJK Wildlife and Fisheries Department will be included in the BAP.

No.	*Issues Raised*	*By*	*Response Provided*
8.	What about the impacts of Project construction and operation on the terrestrial biodiversity of conservation importance such as the Common Leopard, vultures as well as the aquatic mammals particularly the Otter?	UN	Terrestrial Impact Assessment of the Project has been completed, and no significant impact of the Project on the terrestrial ecological resources is expected, considering the small size of terrestrial habitats that will be inundated due to Project construction. Signs of otters were absent from the Project location and vicinity. Otters are present upstream and downstream of the dam but they are not likely to be impacted. Otters depend on impact on fish population as fish is the main source of food for the otter. If fish abundance increases assuming Pro2 Scenario, then the otters will benefit. The Project design will include adequate facilities for solid waste disposal and waste water treatment to minimize impacts on the terrestrial and aquatic resources.
9.	There could be some potential positive ecological impacts in the river stretch that will experience low flows due to Project operations. These may include an increase in the number of waders and birds that prefer to sit on slow moving water with a consequent increase in their predator bird species. The droppings of these birds will increase the organic contect in the dewatered river stretch.	ZBM	Noted. Comments will be incorporated in to the Final Impact Assessment Report.

Other Comments

1. The decision on the minimum Environmental Flow to be released by the Project has still not been finalized. The owners (Mira Power Ltd.) need to determine this after consultations with all the stakeholders. The consultant (Hagler Bailly Pakistan) cannot make this decision; they can only provide analysis of impacts and benefits under different scenarios and assist the stakeholders in taking informed decisions that balance the environmental impacts against economic benefits of various levels of flow release for environment. NESPAK is currently working on the engineering modeling to determine the financial losses that will go with every cumec increase in the EFlow. As soon as this work is completed, the decision on the EFlow will be finalized by the owner.

Environmental and Social Assessment of Gulpur Hydropower Project
Mira Power Ltd (MPL)

Record of the Consultation Meeting

Stakeholders:	Environmental Protection Agency (EPA-AJK) Hydroelectric Board (HEB-EPA) Forest Department, AJK
Date:	March 20th, 2014
Time:	12.00 noon
Meeting Venue:	Pearl Continental Hotel, Muzaffarabad
Attended by:	Dr Aurangzeb, EPA-AJK Forest Department , AJK Hydroelectric Board AJK Jahanzeb Murad, Mira Power Ltd Sultan, Mira Power Ltd
Conducted by:	Vaqar Zakaria (VZ), HBP
Recorded by:	Vaqar Zakaria (FO), HBP
Language:	Urdu, English
Discussion:	VZ informed the participants that the purpose of the consultation was to present the results of environmental flow (EFlow) assessment to the stakeholders and solicit their opinion on what they considered would be an appropriate EFlow regime for the project. The presentation covered the aquatic ecology baseline, methodology adopted for EFlow assessment, results of EFlow assessment, and economic impacts of various EFlow scenarios.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Data on the forest area that will be damaged by the project has not been provided. Plantation will be required to compensate for the vegetation lost.	Forest Department	The section on terrestrial ecology in the ESIA will provide this detail. There is only scrub cover in the area that will be used by the Project, and only a limited area in the ownership of Forest Department will be required for the project. A budget for plantation and re-vegetation will be allocated in the EMMP.

No.	*Issues Raised*	*By*	*Response Provided*
2.	General opinion of all the participants was that commitments made in ESIA for environmental improvements and CSR are not kept by the project owners. The participants provided examples of other hydropower projects in AJK where this had occurred. Concern was expressed that the BAP and CSR commitments will not be implemented		
3.	EPA will not comment on the EFlow at this point. The EPA will review the EIA to be submitted by the Project Owner and will give its opinion after examining the analysis and justification provided for the suggested flow in the EIA	EPA-AJK	Peaking flow which causes substantial damage to downstream section of the river will be avoided. After switching to Option 3 in design the low flow section of the river downstream of the dam and upstream of the power house where major impacts will occur is only 700 meters. A net gain will be achieved through implementation of the BAP in the remaining stretches of the river.

Other Comments

The stakeholders did not express any reservation or concern on this position suggested by the Project Owner.

2.

Environmental and Social Assessment of Gulpur Hydropower Project
Mira Power Ltd (MPL)

Record of the Consultation Meetings

Stakeholder:	Aghar (Gulhar), (Men)
Date:	February 08, 2014
Time:	09:30 am
Meeting Venue:	Residence of Muhammad Kabir
Attended by:	Muhammad Ishaq Janjua Muhammad Iqbal Janjua Abid Azam Muhammad Abdullah Muhammad Mehfooz Qaisar Majeed Waqas Anjum Muhammad Ismail Muhammad Kabir Muhammad Nawaz Muhammad Nazak Muhammad Abid Muhammad Fazial Muhammad Amir AkraMuhammad Khan Noman Ishaq
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Employment preference should be given to the local people		Concern noted
2.	Sites where sand mining is practiced should be protected		Concern noted

No.	Issues Raised	By	Response Provided
3.	If sand mining ban is imposed, alternate mining locations and tracks should be provided		Concern noted
4.	If any land is flooded or affected, adequate compensation should be provided		Concern noted

Others:

Generally the community stakeholders encouraged the project and pledged full support. They were of the view that investment in their area will result in better facilities, infrastructure and opportunities for local people. They endorsed the project and pledged full support.

Stakeholder:	Kohali (Men)
Date:	February 09, 2014
Time:	10.00 am
Meeting Venue:	Residence of Muhammad Azam
Attended by:	Zahid Rasheed Adnan Rasheed Muhammad Azam Muhammad Nazik Javed Iqbal Rafaqat Hussain Muhammad Riasat Muhammad Nazam Abdul Rasheed Mir Zaman Chaudhry Abdul Jabbar Hafiz Umer Khattab
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	Issues Raised	By	Response Provided
1	Survey conducted by engineers for the evaluation of site resulted in degradation of farming land and trees	Javed Iqbal	Concern noted
2	Employment opportunities should be provided to locals during the construction of the project		Concern noted
3	The company should provide schools in the local village to in exchange of their cooperation		Concern noted
4	Sand mining should be allowed to the locals on the banks of Poonch river		Concern noted
5	Free electricity should be provided to the local communities living close to the dam site		Concern noted
6	Quantity of fish in Poonch river has been reduced over the years, mitigation measures should be introduced to protect the fish and biodiversity of the area		Concern noted

Others:

Generally the community stakeholders encouraged the project and pledged full support.. Stakeholders committed full participation and cooperation during the course of the project. Few stakeholders were of concern that in past job opportunities were given to outsiders on other similar projects in Azad Jammu and Kashmir.

Stakeholder:	Bialian (Men)
Date:	February 09, 2014
Time:	03.30 pm
Meeting Venue:	Residence of Raja Aftab
Attended by:	Muhammad Ishaq Ziafat Ali Faizan Khan Raja Shahid Sohail raja Hafoiz Nawaz Asad Aftab Raja Aftab Nadeem Raja Ayaaz Aftab Arif
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP

Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No	*Issues Raised*	*By*	*Response Provided*
1	Blasting noise during construction will affect poultry and chickens negatively. The sound loads might damage the animals and people living in the area	Muhammad Ishaq	Concern noted
2	Employment opportunities should be provided to the local people of the area	Raja Aftab	Concern noted
3	Media and Press Club should be engaged so that they can facilitate the project and promote positve publicity regarding the Gulpur Hydropower Project	Aftab Arif	Concern noted
4	Any land that might be affected due to the project must be compensated appropriately	Raja Munsif Khan	Concern noted

Others:

Generally the community stakeholders encouraged the project and pledged full support. They were of the view that Pakistan needs such projects to overcome the demand and supply gap in the power sector. Stakeholders committed full participation and cooperation during the course of the project.

Stakeholder:	Naroch Colony (Men)
Date:	February 10, 2014
Time:	09.45 am
Meeting Venue:	Residence of Munir Hussain
Attended by:	Muhammad Shareef Shair Ahmed Dil Muhammad Zafar Iqbal Shahzad Ahmed Muhammad Bashir Muhammad Hanif Azhar Hussain Naveed Iqbal Tufail Hussain Sardar Muneer

	Muhammad Latif Muhammad Rasheed Ghulam Mustafa Muhammad Mushtaq Muhammad Akbar Muhammad Sagheer
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Employment opportunities should be provided to locals during the construction and operation of the project		Concern noted
2.	A water supply scheme is needed in the area mdue to various water problems. A primary school is also really needed for the area		Concern noted
3.	Blasting noises during construction should be kept to the minimum to avoid disturbance to the local community		Concern noted
4.	The local communities living around the area should be relieved of electricity load shedding		Concern noted
5.	Most of the people in this village are not engaged in fishing or sand mining so the job opportunities are very limited. Therefore the hydropower project will be supported by the locals as it will bring means of employment and development for the local community.		Concern noted
6.	Free electricity should be provided to the local areas to give them the benefit of their co-operation towards the project		Concern noted

Others:

Generally the community stakeholders encouraged the project and pledged full support.. Stakeholders expressed that if their properties are not affected by the reservoir and construction noises are kept to minimum, the communities will cooperate.

Stakeholder:	Rehmani Mohalla (Men)
Date:	February 10, 2014
Time:	02.30 pm
Meeting Venue:	Residence of Raj Muhammad
Attended by:	Muhammad Hanif Muhammad Khaliq Raj Muhammad Abdul Rehman Haji Muhammad Ashraf Hafiz Muhammad Ghais Azhar Hussain Talib Hussain Hafiz Muhammad Abbas Akhtar Khan Tasawwur Khan Safdar Ali Muhammad Hussain Tahir Aziz Muhammad Khalil Hafiz Abbas Muhammad Salim
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	People of other communities own land around the outlet of the tunnel and the power house. Consult those peple to check if their lands are affected in any way by the project		Concern noted

No.	Issues Raised	By	Response Provided
2.	Preference should be given for employment opportunities during the construction and operation of the dam to local people		Concern noted

Others:

Generally the community stakeholders encouraged the project and pledged full support.. Stakeholders said that if the dam height is relatively low and lands/properties will not be affected in any way. People were of the view that the current dam design does not effect them negatively and they encouraged such projects in their area.

Stakeholder:	Hill Kalan (Men)
Date:	February 11, 2014
Time:	02.00 pm
Meeting Venue:	Residence of Murshid Hanif
Attended by:	Chaudhry Fazal Chaudhry Muhammad Hussain Murshid Sultan Chaudhry Manga Hanif Khan Khadim Hussain Yasir Butt Chaudhry Talib Haneeb Khan Waqash Chaudhry Noor Muhammad Abdul Rahman Shabbir Ahmed Butt Muhammad Azeem Muhammad Manzoor
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Due to the dam, the river might be blocked leading to more extreme floods in the area. Adequate compensation should be given to the locals if such a situation arises.	Khadim Hussain	Concern noted
2.	Locals need a bridge across Poonch river to access Kotli city for daily commute and emergency situations.	Muhammad Hanif	Concern noted
3.	Another survey team visited the area during August 2013, marked all the houses in the community and made a commitment of a hospital, school, bridge and a road. That promise was never completed and there was no follow-up.	Khadim Hussain	Concern noted
4.	During the earlier survey in August 2013, the team committed a 9 feet tall embankment across Poonch river for the protection of the area during floods. If the impact to the area has decreased in the new design, so atleast a 5 feet embankment should be provided to decrease loss of life.	Shabbir Ahmed	Concern noted
5.	Survey team visiting the area during August 2013 instructed the locals not to carry out any construction work until the dam design has been finalised. There was no follow up on this. Local people are waiting for a go ahead from the survey team to carry out needed maintenance work in their houses.	Khadim Hussain	Concern noted

Others:

Generally the community stakeholders expressed that every year their houses are flooded due to flatter tearrain on the banks of the river. They were concerned that the dam will block Poonch river and increase the intensity of floods. They expect protection from the floods such as embankments on the banks or compensation against the loss of their property.

Stakeholder:	Kamili (Men)
Date:	February 11, 2014
Time:	05.00 pm
Meeting Venue:	Residence of Hafiz Nazik
Attended by:	Chaudhry Muhammad Sabar Chaudhry Abdul Rahman Chaudhry Azhar Khan Hafiz Nazik Rabnawaz Muhammad Haris Muhammad Sajid Muhammad Azhar Fazal Ahmed Nawaz Chaudhry

Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	As the project will be located in the vicinity, the locals should be given free electricity	Hafiz Nazik	Concern noted
2.	Employment opportunities should be offered to the people living closest to the area at priority basis	Muhammad Sabar	Concern noted
3.	If any study/sampling/moniroting is scheduled on our land, we should be informed well in advance and our consent should be taken	Fazal Ahmed	Concern noted

Others:

Generally people endorsed rge project stating that such projects provide clean energy and help in fighting the energy gap in Pakistan. People were of the view that construction should be started soon and the work should be completed at a fast pace.

Stakeholder:	Rajdhani (Men)
Date:	February 12, 2014
Time:	11.00 am
Meeting Venue:	Rajdhani Gala Bazaar
Attended by:	Chaudhry Manzoor Shah Chaudhry Mushtaq Ahmed Chadhry Shareef Mirza Shaban Haji Akram Gulfaraz Mughal Raja Saudagar Muhammad Yaseen Liaquat Shah Muhammad Banaris Muhammad Iqbal

	Sabar Ali Qurban Hussain Arshad Hussain Muhammad Hussain
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Accidents can occur due to increased heavy vehicular traffic due to dam activities. Adequate expansion of roads should be carried out to reduce accident risks	Mushtaq Ahmed	Concern noted
2.	Road bends are too sharp in the area and they should be widened if possible	Manzoor Shah	Concern noted
3.	Affect on recreational fishing should be minimised	Manzoor Shah	Concern noted
4.	Many prople depend on sand mining for livelihood in the local area. If there will be any impact, alternate mining sites should be provided by the company	Gulfaraz Mughal	Concern noted
5.	Stagnant water in the reservoir may increase pests and diseases. Appropriate mitiation measures should be taken by the company to minimise impact.	Sabar Ali	Concern noted

Stakeholder:	Gulpur (Men)
Date:	February 12, 2014
Time:	10.00 am
Meeting Venue:	Gulpur Bazaar
Attended by:	Waqar Ahmed Aftab Arif Yasir Shah Rasheed Raja

	Chaudhry Latif Arshad Butt Syed Zeeshan Ali Muhammad Ilyas Raja Rameez Raja Ishtiaq Muhammad Bashir Asadullah Khan Lal Muhammad Muhammad Ali Amjad Khan Afzaal Ahmed Ghafoor Ahmed Muhammad Aslam Wajid Hussain Muhammas Asif Wajid Hussain Muhammad Asif Haider Hafeez Muhammad Shahzad Tauqeer Hussain Aqeel Ahmed Farooq Ahmed Ansar Ahmed Raqib Asif Shah
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Rehman Bridge’s saftey might be affected due to change in flows	Raja Ishtiaq	Concern noted
2.	Local people have transport companies and they should be provided business during dam construction	Chaudhry Latif	Concern noted

No.	*Issues Raised*	*By*	*Response Provided*
3.	Free or discounted elctricity should be provided to the village.	Aqeel Ahmed	Concern noted
4.	Fencing area for the dam should be minimum and affet on people's mobility should be limited	Haider Hafeez	Concern noted

Others:

People were happy on the fact that the project was named after their village. They believed that a hydropower project in their area will bring means of employment and promote development of the area.

Stakeholder:	Barali (Men)
Date:	February 15, 2014
Time:	10.00 am
Meeting Venue:	Residence of Muhammad Siddiq
Attended by:	Haji Muhammad Siddiq Chaudhry Muhammad Qayyum Haji Muhammad Rafiq Muhammad Latif Chaudhry Abdul Rehman Abdul Majeed Maqbool Azad Ahmed Aneel Siddiqui
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	If any land is flooded by the reservoir, adequate compensation should be provided to the land owners	Muhammad Siddiq	Concern noted
2.	If any sand mining sites are flooded by the reservoir, alternate means of employment should be given to those whose livelihoods are affected	Abdul Rehman	Concern noted
3.	The name of the project should be changed from Gulpur Hydropower Project to Barali Hydropower Project	Aneel Siddiqui	Concern noted
4.	Dam saftefy will be of serious concern in case of floods	Muhammaz Siddiq	Concern noted

Stakeholder:	Paghwari (Men)
Date:	February 15, 2014
Time:	10.00 am
Meeting Venue:	Residence of Muhammad Liaqat
Attended by:	Muhammad Liaqat Muhammad Haneef Muhammad Azam Abdul Rahoof Muhammad Gulfam Muhammad Zareem Fazal Ahmed Liaqat Hussain Muhammad Shafiq Iftikhar Ahmed Sehran Ahmed Yasin Haneef Haseeb Haneef Sobidar Khadam Waqas Altaf
Conducted by:	Rashid Khan (RK), Public Consultation Consultant, HBP Hussain Ali (HA), Public Consultation Consultant, HBP
Recorded by:	Muhammad Arshad (MA), Public Consultation Consultant, HBP
Language:	Urdu
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project and the dam location and design. Mr Rashid Khan briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained in Urdu. At the end of the informative session, Mr Khan invited the participants to express or share their concerns. The issues raised are discussed below with responses given.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Loss of livelihood due to limited sand mining sites should be compensated by alternate means of employment	Muhamam d Azam	Concern noted
2.	Preference should be given to fulfill the electricity demand in AJK	Fazal Ahmed	Concern noted

Environmental and Social Assessment of Gulpur Hydropower Project
Mira Power Ltd (MPL)

Record of the Consultation Meeting

Stakeholder:	Aghar (Women)
Date:	February 08, 2014
Time:	09:30 am
Meeting Venue:	Residence of Naseem Iqbal
Attended by:	Naseem Iqbal (NI) Shumaila Asif (SA) Safina Kausar (SK) Asia Kasim (AK) Samina Kausar (SM) Safina Nawaz (SF) Salman Iqbal (SI) Naseem Kabir (NK)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project. Ms Sana Rasool briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained to attendees. At the end of the informative session, Ms Sana invited the participants to express or share their concerns about the project. The issues raised are discussed below with responses given by concerned persons.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Sand and Gravel mining businesses may be affected negatively. We do not want that to happen.	NK	Concern noted.
2.	Some women wash clothes at the river bend where project site is located. Our activity will be affected by the construction of this dam.	AK	Concern noted.

Others:

Female residents of the village were generally satisfied with the project and did not note any serious threat.

Stakeholder:	Kohali (Women)
Date:	February 09, 2014
Time:	09:45 am
Meeting Venue:	Residence of Saima Rasheed
Attended by:	Saima Rasheed (SR) Jannat Khatoon (JK) Zareena Kausar (ZK) Shakeela Rasheed (SH) Zaheen Nazik (ZN) Abbrit Raisat (AR) Shanaz Akhtar (SA) Khalida Nazim (KN) Sakina Nazim (SZ) Shazia Amjad (SA) Manir Begum (MB) Nazia Shokat (NZ) Sehrish Zafar (SZ) Nasih Javaid (NJ) Faiza Kausar (FK) Saika Kausar (SK) Rabia Kausar (RK) Bilqees Begum (BB) Yasmeen (YM) Zainab (ZB) Naveeda (NV) Gulshan (GL) Resham Bibi (RB) Saira Bashir (SB) Khatoon Begum (KH)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The briefing was conducted at various houses in the village as all women could not gather at a single house. Briefing started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP). Ms Sana Rasool briefed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. The main points of the BID were verbally explained to attendees. At the end of the informative session, Ms Sana invited the participants to express or share their concerns.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Dam construction and reservoir may affect some houses, in which case affected persons desire compensation.	JK	Concern noted.
2.	In summers there is no water in streams so people use river water through pumps. Due to the dam, flow in river will	SR	Concern noted.

No.	*Issues Raised*	*By*	*Response Provided*
	decrease, causing problems for the community in Summers.		
3.	Our family recreational activities should not be affected.	SR	Concern noted.
4.	Sand and gravel mining are our sources of income. These activities should be allowed on the river.	MB	Concern noted.
5.	The water should not come to this village at any time during construction or operation?	KN	Concern noted.
6.	Village community uses wood from the area around the river. Access to wood should be allowed during and after construction of dam.	JK	Concern noted.
7.	Some representatives of the project construction team promised a road through the village but there is silence on the issue now.	KN	Concern noted.

Others:

Generally, the women did not object to the construction or operation of the dam however, they were worried about their land and houses being adversely affected by the carrying river flow. Women also desired that the constructing company should provide a proper road network in their village.

Stakeholder:	Biyalian (Women)
Date:	February 09, 2014
Time:	3:10 pm
Meeting Venue:	Residence of Bilqees Begum
Attended by:	Shaoor Begum (SB) Bilqees Begum (BB) Gulshan Begum (GB) Sehrish Begum (SH) Nabeela Begum (NB) Tabassum Begum (TB) Muqqadas Begum (MB) Faziah Liaqat (FL) Naila Begum (NA) Javeria (JV)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP). Ms Sana Rasool briefed on the ESIA of the Gulpur Hydropower Project and the purpose of the meeting. She gave a comprehensive description of the project with the help of posters. At the end of the informative session, Ms Sana invited the participants to express or share their concerns.

No.	*Issues Raised*	*By*	*Response Provided*	*Required Action*
1.	Community’s land should not be affected by the dam in any way.	SB	Concern noted.	
2.	Community should be given free electricity.	NB	Concern noted.	

Others:

The women were contended with the construction of the dam and expressed the desire to be given priority during supply of electricity and necessary provisions such as road, school, dispensary etc.

Stakeholder:	Naroch (Women)
Date:	February 10, 2014
Time:	09:20 am
Meeting Venue:	Residence of Rasheeda Begum
Attended by:	Rasheeda Begum (RB) Marium Ali Akbar (MA) Alizah Munir (AM) Sehrish Khadim (SK) Dana Begum (DB) Shahida Perveen (SP) Shahida Tufail (ST) Jamshaid Begum (JB) Abida Khatoon (AK) Shamsa Ishfaq (SI) Yasmeen Akhtar (YA) Tayyaba Fatima (TB) Fazal Bibi (FB) Kuwaait Begum (KB) Ismat Bibi (IB) Saeeda Akhtar (SA) Barik Bibi (BB) Rizwana Kausar (RK) Sarwar Jan (SJ) Shakeela Kausar (SH)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion commenced with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) who briefed on the ESIA of the Gulpur Hydropower Project. Ms Sana Rasool informed the participants about the purpose of the meeting and gave a comprehensive description of the project with the help of posters. At the end of the informative session, Ms Sana invited the participants to express or share their concerns.

No.	Issues Raised	By	Response Provided
1.	Community's land should not be affected by the dam in any way.	RB	Concern noted.
2,.	Women should be given employment during the construction and operation phases of project.	RB	Concern noted.

Others:

The women were contended with the construction of the dam and expressed the desire to be given employment along with men, during construction and operation phases. Generally, the women expressed joy at the construction of Gulpur dam and saw this as an opportunity for economic development in the area.

Stakeholder:	Rehmani Mohala (Women)
Date:	February 10, 2014
Time:	3:00 pm
Meeting Venue:	Residence of Raj Muhammad
Attended by:	Nusrat Perveen (NP) Manzoor Begum (MB) Shahida Perveen (SP) Yasmeen Bibi (YB) Zareena Bibi (ZB) Naheeda Gul (NB) Munir Begum (MU) Shazia Abid (SA) Zahra Khatoon (ZK) Nasreen Begum (NS)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP). Ms Sana Rasool briefed on the ESIA of the Gulpur Hydropower Project and the purpose of the meeting. She gave a comprehensive description of the project with the help of posters. At the end of the informative session, Ms Sana invited the participants to express or share their concerns.

No.	Issues Raised	By	Response Provided
1.	Community's land should not be affected by the dam in any way.	NP	Concern noted.
2.	Community should be given free electricity.	MU	Concern noted.
3.	Women move in the village during daytime. Camp construction will limit this activity.	NP	Concern noted.
4.	Road, school and dispensary are needed in the	NP	Concern noted.

No.	Issues Raised	By	Response Provided
	village. Construction company should provide these resources.		
5.	The reservoir may extend into our territory and damage the roots of constructed infrastructure in the city,	NP	Concern noted.

Others:

Women expressed a major concern about the presence of Camp Area immediately adjacent to their village and desired the camp location to be moved away from their residences as women worked there in the daytime and did not want their movement to be restricted due to the camp. Land was another major concern with the women as they did not want to be disturbed by the construction and operation of the dam.

Stakeholder:	Hill Kalan (Women)
Date:	February 11, 2014
Time:	12:30 pm
Meeting Venue:	Residence of Murshid Hanif
Attended by:	Khadija Bibi (KB) Isba Kausar (IK) Saira Fatima (SF) Misqeen Akhtar (MA) Rubina Kausar (RK) Haleema Sadia (HS) Shufaida Begum (SH) Saima Bibi (SB) Kulsum (KL) Azra Bibi (AB) Saeeda Bibi (SA) Saiqa Bibi (SQ) Erum Mushtaq (EM) Ashmeen Kausar (AK) Tahira Nazik (TN) Zaroon Fatima (ZF) Rasheeda Begum (RB) Rubina (RU) Anika Shakoor (AS) Saira Fatima (SF) Maria Shafiq (MS) Nadia Hafiz (NH) Mehwish Taraqat (MT) Saba Kausar (SK) Nosheen Basharat (NB)

Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion commenced with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP). Ms Sana Rasool informed the attendees about the ESIA of the Gulpur Hydropower Project and the purpose of the meeting. She gave a comprehensive description of the project and verbally explained salient points of the BID. At the end of the informative session, Ms Sana invited the participants to express or share their concerns. These concerns are presented below:

No.	*Issues Raised*	*By*	*Response Provided*
1.	Route to the river will be blocked and women may have no way of approaching the river,	NP	Concern noted.
2.	The dam will block the flow of water and community land will be submerged in rain water if that happens.	MU	Concern noted.
3.	The vilalge women requested the dam construction company to construct a bridge in their village.	NP	Concern noted.
4.	A dispensary and school is needed in the village.	NP	Concern noted.
5.	Indecisive stage of construction and cosntant changes in the dam design make the community agitated and disturbed as they cannot plan any personal construction or rennovation projects on their lands.	SF	Concern noted.
6.	Women should be given employment during the construction and operation phases of the project.	SF	Concern noted.
7.	The community wants free electricity from the dam, for the sacrifices and hardships that may be faced during its construction.	TN	Concern noted.
8.	Dam will cause flooding of the village during heavy monsoon seasons.	RU	Concern noted.

Others:

The women were concerned about the impact of dam construction on village land, especially in the monsoon season when chances of flooding are high. They also showed reservations regarding ancestral graveyards in the area and wished that the construction company should provide facilities such as bridges, dispensary, schools etc. in their village.

Stakeholder:	Kameli (Women)
Date:	February 11, 2014
Time:	5:00 pm
Meeting Venue:	Residence of Hafiz Nazik

Attended by:	Huma Tayyaba (HT) Irum Gul (IG) Alia Kausar (AK) Shahreen Kausar (SK) Kaniz Fatima (KF) Faiza Kausar (FK) Farmeed Akhtar (FA)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	Ms Sana Rasool briefed the attendees on the ESIA of the Gulpur Hydropower Project and the purpose of the meeting, after introducing the team from Hagler Bailly Pakistan (HBP) and the purpose of the visit. She gave a comprehensive description of the project with the help of posters. Salient points of the BID were communicated to attendees and they were requested to inform other community women of the same. At the end of the briefing session, Ms Sana invited the participants to express and share their concerns, which are recorded below:

No.	*Issues Raised*	*By*	*Response Provided*
1.	The village community is happy with the construction of dam as long as it does not affect people's livelihood in negative ways.	NP	Concern noted.

Others:

Generally, the women of Kameli encouraged construction of the dam in the vicinity of their village and believed that the project will bring economic development and educational opportunities to their area. They noted that an raise in living standards is likely, due to this project.

Stakeholder:	Rajdhani (Women)
Date:	February 12, 2014
Time:	11:00 am
Meeting Venue:	Girls Higher Secondary School Rajdhani, Residence of Rubina Kausar
Attended by:	Zainab Kausar (ZK) Zubaida Kausar (ZB) Shamim Akhtar (SA) Ghulam Fatima (GF) Azmat Nisar (AN) Jamila Nisar (JN) Shaheen Mughal (SM) Anila Mushtaq (AM) Shamila Andleeb (SM) Mubarqa Rani (MR)

	Shafina Akhtar (SA) Kafla Andleeb (KA) Rubina Kausar (RK) Razia (RZ) Zarda Begum (ZB) Fauzia Kausar (FK)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion was conducted at two locations; the Girls Higher Secondary School Rajdhani and residence of Rubina Kausar. Ms Sana Rasool introduced the public consultation team from Hagler Bailly Pakistan (HBP). She briefed the attendees on the ESIA of the Gulpur Hydropower Project and the purpose of the meeting. The project was explained to the women using posters and BID was verbally communicated to them. At the end of the session, Ms Sana invited the participants to express or share their concerns.

No.	*Issues Raised*	*By*	*Response Provided*	*Required Action*
1.	Electricity is a major problem in this village. When Mangla was constructed, load shedding increased instead of decreasing. Gulpur dam should not follw that pattern.	SM	Concern noted.	
2.	Sui Gas supply in the village is desired. The construction company may accommodate the provision of Sui Gas in Rajdhani.	SA	Concern noted.	
3.	Women should also be given employment during the construction and opertion of the dam.	NP	Concern noted.	
4.	A hospital is needed in Rajdhani	ZK	Concern noted.	
5.	A ladies hostel should be built in the village.	AN	Concern noted.	

Others:

The women showed no major reservation towards the construction of the dam and were enthusiastic about economic development and better educational opportunities in their community.

takeholder:	Gulpur (Women)
Date:	February 13, 2014
Time:	10:00 am
Meeting Venue:	Girls Higher Secondary School Gulpur, Residence of Fazal Naseem
Attended by:	Noreen Ilmas (NI) Sehrish Mehfooz (SM) Musarat Jabeen (MJ)

	Shamim Akhtar (SA) Zaqdees Shamim (ZS) Rehana Siddiqui (RS) Tasneem Kausar (TK) Khalida Begum (KB) Sumbal Ghias (SG) Shahida (SH) Salma Rashid (SR) Tazim Akbar (TA) Maryam Siddiqa (MS) Asia Rehman (AR) Rukhsana (RK) Sadia Anwar (SA) Abida Batool (AB) Taskeen Fatima (TF) Hajrah Qadri (HQ) Naseem Akhtar (NA) Shaheen Akhtar (SK) Fazal Naseem (FN) Khalida Arzak (KA) Wallait Bibi (WB) Naeem Akhtar (NA) Shabana Rafique (SR) Zainab Ghulam (ZG) Jamila Ghulam (JG) Salma Latif (SL) Uzma Kausar (UK) Aneela (AN) Shamim Akhtar (SM)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	Ms. Sana Rasool introduced the Gulpur Hydropower Project to the faculty of Gilrs Higher Secondary School Gulpur and informed them about the purposed ot Hagler Bailly team's visit. She verbally explained the project and its impacts to the locals using posters and the BID. At the end of the informative session, Ms Sana invited the participants to express or share their concerns.

No.	*Issues Raised*	*By*	*Response Provided*	*Required Action*
1.	Hospital is urgently needed in the village.	NA	Concern noted.	
2.	The construction company should construct roads through the village.	SA	Concern noted.	
3.	Sui Gas should be supplied by the company to village locals.	TK	Concern noted.	

No.	Issues Raised	By	Response Provided	Required Action
4.	Women should be given employment during the construction and operation phases of the dam.	NA	Concern noted.	
5.	Some village locals have sand mining businesses along the river. They should be provided alternative locations for continuing their business.	KA	Concern noted.	
6.	The tunnels constructed for the dam should not be filled after construction phase is complete. Instead they should be used for transportation.	HQ	Concern noted.	
7.	Water availability is a major problem in the village.	FN	Concern noted.	

Others:

Women were content with the construction of the dam in the vicinity of their village and were willing to support the construction of the project.

Stakeholder:	Barali (Women)
Date:	February 15, 2014
Time:	11:37 am
Meeting Venue:	Residence of Fehmeeda Rehman
Attended by:	Fehmeeda Rehman (FR) Sobia Saddiqi (SS) Tasveer Begum (TB) Naseem Begum (NB) Anwar Begum (AB) Begum Jan (BJ) Rasheed Begum (RB) Nazia Siddiqui (NS) Badra Khatoon (BK) Kesar Bibi (KB) Khatoon Begum (KH) Nabeela (NA) Wasia Kausar (WK) Shaista Kausar (SK)
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	Ms Sana Rasool introduced the Hagler Bailly Pakistan team and the Gupur Hydropower Project to the participants. She used project posters and verbally communicated the salient points of the BID to the women present during consulation session. The women were requested to pass the information to other women in the locality. The concerns voiced by community women were noted and are presented below:

No.	Issues Raised	By	Response Provided	Required Action
1.	The village has all necessary commodities.	FR	Concern noted.	
2.	Women should also be given employment, along with men in the area.	WK	Concern noted.	
3.	A specialist gaenecologist ward will help improve the health condition of women in the area.	SK	Concern noted.	
4.	Load shedding is a major nusisance and Gulpur dam is expected to eradicate the problem once and for all.	WK	Concern noted.	
5.	Tourism should be developed in these areas and the natural scenery should be developed to attract foreign tourists.	FR	Concern noted.	

Others:

Women were content with the construction of the dam and expressed desire to play an active role in the construction and operataion of the dam through office employment at the camp site offices.

Stakeholder:	Pagwari (Women)
Date:	February 17, 2014
Time:	11:10 am
Meeting Venue:	Residence of Ajra Riaz
Attended by:	Ulfat Bibi Ajra Riaz Tauseen Saqib Naila Naveed Farah Naheed Sana Liaqat Perveen Akhtar Naseem Akhtar Nazmeen Akhtar Khadija Begum Kausar Riaz Maqsood Bibi Farooq Bibi
Conducted by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Recorded by:	Sana Rasool (SN), Public Consultation Consultant, HBP
Language:	Urdu, Pahari
Information Provided:	The discussion started with the introduction of the public consultation team from Hagler Bailly Pakistan (HBP) and the Gulpur Hydropower Project. Ms Sana Rasool briefed on the ESIA of the Project and the purpose of the meeting. She gave a comprehensive description of the project with the help of posters and BID. At the end of the informative session, Ms Sana invited the participants to express or share their concerns.

No.	*Issues Raised*	*By*	*Response Provided*
1.	Women do not object to the construction of the dam as it will bring economic prosperity to the area.	UB	Concern noted.
2.	Women education should be given priority by the dam construction company.	AR	Concern noted.
3.	Chances of accidents at the river may increase if dam is constructed.	UB	Concern noted.

Others:

The women of Pagwari expressed full support for the construction of Gulpur Hydropower Project. They were of the view that the dam will bring economic prosperity and employment opportunities to their village, which signifies an improved living standard.

J.1 Presentation Given to Stakeholders

J.2 Background Information Document

J.3 Attendance Sheets

See following pages

Gulpur Hydropower Project

February 26, 2014

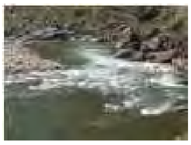
Assessment of Environmental Flows

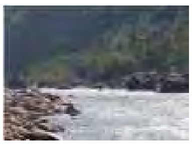
Vaqar Zakaria

River Segments

Poonch River – LoC to Tata Pani


Upstream of Kallar Bridge


Rapids downstream of Kallar Bridge


Rapids downstream of Kallar Bridge


Pool downstream of Kallar Bridge

Poonch River – Tata Pani to Kotli

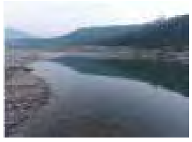

Poonch River at Kotli


View of Kotli town


Rapids on Poonch River


Village

Poonch River – Kotli to Rajdhani


Wide valley and deep pools in Poonch River


Riffles near Gulpur Bridge


Waste dumping area and Egyptian vultures near Rehman Bridge

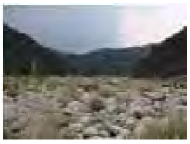

Confluence of Bann Nullah with Poonch river

Poonch River – Rajdhani to Mangla Reservoir

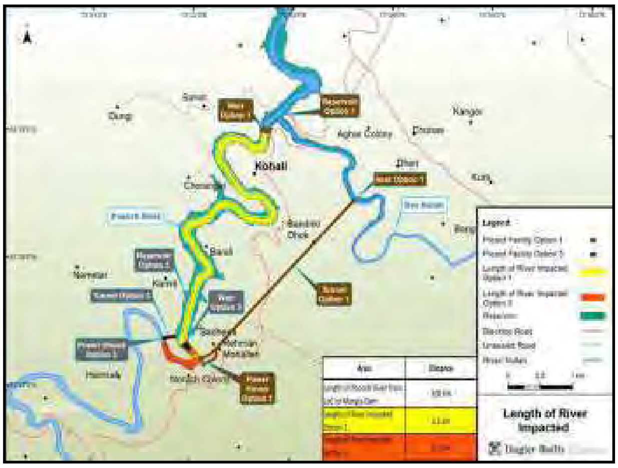

Deep pools and flood plain upstream Billiporian bridge


Wide valley and riffles in Poonch River


Mangla Reservoir


Billiporian Bridge

Project Facilities



Study Team

Name	*Organisation*	*Position on team*
Mr Vaqar Zakaria	Hagler-Bailly Pakistan	Project Director
Dr Cate Brown	Southern Waters	EF Task Leader
Dr Alison Joubert	Southern Waters	DRIFT DSS
Dr Mehr Ali Shah	NESPAK	Hydrology
Dr Andrew Birkhead	Streamflow Solutions	Hydraulic and scenario modeling
Dr Mohammed Rafique	Sub Hagler-Bailly Pakistan	Fish ecology
Mr Mark Rountree	Fluvius Consultants	Geomorphology
Ms Fareeha Irfan Ovais	Sub Hagler-Bailly Pakistan	Manager
Mishkatullah	Sub Hagler-Bailly Pakistan	Macroinvertebrates
Mr Hussain Ali	Hagler-Bailly Pakistan	Field work and data collation
Dr Jackie King	Water Matters	Quality control

Aquatic Study

Fish Baseline – Indicator Species

Tor putitora

Labeo dyocheilus

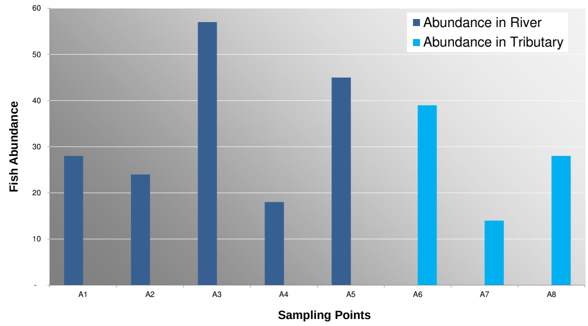
Schizothorax plagiostomus

Botia rostrata

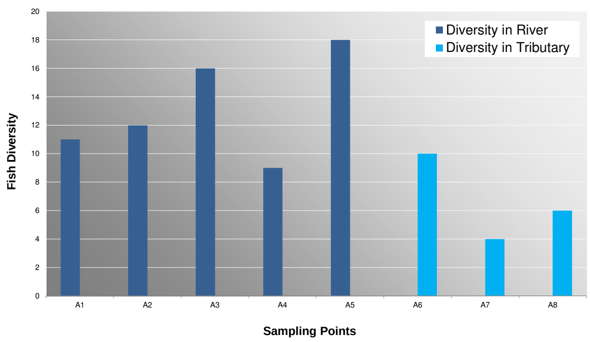
Clupisoma garua

Glyptothorax kashmirensis

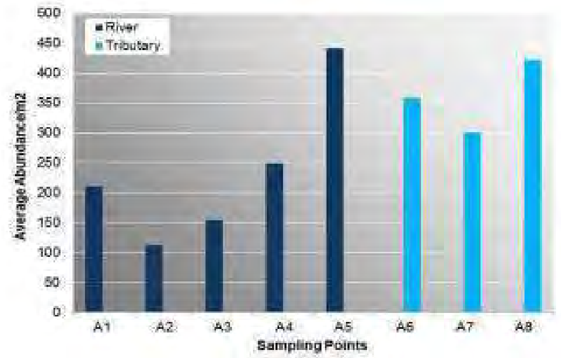
Fish Abundance in Poonch River - October 2013 Survey



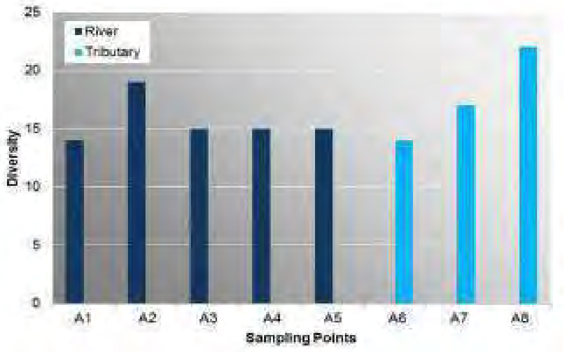
Fish Diversity in Poonch River - October 2013 Survey



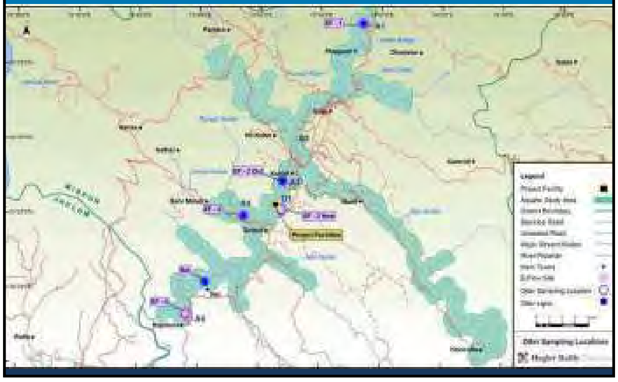
Abundance of Macro-invertebrates October 2013 Survey



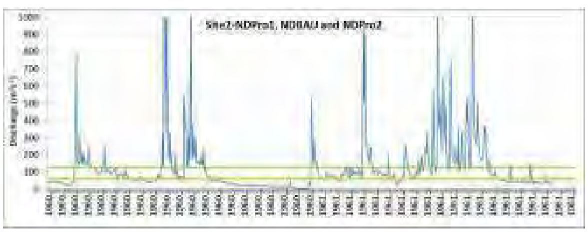
Diversity of Macro-invertebrates
October 2013 Survey



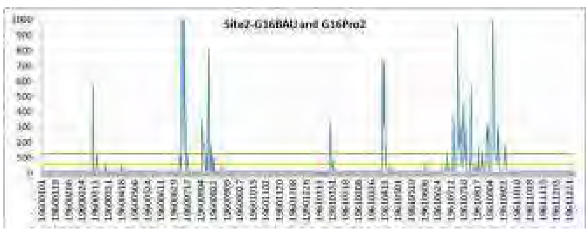
Otter Sampling Locations



Flows at EF Site 2 with no Dam in Place



Flows at EF Site 2 with Gulpur HPP in place, a dry-season release of 16 m3s-1 and spills



Definition of Present Ecological State

Ecological Category	PES % Score	Description of the Habitat
A	90-100%	Still in a Reference Condition.
B	80-90%	Slightly modified from the Reference Condition. A small change has taken place, but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified from the Reference Condition. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified from the Reference Condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	20-40%	Seriously modified from the Reference Condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically/extremely modified from the Reference Condition. The system has been critically modified with an almost complete loss of natural habitat and biota

EFlow Sites

Present Ecological Status of EF Sites

EF Site No.	Site	Description	Present Ecological State
1	Kallar Bridge	Situated upstream of the full supply level of the reservoir.	C
2	Borali Bridge	Situated between the weir and the tailrace	C
3	Gulpur Bridge	Situated c. 7 km downstream of the tailrace.	C
4	Billiporian Bridge	Situated c. 16 km downstream of the tailrace, c. 12 km upstream of the full supply level of Mangla Dam.	C

Hydraulic and Geomorphology Indicators

Hydraulics	Minimum 5-day dry season fish breeding habitat
	Depth
	Minimum 5-day average velocity (across the cross-section)
Geomorphology	Active channel width
	Area of silt/mixed bars (regardless of level of inundation)
	Area of cobble bars (regardless of level of inundation)
	Median bed sediment size (armouring)
	Depth of pools
	Area of secondary channels and backwaters
	Suspended sediment load.

Hydrology Indicators

- Mean annual runoff
- Dry season onset
- Dry season minimum 5-day discharge
- Dry season duration
- Dry season average daily volume
- Wet season onset
- Wet season maximum 5-day discharge
- Wet season duration
- Wet season flood volume
- Wet season minimum instantaneous discharge
- Transition 1 maximum instantaneous discharge
- Transition 2 average daily volume

Fish and Wildlife Indicators

Fish	Pakistani labeo
	Mahaseer
	Twin-banded loach
	Kashmir catfish
	Garua bachwaa
	Snow trout
Wildlife	Fish-eating wildlife (Otter, common leopard)
	Wildlife that drink from the main river (Barking deer)
	Riverine insectivores (White-capped redstart)

Other Ecological Indicators

Water Quality	Nutrient concentration
	Temperature
Riparian vegetation	Dry bank trees and shrubs
Algae	Periphyton biomass
Macro-invertebrates	Simuliidae
	EPT biomass

Socioeconomic Uses of River

Management Issues (Non-flow Related)

- Selective Fishing Pressure
- Non-selective Fishing Pressure
- Mining – Sand and Gravel
- Mining – Cobble and Boulder
- Water Quality

Protection Scenarios

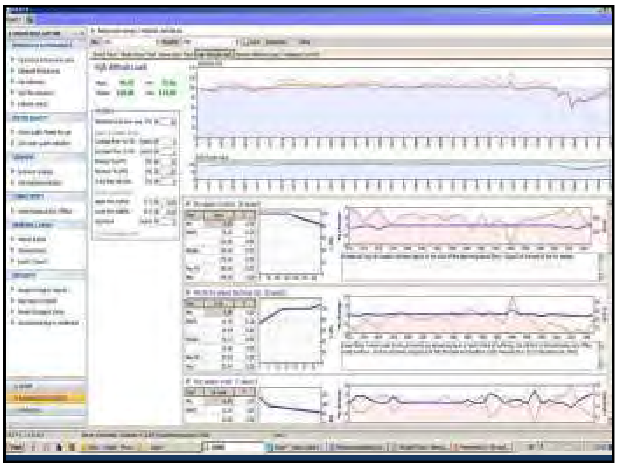
- Protection Level 1 (**Pro 1**) = maintain 2013 pressure levels on the river; i.e., no increase in human-induced pressures over time
- Protection Level 2 (**Pro** 2) = reduce 2013 levels of pressures by 50%, i.e., decline in pressures (relative to 2013) over time
- Business as usual (**BAU**) = - increase pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years.

Scenarios Simulated

- **NDPro1:** No dam in place; Protection Level 1
- **NDBAU:** No dam in place; Protection Level BAU
- **NDPro2:** No dam in place; Protection Level 2
- **G4BAU** A 4 m^3s^{-1} minimum release. Protection level BAU.
- **G4Pro2** A 4 m^3s^{-1} minimum release. Protection Level 2.
- **G8BAU** An 8.0 m^3s^{-1} minimum release. Protection level BAU.
- **G8PeakBAU** An 8.0 m^3s^{-1} minimum release and PEAKING-power releases. Protection level BAU.
- **G8Pro2** An 8.0 m^3s^{-1} minimum release. Protection Level 2.
- **16BAU** A 16 m^3s^{-1} minimum release. Protection level BAU.
- **G16Pro2** A 16 m^3s^{-1} minimum release. Protection Level 2.

Barrier to Fish Movement

- Upstream migration will be halted by the weir, but there will be some downstream movement through the spills.
- The bulk of the tributaries of the Poonch River that are used for breeding by Pakistani Labeo, Mahaseer are located upstream of Gulpur HPP.
- Fish restricted to the lower part of the Poonch River will breed in the main river to some extent
- Pakistani Labeo, Snow Trout and Mahaseer will most likely colonsie the reservoir, which may lead to a slight increase in their populations at EFlow Site 1.
- Bulk of the favoured breeding sites for Garua are located downstream of the Gulpur weir. Garua bachwaa is also unlikely to colonize the reservoir. Thus, it is expected that the population upstream of the dam will be compromised by the weir.



Peaking Operation Discarded

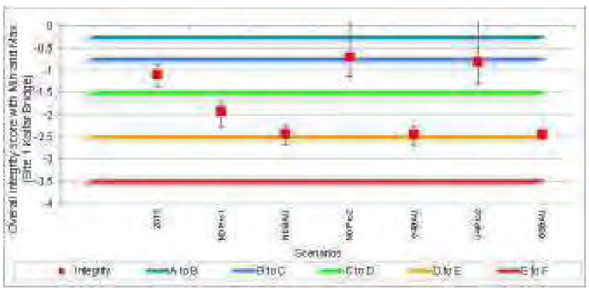
- A peaking operation can be detrimental to the ecology downstream of the dam.
- Low flows normally occur in the section of the river starting just below the dam, to the point where water is added back into the river at the outlet of the of the power house.
- With a peaking operation low flows are extended downstream of the power house as well during the period the power house is shut down to accumulate water in the reservoir upstream.
- The river ecology which is adapted to normal daily and seasonal variations in flows is severely impacted by the daily long dry spells.
- **A peaking operation will result in deterioration starting from a Mid Category C river (Moderately Modified from Reference Condition) to a Mid-Category E river (Seriously Modified) under which the loss of ecosystem functions is extensive.**

Impacts Upstream of the Dam – EFlow Site 1

Indicators	NDPro1	NDBAU	NDPro2	GXBAU	GXBPro2
Pakistani labeo	-64	-86	62	-79	69
Mahasheer	-80	-96	47	-80	80
Twin-banded loach	4	-64	34	-83	23
Kashmir catfish	-3	-62	31	-80	21
Garua bachwaa	-88	-99	-73	-100	8
Snow trout	-24	-40	19	-25	28

NDPro1: No dam in place; Protection Level 1
NDBAU: No dam in place; Protection Level BAU
NDPro2: No dam in place; Protection Level 2
G4BAU A 4 m^3s^{-1} minimum release. Protection level BAU.
G4Pro2 A 4 m^3s^{-1} minimum release. Protection Level 2.
G8BAU An 8.0 m^3s^{-1} minimum release. Protection level BAU.
G8Pro2 An 8.0 m^3s^{-1} minimum release. Protection Level 2.
16BAU A 16 m^3s^{-1} minimum release. Protection level BAU.
G16Pro2 A 16 m^3s^{-1} minimum release. Protection Level 2.

Overall Ecosystem Integrity Upstream of Dam EFlow Site 1



Conclusions: Without Dam in Place 52 Years Later

- With poor protection or Business as Usual (BAU) case, the ecosystem integrity of the river which is presently mid-Category C will deteriorate to a low Category D
- With protection at current levels (Pro1), the river will still deteriorate to a mid-Category D.
- A good level of protection (Pro2) will lead to an improvement of about 0.5 in ecological integrity of the river resulting in low Category B river.
- The conditions are expected to change similarly at all the sites evaluated upstream and downstream the dam.

At EF Site 1 Upstream of the Dam Inundated Area

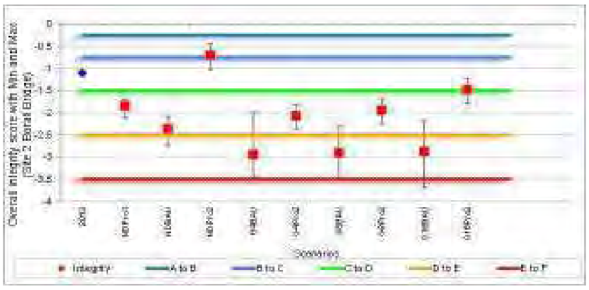
- The ecological integrity and the levels of the indicators evaluated will deteriorate only slightly with dam in place.
- In other words, the barrier effect of the dam as felt upstream of the dam will be minimal under both the business as usual (BAU) and good level of protection (Pro2) protection scenarios.

Impacts Just Downstream of Dam – Low Flow Zone – EFlow Site 2

Indicators	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G16BAU	G16Pro2
Pakistani labeo	-59	-77	58	-100	-26	-99	-5	[illegible]	7
Mahasheer	-55	[illegible]	51	-100	[illegible]	-100	-87	-100	-41
Twin-banded loach	-1	-47	46	-100	-90	-100	[illegible]	[illegible]	-21
Kashmir catfish	-8	-57	15	-100	[illegible]	-100	[illegible]	-97	-54
Garua bachwa	-60	[illegible]	86	-95	[illegible]	-99	[illegible]	[illegible]	-12

NDPro1: No dam in place; Protection Level 1
NDBAU: No dam in place; Protection Level BAU
NDPro2: No dam in place; Protection Level 2
G4BAU A 4 m3s-1 minimum release. Protection level BAU.
G4Pro2 A 4 m3s-1 minimum release. Protection Level 2.
G8BAU An 8.0 m3s-1 minimum release. Protection level BAU.
G8Pro2 An 8.0 m3s-1 minimum release. Protection Level 2.
16BAU A 16 m3s-1 minimum release. Protection level BAU.
G16Pro2 A 16 m3s-1 minimum release. Protection Level 2.

Overall Ecosystem Integrity Just D/Stream of Dam – Low Flow Zone EFlow Site 2



At EF Site 2, Just Downstream of the Dam

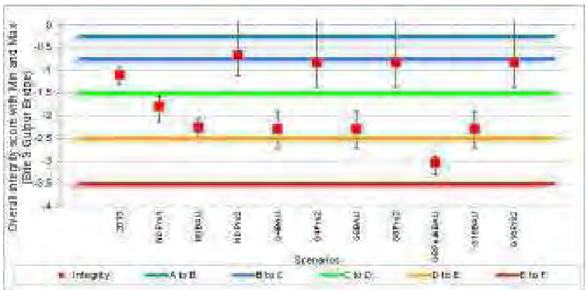
- The river will deteriorate to a mid-Category E under all BAU scenarios. In other words, the impact of poor protection will be far higher than that of the reduced flows, and increasing minimum flow release from 4 cumec to 16 cumec will not result in any significant improvement in the ecological condition of the river.

Impacts Downstream of Tail Race – Eflow Site 3

Indicators	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
Pakistani labeo	-59	[illegible]	59	[illegible]	65	[illegible]	63	[illegible]	[illegible]	63
Mahasheer	-58	[illegible]	51	[illegible]	-8	[illegible]	-8	[illegible]	[illegible]	-8
Twin-banded loach	-1	[illegible]	48	24	[illegible]	24	93	[illegible]	24	93
Kashmir catfish	-8	[illegible]	20	-13	78	-13	78	[illegible]	-13	78
Garua bachwa	[illegible]	[illegible]	[illegible]	-67	67	-67	67	[illegible]	[illegible]	67

NDPro1: No dam in place; Protection Level 1
NDBAU: No dam in place; Protection Level BAU
NDPro2: No dam in place; Protection Level 2
G4BAU: A 4 m3s-1 minimum release. Protection level BAU.
G4Pro2: A 4 m3s-1 minimum release. Protection Level 2.
G8BAU: An 8.0 m3s-1 minimum release. Protection level BAU.
G8Pro2: An 8.0 m3s-1 minimum release. Protection Level 2.
16BAU: A 16 m3s-1 minimum release. Protection level BAU.
G16Pro2: A 16 m3s-1 minimum release. Protection Level 2.

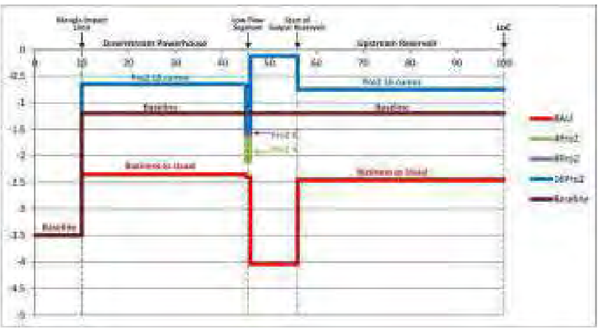
Overall Ecosystem Integrity Downstream of Tailrace EFlow Site 3



At EF Site 3, Downstream of the Power Station

- A peaking operation will result in deterioration to a Mid-Category E river similar to that at EF Site 2 where the flows are reduced.
- Under BAU or poor protection levels, the river will deteriorate to a low Category D under all minimum release scenarios, for reason similar to those indicated for EF Site 2.
- Under Pro2 or good protection levels, the conditions will improve to border line between Category B and C, similar to those at EF Site 1 upstream of the dam**. In other words, the contribution of good protection measures will more than compensate for harm done by the dam.**

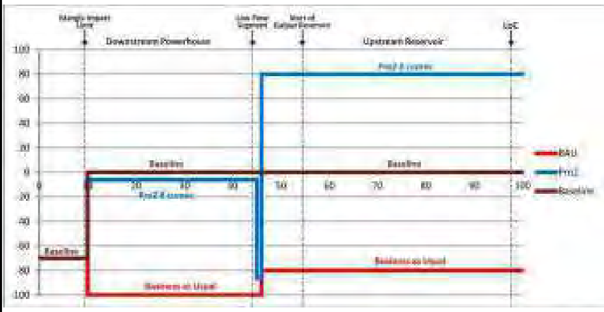
Ecosystem Integrity Along the Length of the River



Impacts on Mahaseer

	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
EF Site 1	-60	-96	47	-80	80	-80	80		80	80
EF Site 2	-55	-91	51	-100	-93	100	87		-100	-41
EF Site 3	-58	-93	51	-100	-6	100	-6	-100	-100	-6

Impact on Mahaseer



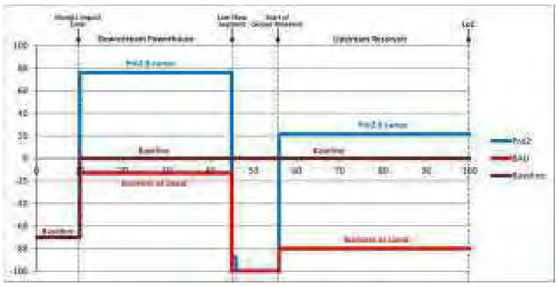
Pakistani Labeo

	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
EF Site 1	-64	-88	62	79	69	79	69		-79	69
EF Site 2	-59	77	58	100	-26	-88	-5		-88	7
EF Site 3	-59	-97	59	-85	63	-86	63	-100	-88	63

Kashmir Catfish

	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
EF Site 1	-3	-62	31	-86	21	-86	21		-80	21
EF Site 2	-8	-57	15	-100	-91	-100	-88		-97	-54
EF Site 3	-8	-56	20	-13	75	-13	75	-100	-13	75

Impact on Kashmir Catfish



Twin Banded Loach

	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
EF Site 1	4	-64	34	-83	23	-83	23		-83	23
EF Site 2	-1	-47	46	-100	-98	-100	-80		-88	-21
EF Site 3	-1	-46	48	24	93	24	93	-100	24	93

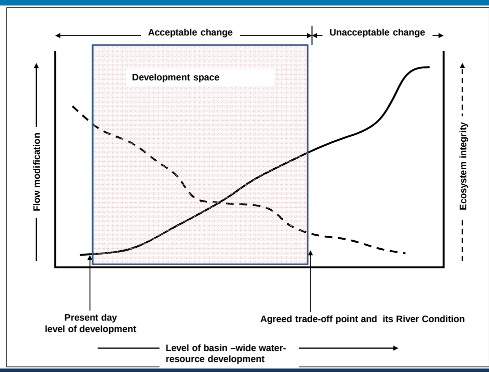
Garua Bachwa

	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
EF Site 1	-68	-99	73	-100	8	-100	8		-100	8
EF Site 2	-60	-95	80	-95	-89	-95	-88		-95	-12
EF Site 3	-60	-92	80	-97	67	-97	67	-100	-97	67

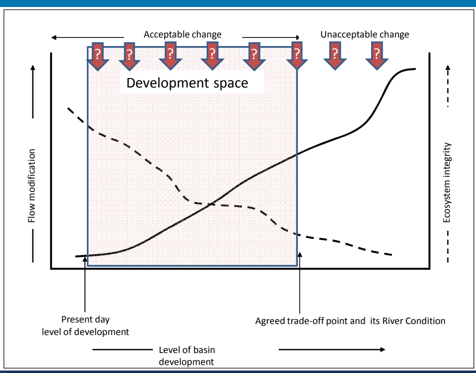
Snow Trout

	NDPro1	NDBAU	NDPro2	G4BAU	G4Pro2	G8BAU	G8Pro2	G8PeakBAU	G16BAU	G16Pro2
EF Site 1	-24	-40	19	-25	29		-25	29	-25	29

The Concept of Development Space



How Scenarios help define the Development Space



January 2014

Background Information Document Environmental Impact Assessment of Gulpur Hydropower Project

Introduction

Mira Power Limited (MPL) is an Independent Power Producer (IPP) developing the Gulpur Hydropower Project in Azad Jammu and Kashmir (AJK). It is a run-of-the-river project being developed in private sector on Build, Own and Operate Basis under Policy for Power Generation Projects 2002 promulgated by the Government of Pakistan (GoP) and adopted by the government of AJK.

MPL has initiated an Environmental Impact Assessment (EIA) to assess the biodiversity impacts, inclusive of terrestrial ecology and ecology of the Poonch River and likely environmental and socioeconomic impacts that may result from Project activities and to mitigate any potential negative impacts. The EIA process and the report will meet national regulations and international environmental guidelines.

MPL has acquired the services of Hagler Bailly Pakistan (HBP) (Pvt.) Ltd. to undertake the EIA study. Southern Waters from South Africa and National Engineering Services Pakistan (NESPAK) are supporting HBP in this study.

As part of the EIA process, consultations are undertaken with communities and institutions that may have interest in the Project or may be affected by the Project (the “Stakeholders”) to record their concerns and to address them in the course of project design and preparation of the EIA. For informed consultations with the Stakeholder, this Background Information Document (BID) has been prepared to provide information on the project design, its setting, EIA process, potential impacts that will be the subject of the study, and the process to be followed for environmental impact assessment.

The BID is subject to changes as further information on some aspects of the Project become available during the course of the EIA.

Project Setting

The Project site is located in the Kotli district of AJK, about 11 km south of Kotli town on the Poonch River, a tributary of Jhelum River. The site is about 167 km from Islamabad and 285 km from Lahore. The project setting is shown in **Exhibit 1**.

The Poonch River originates in the western foothills of Pir Panjal range, in the areas of Neel-Kanth Gali and Jamian Gali. The steep slopes of the Pir Panjal form the upper catchment of this river. It is a small gurgling water channel in this tract and descends along a very steep gradient until it reaches in the foothill areas. The river widens as more and more tributaries from both sides enter into the main river. The upper catchment is covered by dense forests while the vegetation of the middle and lower region is under intense biotic pressure. Poonch River from the line of control to Kotli town has steep slope (6.9-8.3 m/km) and the valley is narrow. Below Kotli, the river gradient is relatively mild (3.7 m/km). The river ultimately joins the Mangla reservoir near Chomukh in Mirpur district of Azad Jammu and Kashmir. The photographs of project area are shown in **Exhibit 2**.

The Poonch is a warm water river and the water temperature approaches 30^{o}C during the summer months At least twenty-nine species of fish are reported from the Poonch River. The River is also the refuge for the Golden Mahseer fish (*Tor putitora*) in Pakistan, which is listed “Endangered” in IUCN Red List of Threatened Species[1] and is an important food and recreational fish. To conserve the Mahseer fish and the other ecological resources of the Poonch River, the AJK Wildlife and Fisheries Department has declared the entire stretch of the Poonch River as National Park.

Project Outline

The Project is a 100 megawatt (MW) power generation facility with annual generation capability of 465 gigawatt-hour (GWh). **Exhibit 3** illustrates the layout of the Project.

The Project will require construction of a 58 meter high weir on the upstream bend of the Poonch River, about 6 km downstream of its confluence with Bann Nullah, a tributary of Poonch River. The intake of the tunnel will be located on the right side near the weir. A surface powerhouse will be located about 1 km downstream of the weir. Two or three tunnels (depending on the number of units chosen), each about 180 m long, will connect the intake to the powerhouse. The water after passing through the powerhouse will be discharged back into the Poonch River.

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[1] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 24 July 2013.

Exhibit 1: Project Setting

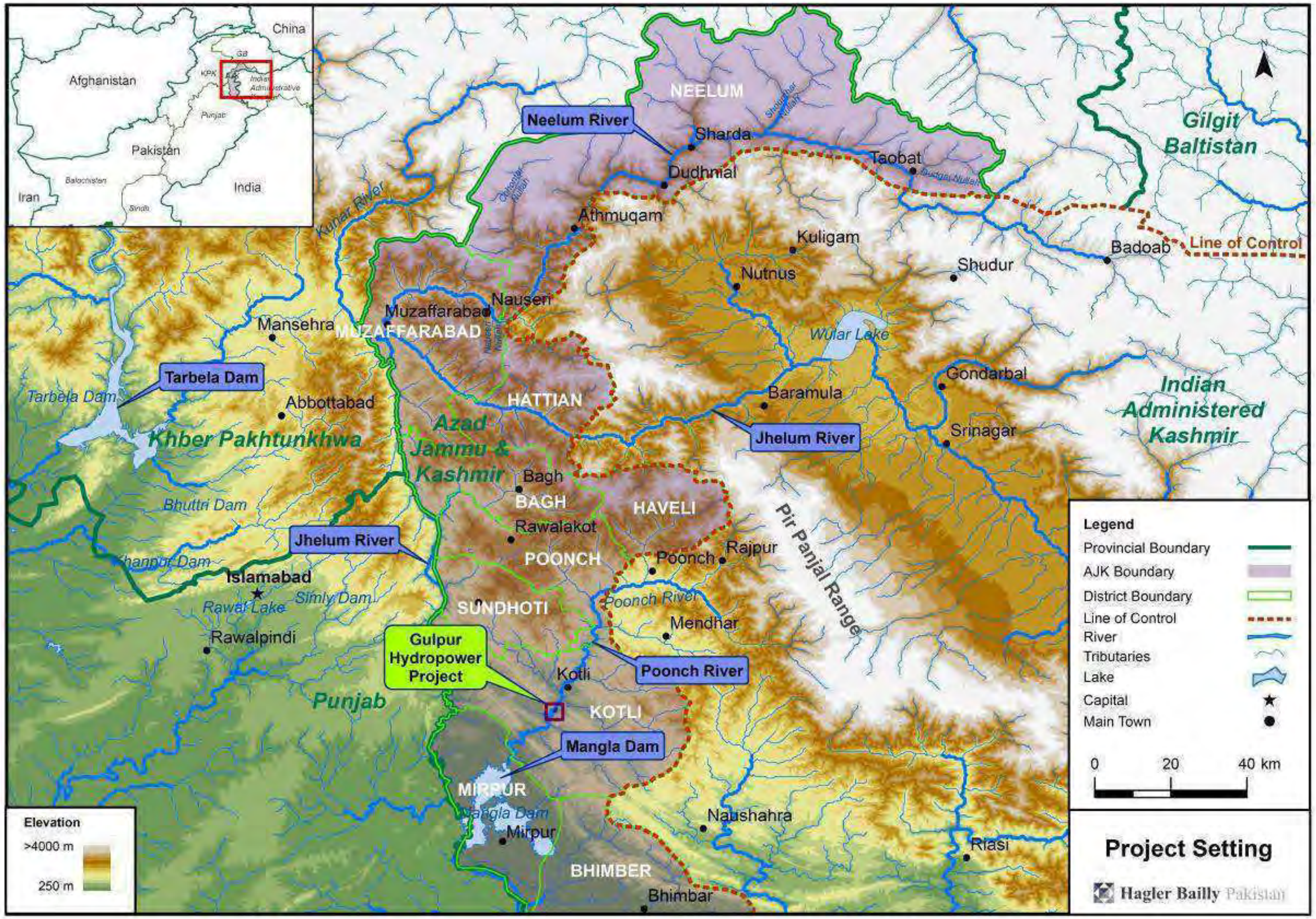
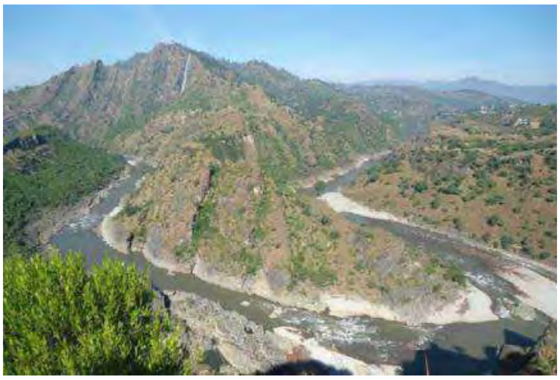


Exhibit 2: Photographs of the Project Area



View of the Project Site

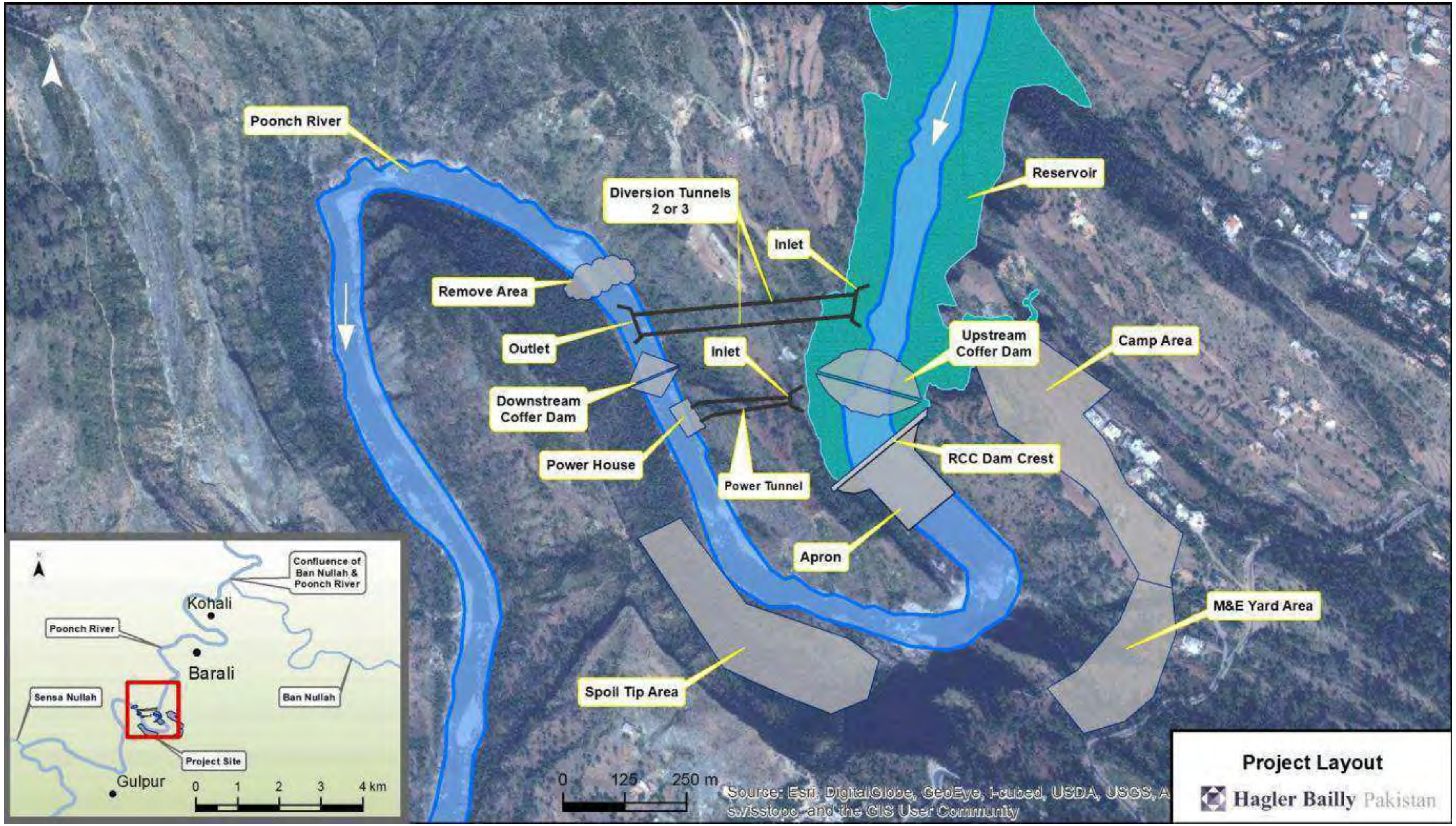
Bann Nullah at Manil

Confluence of Bann Nullah & Poonch River

Poonch River Upstream of Kotli

View of Poonch River at Kotli City

Exhibit 3: Project Layout



Approach to the EIA

The study will be undertaken in compliance with relevant national legislation and international guidelines. The major components of the study include:

- comprehensive baseline studies to characterize the existing ecological environment in the project area;
- a public consultation process to ensure that project stakeholders are informed of the project development plan and have an opportunity to influence it;
- input to the project planning process to ensure that ecological constraints are considered in project design;
- a comprehensive analysis of the ecological impacts of the project, both negative and positive; and,
- suggested mitigation measures to address the identified impacts.

A brief overview of the conceptual components of an EIA process that meets both Pakistan and international standards is given in **Exhibit 4,** whereas the detailed process to be followed for the study of ecological impacts of the Project is provided in **Exhibit 5**. A preliminary list of potential environmental and social impacts of the Project and a list of biodiversity issues that will be investigated during the EIA are provided below.

List of potential environmental and social impacts
• Provision of employment to people
• Creation of service-sector jobs, procurement of consumables and the outsourcing to local service providers.
• Construction related impacts such as noise and dust
• Reduction in power outages and revival of the affected economies
• Increase in traffic due to Project related transportation
• Disturbance due to blasting, dust, noise, vibration, road congestion, and safety hazard from heavy traffic
• Damage to infrastructure due to blasting and noise nuisance due to blasting, drilling and batching plant
• Changes to existing social and cultural norms
• Pressure on existing infrastructure as a result of influx of job seekers
• Impact on sand mining and gravel extraction
• Contamination of soil
• Transformation of landscape
• Physical displacement resulting in disruption of existing socioeconomic setup

List of potential environmental and social impacts
List of biodiversity issues
• Reduction in water quality and quantity
• Changes in sediment load of river
• Changes in the geomorphology of the river
• Fragmentation of fish habitat
• Damage to natural flora and fauna and river ecosystem
• Impact on endangered and migratory species

As impacts on the aquatic ecology due to the project are of critical importance, Hagler Bailly Pakistan (HBP) will employ the DRIFT (Downstream Implications of Flow Transformation) approach to assess the changes in flow regime of the river on fish and other river dependent wildlife. DRIFT is a holistic approach that employs a multidisciplinary team to analyse the likely effects on a range of flow scenarios, and has been tested in Himalayan rivers in the AJK. The DRIFT Process is shown in **Exhibit 6**. Its aim is to predict changes in the form of three streams of information—ecological, economic and social—that represent the three pillars of sustainable development. It incorporates a custom-built Decision Support System (DSS) that holds all the relevant data, understanding and local wisdom about the river provided by the team of river and social specialists.

The four main aims incorporated into the DRIFT process are to:

1) Synthesize present relevant knowledge on the river ecosystem;
2) Synthesize present relevant knowledge on use of the river;
3) Predict how the river ecosystem could change with water-resource development; and
4) Predict how these river changes could affect people and the economy.

Exhibit 4: Conceptual Components of an EIA Process

Component	*Main purpose*	*Activities related to Stakeholder Consultations*
Scoping	▶ Identify the issues on which the EIA should focus. ▶ Identify project alternatives that should be evaluated during the course of the EIA.	▶ Identify institutional and community stakeholders ▶ Engage stakeholders and record issues raised ▶ Provide feedback to the EIA team to incorporate stakeholders' concern in baseline investigations and impact assessment
Baseline investigations	▶ Collect background information on the environmental and social setting of the project.	▶ Incorporate additional issues raised during the baseline survey
Impact assessment, studies	▶ Define the potential impacts of the project ▶ Undertake specialist investigations to predict changes to environment due to the project ▶ Determine the significance of the potential impacts ▶ Identify measures for the management of the impacts ▶ Determine the residual impacts of the project after incorporation of the management measures. ▶ Evaluate the overall acceptability of the project (from environmental and social perspectives).	▶ Assess issues raised by stakeholders
Mitigation Measures and management plan	▶ Environmental mitigation and monitoring plan will describe the measures proposed to ensure implementation of the mitigation measures identified during the impact assessment. It will include, for example, specific designs and plans, training requirements, resource requirements, monitoring details (sampling locations, methodology, and frequency), review and reporting requirements and budget.	▶ Assess the acceptability and practicability of the proposed mitigation measures
EIA Report Preparation	▶ After the studies, the EIA team will pull together the detailed assessment of impacts and mitigation measures. This may involve liaison with various specialists to ensure correct interpretation of information and compile EIA report.	▶ Provide stakeholders with a feedback on the EIA specifically communicate how the project proponent proposes to address the issues raised by the stakeholders.
EIA submittal to regulatory authorities and decision making	▶ Submittal and review of the EIA report by regulatory authorities and other interested stakeholders. The reviewers will inform about their decision on the acceptability of the Project from environmental and social perspectives and the conditions of approval for the development	▶ Attend the public hearings and respond to the issues raised during the public hearings.

Exhibit 5: Detailed Biodiversity Assessment and Management Process

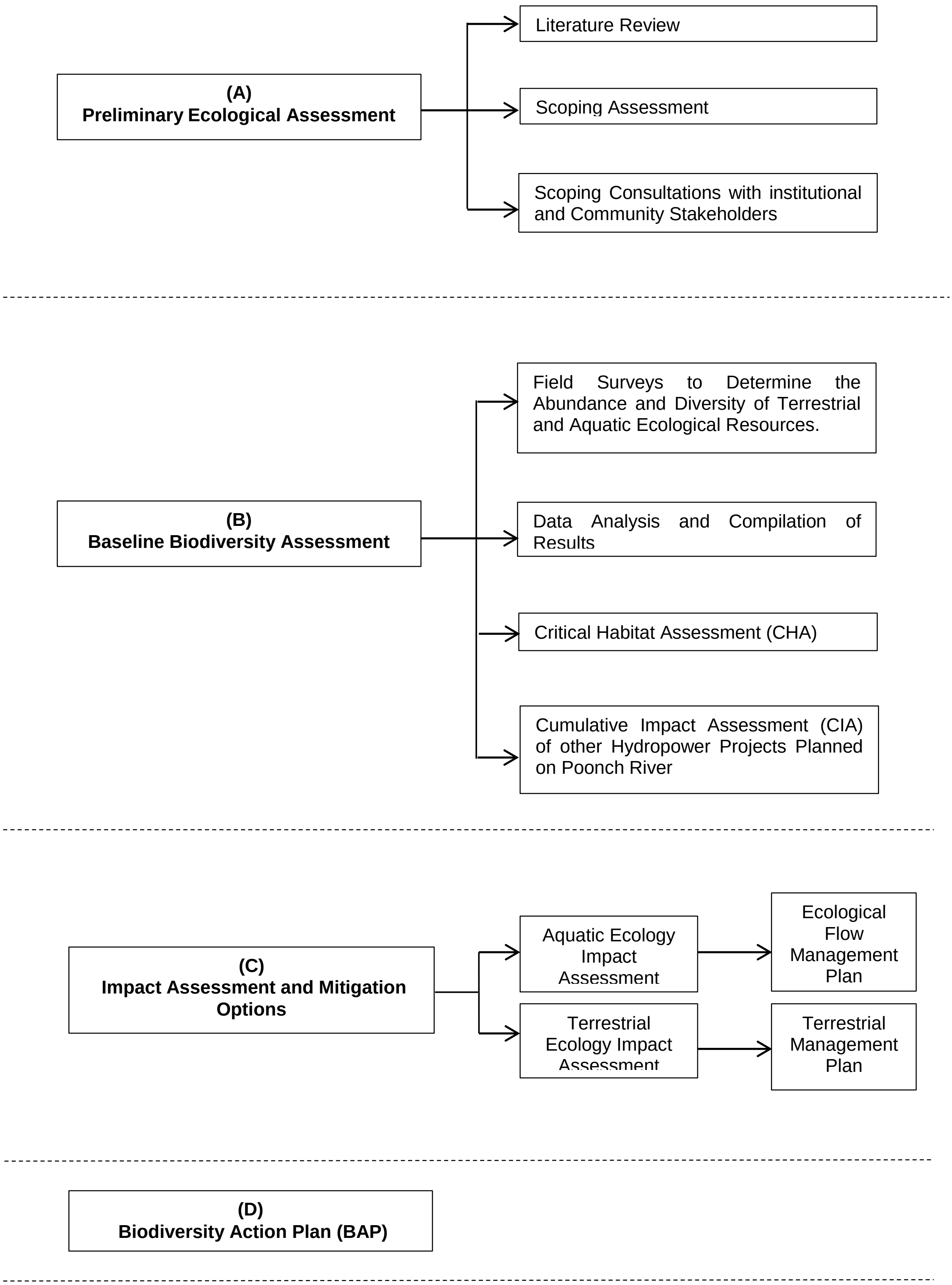
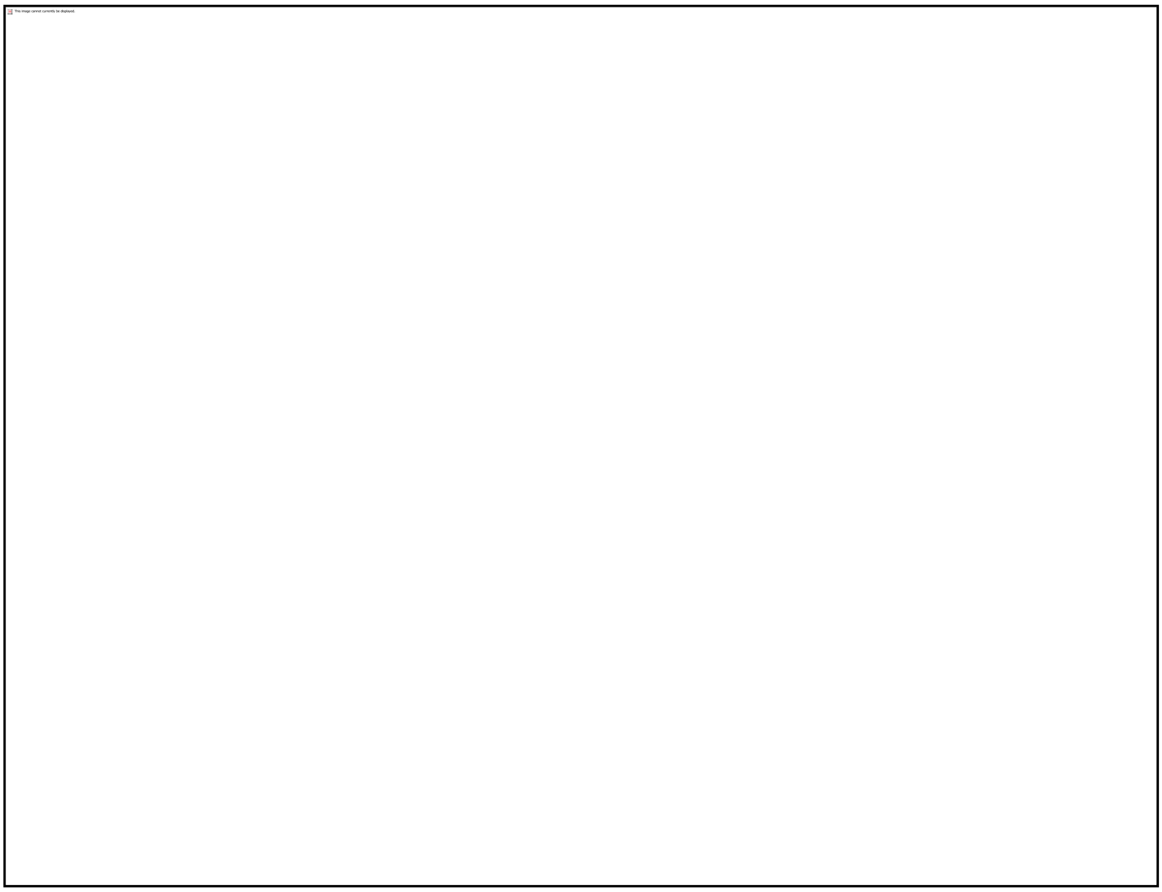


Exhibit 6: DRIFT Process



For further information on the study please contact:

Vaqar Zakaria *Hagler Bailly Pakistan* *39, Street E-7, Islamabad* *Tel: +92 51 261 0200* *Fax: +92 51 261 0208* *Email: vzakaria@haglerbailly.com.pk*	*Fareeha Irfan Ovais* *Hagler Bailly Pakistan* *39, Street E-7, Islamabad* *Tel: +92 51 261 0200* *Fax: +92 51 261 0208* *Email: fovais@haglerbailly.com.pk*

Community Consultation
Attendance Sheet

Settlement Name: Agar (Gulhar) men Coordinates : 32 2948.1, 7355.

Date: February 28, 2014 Time: 9:30 a.m.

No.	Name	Role	Contact Number	Signature
1.	M. Ishaq Janjoha	Govt. Job	0300-5226915	اسحاق
2.	M. Iqbal Janjoha	Business	0341-0053914	محمد اقبال
3.	Abid Azam	Govt. Job	0300-5249029	[illegible]
4.	M. Abdullah	Farmer		عبداللہ
5.	M. Mahfooz	Labour	0344-6927431	محمد محفوظ
6.	Qaisar Majeed	Labour	0343-8507761	قیصر مجید
7.	Waqas Anjum	Business	0342-5547328	Waqas
8.	M. Ismaheel	Farmer		اسماعیل
9.	M. Kabir	Labour	0343-5834231	[illegible]
10.	M. Nawaz	Labour	0345-6615244	[illegible]
11.	M. Nazak	Labour	0344-5160788	نازک
12.	M. Abid	Labour	0346-5717229	عابد
13.	M. Fazial	Labour	0346-7449656	محمد فضل
14.	M. Aamir	Labour	0346-8119293	عامر
15.	Akram Khan	Labour	0344-2831926	اکرم
16.	Nohman Ishaq	Student	0342-5560867	Noman
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Community Consultation
Attendance Sheet

Settlement Name: Agari (women) Coordinates : 32 29 481 73 53 060

Date: February 08, 2014 Time: 9:30

No.	Name	Role	Contact Number	Signature
1.	Naseem Iqbal	Housewife		
2.	Shumaila Asif	Housewife		Shumaila ASIF
3.	Safina Kausar	Housewife		صفینہ کوثر
4.	Asia Kasim	Housewife		Asia
5.	Samina Kausar	Student		Samina
6.	Safina Nawaz	Housewife		
7.	Salma Iqbal	Housewife		Salma
8.	Naseem Kabir	Housewife		
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Community Consultations
Attendance Sheet

Settlement Name: KOHALI (Men) Coordinates: 33 28 40.8
73 52 41.0

Date: February 09, 2014 Time: 9:45 AM

No.	Name	Role	Contact Number	Signature
1.	Zahid Rasheed	Business	0301-8566589	[signature]
2.	Adnan Rasheed	Labour	0306-8486860	[signature]
3.	M. Azam	Labour	03435237491	M. Azam
4.	Abdul Rasheed	Business	0345-8506004	[signature]
5.	M. Nazik	Govt. Servant	0346-5184498	M. Nazik
6.	Javed Iqbal	Milk Serves	03465550511	Javed Iqbal
7.	Rafaqat Hussain	Employ (PVT)	03038800808	[signature]
8.	M. Riasat	Labour/Fish	0346-5727259	—
9.	M. Nazam	Labour	0346-5165136	
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Community Consultation
Attendance Sheet

Settlement Name: Kohali (men) Coordinates : 33 28 40.8, 73 52 41.0

Date: February 09 2014 Time: 01:00 PM

No.	Name	Role	Contact Number	Signature
1.	Mir Zaman Ch	Govt Ser DC Off	03009855151	[signature]
2.		Kotli Rehabilitation		
3.	Abdul Jabbar	Officer UAE Overseas (lab)		[signature]
4.	Hafiz Umer Khitab	Imam masjid	03465016357	[signature]
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Community Consultations
Attendance Sheet

Settlement Name: KOHALI (woman) Coordinates : 33 28 408
73 52 41.0

Date: February 09, 2014 Time: 9:45

No.	Name	Role	Contact Number	Signature
1.	Saima Rasheed	Student	0301-8506008	[signature]
2.	Jannat Katoon	Housewife		
3.	Zareena Kousar	Housewife	0301-8506008	Zareena
4.	Shakeela Rasheed	Housewife		
5.	Zaheen Nazik	Housewife		
6.	Abbrit Raisat	Housewife	0346-5727259	[signature]
7.	Shanaz Akhtar	Housewife	0343-0530876	
8.	Khalida Nazim	Housewife	0346-5165038	
9.	Sakina Nazim		//	Sakeena
10.	Shazia Amjad	Housewife	0343-5025065	Shazia
11.	Manir Beggum	Housewife		
12.	Nazia Shokat	Housewife		Nazia
13.	Sherish Zafar	Student		Sehrish
14.	Nasih Javid	Student		[signature]
15.	Faiza Kousar	Housewife	0346-5016357	Faiza
16.	Saika Kousar	0	0344-2397671	Saika
17.	Rabia Kousar		//	Rabia
18.	Balkees Beggum		//	
19.	Yasmeen		//	
20.	Zainab		//	
21.	Naveeda		//	
22.	Gulshan		//	Gulshan
23.	Raisham Bibi	Housewife	//	[signature]
24.	Saira Bashir	Housewife		Saira
25.	Khatoon Begum	Housewife		

Community Consultation
Attendance Sheet

Settlement Name: Bialgaan (Mer) Coordinates: 33 26 44.0
73 52 21.8

Date: February 09, 2014 Time: 3 P.M.

No.	Name	Role	Contact Number	Signature
1.	M. Ishfaq	Jurnalist	0346-5412346	[signature]
2.	M. Ishaq	Health Job	0344-5123553	[signature]
3.	Ziafat Ali	Jobless	0343-5719661	[signature]
4.	Faizan Khan	Student	0343-8836165	Faizan
5.	Raja Shahid	Farmer	0341-6382812	Shahid
6.	Sohail Raja	Student	0343-5865470	[signature]
7.	Hafiz Nawaz	Teacher	0346-5030341	[signature]
8.	Asad Aftab	Student	0343-5755524	[signature]
9.	Raja Aftab	President P.ML.N.	0346-8119396	[signature]
10.	Nadeem	Barbar	0344-8835510	نديم
11.	Raja Ajaaz	Student	0346-0723770	[signature]
12.	Aftab Arif	Jurnalist	0343-5133818	[signature]
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Community Consultation
Attendance Sheet

Settlement Name: ~~Biyali~~ Bialian (Women) Coordinates : 33 26 44.0
73 52 21.8

Date: February 09, 2014 Time: 3:10 pm

No.	Name	Role	Contact Number	Signature
1.	Shaoor Begum	Housewife		شور بیگم
2.	Bilqees Begum	Housewife		
3.	Gulshan Begum	"		Gulshan
4.	Sehrish Begum	"		Sehrish
5.	Nabeela Begum	"		
6.	Tabassum Begum	"		Tab
7.	Muqaddas Aftab	"		Muqaddas
8.	Faziah Liaqat	"		Faziah Liaqat
9.	Naila Begum	"		Naila
10.	Javeria	"		Javeria
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Community Consultation
Attendance Sheet

Settlement Name: Naroch Colony (MGN) Coordinates : 33 27 00-7
73 51 53-3

Date: February 10, 2014 Time: 9:30 am

No.	Name	Role	Contact Number	Signature
1.	M. Shareef	Labour	0346-5179834	
2.	Shair Ahmed	Rt. Army	0321-6832897	
3.	Dil Muhammad	Govt. Job. Ele	0346-5040258	
4.	Zafar Iqbal	Labour	0344-5176388	
5.	Shahzad Ahmed	Foreign Coun	0345-3819282	Shahzad
6.	M. Bashir	Labour	0302-6472182	
7.	M. Haneef	Labour	0305-8526758	
8.	Azhar Hussain	Labour	0346-5446551	
9.	Naveed Iqbal	Driver (P)	0345-4450643	Naveed
10.	Tufail Hussain	Driver (P)	0343-4397079	
11.	Saidan Muneer	Labour-O	0346-5247256	
12.	M. Latief	Labour	0344-8620567	M. Latif
13.	M. Rasheed	wapda	0312-5528540	
14.	M. Zaman	Labour	0346-3998628	
15.	Ghulam Mustafa	Road Driver (own)	0347-5630865	
16.	M. Mushtaq	Imam masjid	03453819283	
17.	M. Akbar			
18.	M. Saphe			M. Sabir
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Sardar Munir
Rasheeda Khatoon
Tanveer Hussain

Environmental Impact Assessment of Gulpur Hydropower Project

Community Consultation
Attendance Sheet

Settlement Name: Naroch (Women) Coordinates : 33 27 00-7
73 51 53-3

Date: February 10, 2014 Time: 9:30 am

No.	Name	Role	Contact Number	Signature
1.	Rasheeda Begum	Housewife		
2.	Mariam Ali Akbar	Housewife		
3.	Alizah Munir	Housewife		
4.	Sehrish Khadim	Student		
5.	Dana Begum	Housewife		
6.	Shahida Perveen	Housewife		
7.	Shahida Tufail	Housewife		
8.	Jamshaid Begum	Housewife		
9.	Abida Khatoon	Housewife		Abida
10.	Shamsa Ishaq	Housewife		
11.	Yasmeen Akhtar	Student		
12.	Tayyaba Fatima	-		
13.	Fazal Bibi			
14.	Kuwait Begum			
15.	[illegible]			
16.	Saeeda Akhtar			[illegible]
17.	Barik Bibi			
18.	Rizwana Kausar			RIZWANA
19.	Sarwar Jan			
20.	Shakeela [illegible]			Shakila
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Pahari, Urdu

Community Consultation
Attendance Sheet

Settlement Name: Rahmani Mahalla Coordinates : 33 27 17-5
73 52 16-8

Date: February 10, 2014 Time: 2:30 P.M.

No.	Name	Role	Contact Number	Signature
1.	M. Haneef	Farmer.	0341-8885937	محمد حنیف
2.	M. Khaliq	labour	0346-5245915	[illegible]
3.	Raj Muhammad	Farmer	0341-5181671	[illegible]
4.	Abdul Rahman	Foreign Country	0346-5165495	[illegible]
5.	Haji M Ashraf	Farmer	0347-5003736	محمد اشرف
6.	Hafiz M. Ghais	Imam masjid	0346-5420712	Ghyas
7.	Azhar Hussain	Labour	0344-8901680	اظہر حسین
8.	Talib Hussain	Labour	0346-5247458	Talib Hussain
9.	Hafiz M. Abbas	Imam Masjid	0341-5015636	حافظ عباس
10.	Akhtar Khan	Shopkeepar	0346-5165495	اختر علی
11.	Tasawar Hussain	Rt/Army	0347-5831011	[illegible]
12.	Safdar Ali	Dubai	0344-8878645	صفدر علی
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Community Consultation
Attendance Sheet

Settlement Name: Rehmani Mallah Coordinates : 32 27 17-5
73 52 16-8

Date: February 10, 2014 Time: 2:30 PM

No.	Name	Role	Contact Number	Signature
1.	Muhammad Hussain	Farmer	03125130467	
2.	Tahir Aziz	Student	03445127306	M. Tahir
3.	Muhammad Khalil	ShopOwner	03418885948	Khalil
4.	Hafiz Abbas	Imam Mossue	03415019554	حافظ عباس
5.	Muhammad Salim	Labor	03454457783	سلیم
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Community Consultation
Attendance Sheet

Settlement Name: Kelunani [illegible] (Women) Coordinates : 33 27 17.5 / 73 52 16.8

Date: February , 2014 Time: ____________

No.	Name	Role	Contact Number	Signature
1.	Nusrat Perveen	Housewife		Nusrat Perveen
2.	Manzoor Begum			[illegible] B[illegible]
3.	Faida Shaida Perveen			Shaida Perveen
4.	[illegible] Bibi			[illegible]
5.	[illegible] Bibi			زرینہ
6.	Naheeda Gul			Nahee[illegible]
7.	Munir Begum			Munir Begum
8.	[illegible]			Shazia Abid
9.	Zohra Khatoon			Zohra Katoon
10.	Nasreen Begum			Nasreen Begum
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Community Consultation
Attendance Sheet

Settlement Name: Juzvi Mandi Coordinates : 33 30 54.2
73 52 53.6

Date: February 11 , 2014 Time: 9.00

No.	Name	Role	Contact Number	Signature
1.	Maroof Ahmed	Farmer	0346-5192660	[illegible]
2.	Javeed Iqbal	Tailor	0346-5166456	جاوید اقبال
3.	[illegible] Hussain	Tractor Trolly owner	0345-150771	
4.	M. Basharat	Labourer	0343-5615778	
5.	Syed Waheed [illegible]	" "	0343-4478871	[illegible]
6.	M. Haq. Hussain	" "	0346-5152521	[illegible]
7.	Tariq [illegible]	Mechanic	03065877577	[illegible]
8.	[illegible]	Mechanic	034[illegible]	[illegible]
9.	M. Kabir	Mechanic	[illegible]6-512[illegible]	[illegible]
10.	Manzoor [illegible]	Labour	0302/5600213	[illegible]
11.	Yasin Hussain	Labour	0346-6251557	یاسین حسین شاہ
12.	Anwar Hussain	Property dealer	0301-5492947	[illegible]
13.	Khalid Mehmood	Cabel operator	0343-7308185	Kha[illegible]
14.	Mazhar Hussain	Teacher	03451907171	[illegible]
15.	Shamreez Iqbal	Labour	0346-5068[illegible]	شمریز اقبال
16.	Ibrar Hussain	Labour	0346-[illegible]085	ابرار حسین
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Community Consultation
Attendance Sheet

Settlement Name: Hill Clean (Men) Coordinates : 33 30 37-7
73 52 40-6

Date: February 11 , 2014 Time: 11-30 a.m

No.	Name	Role	Contact Number	Signature
1.	Ch. Fazal	labour		U.E.
2.	Ch Muhammad Hassan	Labour		—
3.	murshad sultan	Shopkeeper		U.E
4.	Ch Manga	Shopkeeper		U.E
5.	Hanif Khan	Labour	0346-[illegible]47234	محمد حنیف
6.	Khadam Hussain	Foreighn Country		U.E.
7.	Yasir But	Private Job	0344-5743023	[illegible]
8.	Ch. Talib	Mecanic		طالب
9.	Haneeb khan	Labour	0342-5083958	[illegible]
10.	Waqjash Ch	Sand mining	0342-4673410	WaqyasH
11.	Noor Muhammad	Labour		U.E
12.	Abdul Rahim	Labour	0344-5906331	[illegible]
13.	Shebir Ahmed But	movimaker	0344-5088848	[illegible]
14.	Muhammad Azeem	Labour	—	U.E.
15.	Muhammad Mahfooz	Labour	0346-7449830	U.E
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Community Consultation
Attendance Sheet

Settlement Name: Hill Kalan (women) Coordinates: 33 30 37-7
73 52 40-6

Date: February 11, 2014 Time: 12:30 PM

No.	Name	Role	Contact Number	Signature
1.	hadija bibi			
2.	[illegible]			[illegible]
3.	[illegible]			[illegible]
4.	[illegible]			[illegible]
5.	[illegible]			
6.	[illegible]			
7.	[illegible]			
8.	[illegible]			
9.	Kulsom			
10.	Azra Bibi			
11.	Saeeda Bibi			
12.	[illegible] Bi			[illegible]
13.	[illegible]			
14.	[illegible]			[illegible]
15.	Ashraf [illegible]			[illegible]
16.	[illegible]			[illegible]
17.				[illegible]
18.	[illegible]		Zavoor	[illegible]
19.	R[illegible] Bi[illegible]			
20.	Rubina			
21.	Aniqa S[illegible]			Aniqa
22.	[illegible]			[illegible]
23.	[illegible]			
24.	[illegible]			
25.	[illegible]			

Community Consultation Attendance Sheet

Settlement Name: Kamuli (Men) Coordinates: 33 27 51.2 / 73 51 44.3

Date: February 11, 2014. Time: 4:30 P.M.

No.	Name	Role	Contact Number	Signature
1.	Ch Muhammad Seboor	Foreigner	0345-4430954	[signature]
2.	Ch. Abdul. Rahman	Foreighner	0300-9146846	[signature]
3.	Ch. Azhar khan	" "	0307-8620954	اظہار [signature]
4.	Hafiz Nazir	Imam khan	0346-5397475	[signature]
5.	Rab Nwaz	Student	0346-5168579	[signature]
6.	Muhammad Haris	"	03 " " " "	Haris
7.	Muhammad Sajid	" "	0346-5165458	[signature]
8.	Muhamad Azhar	Labour	0341-9443583	[signature]
9.	Fazal Ahmed	" "	0301-5816985	فضل احمد
10.	Nwas Chaudhry	Studen	0303-8158314	[signature]
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Community Consultation
Attendance Sheet

Settlement Name: Kameli (Women   Coordinates : 33 27 51-2
73 51 44-3

Date: February 11, 2014   Time: 5:00

No.	Name	Role	Contact Number	Signature
1.	Huma Tayyaba	~~Flo~~		
2.	Irum Gul			
3.	Alia Kausar	Student		
4.	Shahreen Kausar	Student		
5.	Kaniz Fatima			
6.	Faiza Kausar			
7.	Farmeed Akhtar			
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Community Consultation
Attendance Sheet

Settlement Name: Rajdahani (MEN) Coordinates : 33 22 33-9
73 46 58.4

Date: February 12, 2014 Time: 11a.m

No.	Name	Role	Contact Number	Signature
1.	Ch. Manzoor Sb	Business	0300-9576169	[illegible]
2.	Ch. Mushtaq Ah	Service	0345-9722356	Ahmed
3.	Ch. Sharief	Labour.	0346-5179284	شریف
4.	Mirza Shaban	Inshurance	0345-5465227	[illegible]
5.	Haji Akram	Shopkeepr	0346-5038563	Akram
6.	Gulfraz Mughal	Agriculture	0343-5697019	[illegible]
7.	Raja Sodagar	Shopkeepr	0346-5013218	Sodgr Ali
8.	M. Yasine	Tailer	0344-5154288	[illegible]
9.	Liaqat Sb	Labour	0346-5142462	[illegible]
10.	M. Banaris	Farmer	0345-5695272	[illegible]
11.	M. Iqbal	Farmer	0343-514284	[illegible]
12.	Sabar Ali	Farmer	0346-514515	[illegible]
13.	Qurban Hassa	Farm	0343-5393654	[illegible]
14.	Arshad Hussan	Shopkeepr	0346-5038638	[illegible]
15.	Muhamad Haseeb	Barber	0346-5412558	Haseeb
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Community Consultation
Attendance Sheet

Settlement Name: Rajdahni (women) Coordinates : 33 22 33-9 / 73 46 58-4

Date: February 12, 2014 Time: 11:00 am

No.	Name	Role	Contact Number	Signature
1.	Imtiaz Kousar		03469620016	Imtiaz
2.	Zubaida. Kousar		03456640291	Zu
3.	شمیم اختر		03455463356	Sha
4.	Ghulam Fatima			Fatima
5.	Azmat Nisar			Azmat
6.	Jamila Nisar			Jamila
7.	Shaheen Mughal			Sh
8.	Anila mustaq.			Anila
9.	Shamila Andleeb.		03455675348	Sh
10.	Mubarqa Rani			Mub
11.	Shafina Akhter.			Sh
12.	Kafela Andleeb.			K
13.	Rubina Kausar			R
14.	Razia			
15.	Zaida Begum			[illegible]
16.	Fauzia Kausar			Fouzia Kausar
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Community Consultation
Attendance Sheet

Settlement Name: Gulpur / Men's Coordinates : 332613.5 735[illegible]9.5

Date: February 13, 2014 Time: 10:00 am

No.	Name	Role	Contact Number	Signature
1.	Waqar Ahmed	LPG shop	0346544[illegible]	[illegible]
2.	Ali [illegible] Asif	Journalist	03435133[illegible]	[illegible]
3.	Yasir Shah	labour	[illegible]	یاسر
4.	Rasheed [illegible]	Shopkeeper		[illegible]
5.	Ch. Latif	labour		[illegible]
6.	Arshad Butt	labour	[illegible]	ارشاد
7.	Syed Zeeshan [illegible]	[illegible]	0342[illegible]	[illegible]
8.	M. [illegible]	Poultry [illegible]	0346546[illegible]	[illegible]
9.	[illegible]	Journalist	[illegible]	[illegible]
10.	Raja [illegible]	Shopkeeper	-	[illegible]
11.	M. Bashir	Shopkeeper	-	[illegible]
12.	Abdullah Khan	[illegible]	034685160[illegible]9	[illegible]
13.	Lal Muhammed	[illegible]	[illegible]4451235[illegible]	لال محمد
14.	Muhammad Ali	Shopkeeper	[illegible]	[illegible]
15.	Amjad Khan	Hotelman	[illegible]	Amjad
16.	[illegible] Ahmed	Barber	[illegible]	[illegible]
17.	Ghafoor Ahmed	labour	—	غفور
18.	M. Aslam	Retired [illegible]	03435550325	[illegible]
19.	Wajid Hussain	Hotelman	03478333667	واجد
20.	M. Asif	[illegible]	0343508[illegible]285	[illegible]
21.	[illegible] Hafeez	Journalist	03465[illegible]	[illegible]
22.	M. Shahzad	Student	[illegible]	[illegible]
23.	[illegible] Hussain	Driver	03455[illegible]28[illegible]4	[illegible]
24.	Aqeel Ahmed	Govt. Job	[illegible]	[illegible]
25.	[illegible] Ahmed	Operator	0346[illegible]	[illegible]

Community Consultation
Attendance Sheet

Settlement Name: ______ (Men) Coordinates : 33 26 13.5
73 51 27.5

Date: February ___, 2014 Time: 10 00

No.	Name	Role	Contact Number	Signature
1.	Anees Ahmed	Operator	0346516852	[signature]
2.	Raqeeb	Mechanic	03435087228	[signature]
3.	[illegible] Shah	Shopkeeper	03465[illegible]	[signature]
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Community Consultation
Attendance Sheet

Settlement Name: Gulpur (Women) Coordinates : 33 26 13.5 / 73 51 27.5

Date: February 13, 2014 Time: ____________

No.	Name	Role	Contact Number	Signature
	Taskeen Fatima			[signature]
	Hajrah Dada			Hajrah
	Naseem Akhtar			نسیم اختر
	Shaheen Akhtar			شاھین اختر
	Fehmeeda Shaukat			فہمیدہ شوکت
	Khalida Arzak			
	Walltair Bibi			
	Rani Bibi			
	Naeem Akhtar			نعیم اختر
	Shabana Rafique			Shabana
	Zaineb Ghulam			
	Jamila Ghulam			Jamia
	Salma Latif			SALMA LATF
	Uzma Kausar			UZMA KOUSAR.
	Aneela Ghulam			Anila Ghulam
	Bushra Khokhar			Bu
	Shamim Akhtar			شمیم اختر
	Aroog Kokab			AROOJ KOKAB
	Sobia Khurram			Sobia Khurram

Community Consultation
Attendance Sheet

Settlement Name: Gulpur (Women) Coordinates : 33 26 13.5 / 73 51 27.5

Date: February 13, 2014 Time: ______

No.	Name	Role	Contact Number	Signature
1.				

Noreen Ilmas
Sehrish Mehfooz
Mussarat Jabeen
Shamim Akhtar
Zaradee Shamim
Rehana Siddique
Tasneem Kausar
Khalida Begum
Sumbal Ghias
Shahida Shaukat
Safia Rafiq Mir
Tazim Akhtar
Maryam Siddiqa
Asia Rehana
Rukhsana
Rabia Anwar
Abida Batool

Community Consultation
Attendance Sheet

Settlement Name: Barali   Coordinates : 332740.8, -.2

Date: February 15, 2014.   Time: 10 :30 am

No.	Name	Role	Contact Number	Signature
1.	Haji M. Saddique -	Politcal worker	0302-5305247	
2.	Ch. M. Qayoum -	" "	0300-5304278	عبدالقیوم
3.	Haji M. Rafique -	Business -	0346-5209893	محمد رفیق
4.	Muhammed Latief	Former	0302-5193276	لطیف
5.	Ch. Abdul-Rahman	Transportar	0300-8853885	
6.	Abdul Majeed	Former	0300-5398333	عبدالمجید
7.	Maqbool	overseas	0346-6109266	مقبول احمد
8.	Azad Ahmed	O.L.B.	0346-5183256	Azad
9.	Aneel Saddque	Student	0303-5590453	Aneel Saddique
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Community Consultation Attendance Sheet

Settlement Name: Barali (women) Coordinates : 33 27 -40- 8
73 52 29-4

Date: February 15, 2014 Time: 11:37 am

No.	Name	Role	Contact Number	Signature
1.	Fehmeeda Rehman			Fehmeeda
2.	Sobia Saddique			
3.	Tasveer Begum			
4.	Naseem Begum			
5.	Anwar Begum			
6.	Begum Jan			
7.	Rasheed Begum			
8.	Nazia Siddique			Na
9.	Badia Khatoon			
10.	Kesar Bibi			
11.	Khatoon Begum			
12.	Nabeela			
13.	Wazia Kausar			
14.	Shaista Kausar			
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Community Consultation
Attendance Sheet

Settlement Name: Phagwari Coordinates: 333329.4
735591.5

Date: February 17, 2014. Time: 11:20a.m.

No.	Name	Role	Contact Number	Signature
1.	Muhammed Liaqat	Sect. Un. Council	0306-5473715	[signature]
2.	Muhammed Haneef	Electricity Dep.	0306-5877580	M. [signature]
3.	Muhammed Azam	Labour	0307-6444765	AZAM
4.	Abdul-Rahoof	Wildlife	0347-0558752	A R [signature]
5.	Muhammed Gulfam	Elect. Job.	0301-3126268	[signature]
6.	Muhammed Zareen	Job. Loc. Govt.	0306-8918919	[signature]
7.	Fazal Ahmed	" " "	0308-8467138	[signature]
8.	Liaqat Hussain	Farmering	0309-5108440	[signature]
9.	Muhammed Shafique	Labour	0303-8465742	[signature]
10.	Iftikhar Ahmed	Labour	03013664862	[signature]
11.	Sehran Ahmed	Plumber	0306-5640750	Sehran Ahmed
12.	Yasin Haneef	Student	0303-5648180	Yasir Hanif
13.	Haseeb Haneef	" "	0303-5602665	Haseeb Hanif
14.	Sobidar Khadam	Rt. Sobi-Army	0345-9717267	[signature] Hussain
15.	Waqas Attaf	Student	0306-5043753	waqas Ahmad
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Community Consultation
Attendance Sheet

Settlement Name: Pagwari (women) Coordinates : 33 33 29.4
73 55 41.5

Date: February 17, 2014 Time: 11:10 am

No.	Name	Role	Contact Number	Signature
1.	Ulfat Bibi			
2.	Ajra Riaz			AJRA
3.	Tavseen Saqib			[signature]
4.	Naila Naveed			[signature]
5.	Farah Naheed			[signature]
6.	Sana Ulaqat			[signature]
7.	Perveen Akhtar			[signature]
8.	Naseem Akhtar			
9.	Nazmeen Akhtar			Nazmeen
10.	Khadija Begum			
11.	Kausar Riaz			
12.	Maqsood Bibi			
13.	Farooq Bibi			
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Community Consultation
Attendance Sheet

Settlement Name: Kotli City (Trader) Coordinates : ____________________

Date: February 15, 2014 Time: 6:30 PM

No.	Name	Role	Contact Number	Signature
1.	Raja Abdul Rahim	voice President	03445090429	
2.	M. Yaqoob	Presedent Traders	03445090299	
3.	Anwar Baig	Secretery general	03008339009	
4.	Marroof Mughle	organizer	034458481	
5.	Taseer Ahmad -		0344-5008860	Taseer Ahmad
6.	Bashir Butt	president	0344-5942677	Bashir Butt
7.	Anwaar Azam	Depth General Secretary	0342-5173617	M Anwar
8.	NAjeeb Ahmed.	Trader	0301-5667292	Najeeb
9.	Malik M. Asif	Trader	03009130935	
10.	muhammad Naeem		03421544672	Naeem
11.	Muzaffar Mehboob		0315-7148764	
12.	WAjid AZAm		03435281388	wajid
13.	M. Azam		03465177799	
14.	Dr. M. Waqas		0344-9533101	
15.	Shahzad Gillani		03465194711	Gillani
16.	Dr Tajeer Gilani		03470786373	
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Community Consultation
Attendance Sheet

Settlement Name: Kotli Coordinates : ____________

Date: February 16, 2014 Time: ____________

No.	Name	Role	Contact Number	Signature
1.	Hameer Begum			Atiqa
2.	Atika Kausar			
3.	Naseem Akhtar			
4.	Shazia			
5.	Saira Kausar			
6.	Azoor Talima			Fatima
7.	Ruqaiah Basheer			Ruqaia
8.	Fauzia			
9.	Inza Iftikhar			Inza
10.	Nazish Ahsan			Nazish
11.	Afifa Akhtar			
12.	Nargis Perveen			
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Stadium Road (6–9)
Tamgi (10–12)

Community Consultation
Attendance Sheet

Settlement Name: KOTLI CITY Coordinates : ____________________

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Date: February 16, 2014 Time: ____________

No.	Name	Role	Contact Number	Signature
1.	Sajida Imtiaz			
2.	Asma Sadaf			[signature]
3.	Zahida Akhtar			ASMA
4.	Nighat			[signature]
5.	Perveen Akhtar			Anam
6.	Anam Mustaq			
7.	Bushra			Bushra
8.	Zubaida Ijaz			[illegible]
9.	Arfeen Ikhlas			
10.	Nasreen Asad			Nasreen
11.	Zaheen Ilyas			zaheen Alyas
12.	Safina			
13.	Zara Sabir			ZARA
14.	Momina Habib			
15.	Rubina Kausar			
16.	Shazia			Shazia
17.	Andleeb			Andleeb
18.	Noor Jahan			
19.	Fareeha			[signature]
20.	Sana Rafique			Sana
21.	Kiran			Kiran
22.	Romana			Roomana
23.	Zakia Bibi			[signature]
24.	Gultaj			[illegible]
25.	Bilqees Akhtar			

Appendix K: Frameworks for Management Plans

K.1 Construction Management Plan

K.1.1 Framework

Objective and Scope

The objective of the CMP is to minimize the impacts of construction activities on the local flora and fauna, surface and ground water resources, air quality, and traffic. Moreover, it will also improve workers personal hygiene

The Construction Management Plan (CMP) will cover all activities related to construction which will be undertaken by construction contractor(s).

Responsibility and Timeline

The construction contractor(s) will develop the Construction Management Plan (CMP). The contractor(s) will submit the CMP to the MPL at least 60 days prior to field mobilization. All CMPs will require prior approval of the MPL and, where required, of ADB and IFC before the commencement of any activity on the site.

Key Features

At the minimum, the CMP should include the mitigation and management measure for the following issues:

1. Vegetation clearance
2. Poaching
3. Discharge from construction sites
4. Soil Erosion and siltation
5. Excavation, earth works, and construction yards
6. Construction vehicular traffic, and Construction machinery
7. Construction activities
8. Siting and location of construction camps and Construction Camp Facilities
9. Disposal of waste, Water and sanitation facilities at the construction sites

K.1.2 Guidelines

The CMP will clearly identify all areas that will be utilized during construction for various purposes. For example, on a plot plan of the construction site the following will be shown:

- Areas used for camp
- Storage areas for raw material and equipment
- Waste yard
- Location of any potentially hazardous material such as oil
- Parking area
- Loading and unloading of material
- Septic tanks

The plan should:

- Be in line with the client requirement
- Adhere to the rules and regulation
- Identify clear roles and responsibilities
- Identify monitoring plan for management

Exhibit K.1: Aspects and Objectives of Construction Management Plan

Aspect	*Objective*	*Mitigation and Management Measure*
Vegetation clearance	Minimize vegetation clearance and felling of trees	• Removal of trees should be restricted to the development footprint. • Construction activities shall minimize the loss or disturbance of vegetation • Use clear areas to avoid felling of trees • A procedure shall be prepared to manage • vegetation removal, clearance and reuse • Cleared areas will be re-vegetated
Poaching	Avoid illegal poaching	• Contractual obligation to avoid illegal poaching • Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching
Discharge from construction sites	Minimize surface and ground water contamination Reduce contaminant and sediment load discharged into water bodies affecting humans and aquatic life	• Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials • Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot • Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean

Aspect	Objective	Mitigation and Management Measure
Soil Erosion and siltation	Avoid sediment and contaminant loading of surface water bodies and agricultural lands.	• Minimize the length of time an area is left disturbed or exposed. • Reduce length of slope of runoff • Construct temporary cutoff drains across excavated area • Setup check dams along catch drains in order to slow flow and capture sediment • Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust • Increase the watering frequency during periods of high risk (e.g. high winds) • All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover).
Excavation, earth works, and construction yards	Proper drainage of rainwater and wastewater to avoid water and soil contamination	• Prepare a program for prevent/avoid standing waters, which Construction Supervision Contractor (CSC) will verify in advance and confirm during implementation • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there
Construction vehicular traffic	Control vehicle exhaust emissions and combustion of fuels	• Use vehicles with appropriate exhaust systems and emission control devices. • Establish and enforce vehicle speed limits to minimize dust generation • Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site • Level loads of haul trucks travelling to and from the site to avoid spillage • Use of defined haulage routes and reduce vehicle speed where required. • Transport materials to site in off peak hours. • Regular maintenance of all vehicles • All vehicle exit points from the construction site shall have a wash-down area where mud and • earth can be removed from a vehicle before it enters the public road system.
	Minimize nuisance due to noise	• Maintain all vehicles in good working order • Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc.

Aspect	***Objective***	***Mitigation and Management Measure***
	Avoid impact on existing traffic conditions	• Prepare and submit a traffic management plan • Restrict the transport of oversize loads • Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions.
	Prevent accidents and spillage of fuels and chemicals	• Restrict the transport of oversize loads • Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions • Design and implement safety measures and an emergency response plan to contain damages from accidental spills • Designate special routes for hazardous materials transport.
Construction machinery	Prevent impact on air quality from emissions	• Use machinery with appropriate exhaust systems and emission control devices. • Regular maintenance of all construction machinery • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages
	Reduce impact of noise and vibration on the surrounding	• Appropriately site all noise generating activities to avoid noise pollution to local residents. • Ensure all equipment is in good repair and operated in correct manner. • Install high efficiency mufflers to construction equipment. • Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment • The project shall include reasonable actions to ensure that construction works do not result in vibration that could damage property adjacent to the works
Construction activities	Minimize dust generation	• Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust • Increase the watering frequency during periods of high risk (e.g. high winds). • Stored materials such as gravel and sand should be covered and confined • Locate stockpiles away from sensitive receptors
	Reduce impact of noise and vibration on the surrounding	• Notify adjacent landholders or residents prior to noise events during night hours

Aspect	Objective	Mitigation and Management Measure
	Avoid driving hazard where construction interferes with pre–existing roads	• Install temporary noise control barriers where appropriate • Avoid working during 21:00 to 06:00 within 500m from residences.
	Minimizing impact on water quality	• Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be locate so as to minimize the potential of contaminants to enter local watercourses or storm-water drainage • Storm-water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse. • An Emergency Spills Contingency Plan shall be prepared.
Siting and location of construction camps	Minimize impact from construction footprint	• Arrange accommodation in local towns for small workforce • Locate the construction camps at areas which are acceptable from environmental point of view
Construction Camp Facilities	Minimize pressure on local services	• Adequate housing for all workers • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage system. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • In–house community entertainment facilities
Disposal of waste	Minimize impacts on the environment	• Ensure that all on-site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways, • and the waste contained does not contaminate soil, surface or groundwater or create unpleasant odors for neighbors and workers • Prepare detailed waste management and muck disposal plan incorporating safe disposal of the expected waste from the construction activities
Water and sanitation facilities at the construction sites	Improve workers personal hygiene	• Provide portable toilets at the construction sites and drinking water facilities. • Portable toilets should be cleaned once a day. • All the sewerage should be pumped from the collection tank once a day into the common septic tank for further treatment.

K.2 Spill Contingency Plan

K.2.1 Framework

Scope and Objective

Spill Contingency Plan (SCP) scope is to provide the basis and the guidelines for the management of spills which could happen during the execution of the Project. Starting from the identification of the main situations in which a spill of pollutants may occur, the plan outlines strategies for spill prevention relevant to the site activities and describes procedures for the control and limitation of the releases, in order to avoid or minimize the impact on the environment.

The objective of the SCP is the identification of the relevant types of spill and the scenarios which could possibly lead to pollution. It will also identify the preventive strategies and the actions, which should be adopted during and immediately after the release of pollutants

Responsibility and Timeline

The construction contractor will develop a Spill Contingency Plan (SCP) for the project and get a prior approval from the client before the commencement of any activity on the site.

Key Features

The SCP should include and ensure following things;

1. It should identify all the hazardous materials, related to Project activities, that may produce a health and safety risk for project employees and subcontractors and that may produce an environmental impact;
2. It should make sure that all personnel working on the project are informed about environmental protection concerns and to ensure that all workers are familiar with response procedures when a spill occurs;
3. It should ensure that the activities carried out comply with the procedures, especially those regarding prevention of spills into the environment of pollutant substances;
4. It should include a clause for continuous training of the workers to enable them to perform their work in a safe and healthy manner.
5. It should include a clause asking to keep an updated inventory of all chemicals and hazardous materials stored on site. Also, to keep Material Safety Data Sheets (MSDSs) at storage areas.
6. It should ensure use of appropriate chemical segregation practices where any potentially toxic or hazardous material will be stored;
7. It should prohibit manual handling of hazardous materials and the use of forklifts or cranes with pallet loads shall be preferred;
8. It should include the storage protocol of hazardous materials/chemicals. Such areas shall be sheltered from the sun, provided with a means to restrict access, located away

from occupied buildings and work areas, and properly sign posted - eg. “no smoking”, “hazardous material storage area”, etc”.Waste oils and other liquid wastes shall be stored in sealed drums within a designated secondary containment area or in a temporary storage area consisting of an earth bound lined with plastic sheeting;

9. It should identify sources of spills like welding machine, compressor units, water pumps, power generators (on wheels or not) - diesel and petrol operating construction equipment.
10. There should be a section which provides a general overview of response options to deal with possible oil and chemical spills during site activities. These may include more significant spills arising from accidents, or spills resulting from leaking fuel tanks, chemical drums, etc., that can lead to large releases of material.
11. It should include steps to identify the source of spill and the evaluation of severity of the spill in order to select the proper response strategies.
12. It should include a list of spill kit equipment related to the types of potential spills identified earlier, which shall be provided at the site.
13. It should explicitly define that the contractor and subcontractor are responsible to verify that their workers are equipped (and trained to use) with all PPE prescript on specific MSDS concerning each chemical substance used.
14. It should provide appropriate control and containment techniques to control the potential spills.
15. The appropriate clean-up technique to be used depends on the location of the incident, volume and type of the pollutant involved, and the amount of soil that has to be removed, however, the SCP should include the general recovery and removal strategies

K.2.2 Guidelines

- The SCP should include the following things
- identification of the relevant types of spill and the scenarios which could possibly lead to pollution;
- identification of the prevention strategies and the actions adopted during and immediately after the release of pollutants;
- description of the project site organization, both during the prevention and emergency intervention phases;
- The SCP should consider the following actions as priorities:
  - Carrying out all the necessary operations for the protection of the health and safety of all people present where the spill occurs, both employees and others;
  - Minimization of the spill dimensions and protection of the main structures;
  - Minimization of environmental impact due to spill.

- The review of the procedures of this Plan will be carried out by contractor on as-needed basis.
- The SCP should provide an inventory of polluting substances present on site, which include diesel fuels, brake fluids, oil and lubricants, paints and solvents/chemicals, cement additives and residue, battery acid, and hazardous liquid wastes
- It should indicate a possible classification of spills by degree of severity. The classification should be based on the entity of the spill and on the response resources required to deal with it.
- It should identify the various pollution scenarios which may include spills during vehicle maintenance, Oil/diesel spills from drums, Paint spills, spills due to vehicle overturning, spill from breakdown of storage tanks, and spills from vehicle accident / collision.
- It should provide spill prevention strategies and general response actions which should include the preventive and planning measures and the responding procedures for dealing with spills of pollutant substances during the execution of the Project.

Moreover this plan should detail the overall response coordination in order to organize the control, alert and intervention, so as to avoid or reduce any potential pollution. Following sections provide the details expected in the plan.

Identification of Potentially Polluting Substances and Pollution Scenarios

This section provides an inventory of polluting substances present on site, indicates a possible classification of spills by degree of severity, and identifies the various pollution scenarios.

Inventory of Potentially Polluting Substances

Potentially polluting substances have been identified by analyzing the main critical activities performed during the Project. The detailed list of construction activities is provided in ESIA, **Section 3**.

An analysis of the above-mentioned activities shows that the most critical substances that may be involved in spills are:

- diesel fuels;
- brake fluids;
- lubricants, such as engine and transmission fluids;
- solvents and chemicals;
- cement additives and residues;
- paints;
- battery acid;
- hazardous liquid wastes (e.g. used oil, spent paints and solvents, wastewater from washing equipment facilities).

However, during the execution of the Project, only small quantities are typically involved in incidents, with the possible exceptions of fuel transportation operations, breakdown of storage tanks or of existing pipelines.

The following subsections outlines descriptions of the main identified hazardous substances that will be possibly used throughout the PROJECT, and gives preliminary indications about their use and storage.

Polluting Substances and Management Options

The following subsections outlines descriptions of the main identified hazardous substances that will be possibly used throughout the project, and gives preliminary indications about their use and storage.

Diesel fuels

The most of diesel fuels will be used for vehicles and equipment throughout the project area.

- ▷ Designated refueling areas are classified for mobile machinery and equipment and semi-permanent equipment installations. Vehicles and equipment that are difficult to move due to their size or whose movement to the designated refueling areas may cause further damage to the environment and create a road safety hazard shall be refueled by means of mobile refueling vehicles.
- ▷ Diesel fuel will be stored in dedicated facilities protected by concrete retention bounds or lined with plastic sheeting for spill containment.

Brake Fluids

- ▷ Brake fluid is a specially formulated liquid used in the brake hydraulic system.
- ▷ Brake fluids will be stored in sealed containers within a designed and bounded area. The storage in non-designated areas is forbidden. In addition, drip trays will be used during maintenance activities.

Oil and Lubricants

- ▷ Oil and lubricants will be used for the maintenance of all vehicles, vessels and equipment, usually during planned maintenance processes at the site maintenance facilities. However, it is possible that machinery and equipment will have to be serviced or repaired outside of the maintenance area: oil and lubricants may be de-canted from their storage drums and transported for use to other areas of operation.
- ▷ Oil and lubricants shall be stored in sealed drums (150 – 200 L) within a designed secondary containment area at the main camp facility designated maintenance and storage areas. The storage in non-designated areas is forbidden.

Paints and Solvents/Chemicals

- ▷ Paints (used during painting activities) shall be stored in sealed drums in properly designated areas with appropriate environmental and safety controls.

- Solvents and other chemicals shall be stored in sealed drums in properly designated areas with appropriate environmental and safety controls.
- All solvents and chemicals shall be segregated as per their MSDS and stored separately depending on their chemical reactivity and compatibility criteria.
- Chemicals shall be used, in any significant quantity, for maintenance in camp areas.

Cement Additives and Residues

Cement additives will be used during the Construction activities and will be stored within the cement production area in designated compounds.

Cement residues may be arisen during cleaning operations involving cement trucks and mixing facilities, when they are performed in-site. The residue shall be mixed with copious amounts of water. An area for the cleaning of cement-contaminated equipment shall be designated within the cement production area. This kind of wastewater shall be properly collected and disposed of in an environmental responsible manner.

Battery Acid

Battery acids will be used for maintenance requirements. They shall be stored separately from any other substance in a designated area within the hazardous substance storage area. It shall be stored in a supplier's container and shall not be de-canted into any other container.

Hazardous liquid wastes

The provisions of this Plan may be applied also to respond to potential spills of liquid wastes. Recommendations about hazardous liquid wastes management is reported in the Waste Management Plan

In addition, it shall be remarked that wastewater for large concrete-mixing equipment, if any, shall not be discharged on the ground. It shall be collected and disposed of properly. All washing equipment operation shall be carried out in identified locations where produced wastewater may be collected and disposed of in a proper manner.

Classification of Spills

As it may be detected from the above inventory, the pollutants most likely to be spilled are hydrocarbons and there would be essentially no difference in the impact of any one of these substances on the environment.

Therefore the spill contingencies are usually classified into three levels, or "Tier" approach and the classification is based on the entity of the spill and on the response resources required to deal with it, shown in **Exhibit K.2**. :

Exhibit K.2: Classification of Spill Contingencies

Tier	*Definition*	*Example*	*Responsibility*
Tier A	Minor Incident One that is easily brought under control and prevented from re-occurring by the Contractor	• Small, containable spills within the site boundary • Minor nuisance but controllable and preventable from re-occurrence • Minimal environmental damage but controllable and preventable from re-occurrence	Following the incident response the HSE Coordinator will be responsible for notifying the Environmental Manager / Construction Manager.
Tier B	Medium Incident One that will need to be brought under control and prevented from re-occurrences in consultation with the HSE Coordinator	• Un-containable or uncontrollable spills within the site boundary • Excessive uncontrollable incidents which are likely to re-occur to cause nuisance or when a complaint is received • Un-rectifiable environmental damage and likely to re-occur	Following incident response the Environmental Manager / Construction Manager will be responsible for notifying the local authorities and detailing actions to prevent re-occurrence.
Tier C	Major Incident (Emergency) One which cannot be controlled by the Project or that effects local authorities or independent parties	• Un-containable or uncontrollable spills outside the site boundary or which affect authorities supply networks • Excessive uncontrollable incidents which will re-occur to cause danger, nuisance, numerous complaints or significant impact to proponents reputation and / or principles • Massive environmental damage at the site which will re-occur to cause long term major impacts.	Following incident response the Environmental Manager / Construction Manager will, in agreement with proponent, be responsible for implementing the relevant authority's response plans.

The classification is to be considered only as a general guideline: who is responsible for dealing with the emergency shall decide, case by case, which actions are the most appropriate for the specific spill occurred.

The potential severity of a spill may be reduced by the following actions:

- Ensure that in site there are appointed personnel with appropriate and sufficient skills and information in order to mobilize promptly suitable resources;
- Allow rapid and orderly expansion of spill response by each Project areas as needed during a declared emergency;
- Optimize use of project resources, and facilitates the interface among contractor, Subcontractors, Government and their Agencies and others that could become involved in an escalating spill response;
- Provide flexibility to address local, regional, countrywide emergencies, with a clear understanding and devolution of responsibilities.
- As a spill evolves, its severity is continuously re-evaluated, and the level of response is adjusted as appropriate.

For the Project activities, the most probably spills are of Tier A: in order to deal with them the procedure explained in this plan will be applied.

Pollution Scenarios/Potential Incidents

Spills are usually related either to operator errors or to incidental events due to equipment failures.

Equipment failures include corrosion and leaking of pipes and tanks, valves failure, and sewer and drain leaks. Many of these failures may be avoided through proper inspection and maintenance procedures.

Operator errors include overfilling tanks and improper alignment of valves and piping. These and other operator errors can properly be corrected through developing operating procedures, regular training and testing of personnel, and systematic follow-up to assure that procedures are followed.

It is assumed that all personnel performing or supervising the various phases of work are familiar with international and local standards and have gained sufficient operational experience to be able to take preventive measures in all types of high-risk situations.

Furthermore, those responsible for the various phases of the Project Execution shall ensure that all vessels, vehicles, and equipment are kept in perfect working order and functioning efficiently. This will reduce drastically the likelihood of spill due to both human errors and malfunction/breakdown.

In addition, it will be their responsibility to ensure that all controls and necessary maintenance work are carried out correctly, so that the equipment in use is always in a perfect state.

Possible common incidents that may occur during site activities and may cause the release of hazardous materials include the following:

- **Spills during vehicle maintenance** such as oil leaks while changing the oil, engine coolant leaks while changing or adding coolant, and fuel leaks while refueling the vehicles. If these spills occur, the quantities should be minimal;
- **Oil/diesel spills** due to improper handling of drums and improper storage of them (Tier A expected – 200, 250 liters);

- **Paint spills** from painting and labeling equipment, oil and hydraulic fluid leaks from machinery, and gas leaks from welding equipment. The severity of these spills will vary depend upon spill detention and response (Mostly it is expected to be Tier A);
- In case of a **vehicle overturning**, the fuel tank may be damaged and a fuel spill occurs. Furthermore, depending upon what the vehicle was transporting, other spills may occur in conjunction with the fuel spill. The severity of these spill events is highly dependent upon several factors such as the hazard degree of the substances transported, where the spill occurred, and what, environmentally sensitive areas were affected, if any.
- **Breakdown of storage tanks**. The severity of these spills will vary depending upon the quantity involved, expected to be quite high (it shall be noticed that if the release occurs in the retention basin it is not to be considered as environmental accident, but a near miss).

In case of spills as a result of a **vehicle accident / collision** the severity will vary depending upon the quantity of vehicles involved and the severity of the incident.

Spill Prevention Strategies and General Response Action

Potential incidents are usually related either to operational/human errors or to unexpected events/breakdown.

All personnel performing or supervising the various phases of work shall be familiar with international and local standards and have gained sufficient operational experience to be able to take preventive measures in all types of high-risk situations.

The purpose of this section is to describe the preventive and planning measures and the responding procedures for dealing with spills of pollutant substances during the execution of the Project.

Specific responsibilities and procedures to be followed during prevention, planning, and spill response activities are detailed in the following.

The review of the procedures of this Plan will be carried out by contractor on as-needed basis.

The main objective of the emergency procedures review is:

- to determine if the procedures should be modified to prevent reoccurrence of similar accidents;
- to improve preventive and response measures;
- to investigate the causes that led to the spill;
- to keep records of spills and actions undertaken to deal with the emergency.

Spill Prevention

The main objective of the prevention and planning phase is the implementation of all possible measures to prevent any potential spill of polluting substances.

Prevention of spills shall be the prime objective and shall include operating practices (maintenance to the construction equipment and tools), inspections and monitoring of facilities.

Personnel responsible for handling and storage of liquids which may be involved in spills shall receive training on the best practices to be adopted in site.

In this phase, the resources appointed to manage the emergency arisen by the spill of pollutant substances, has the following tasks:

- ▷ to identify all the hazardous materials, related to Project activities, that may produce a health and safety risk for project employees and subcontractors and that may produce an environmental impact;
- ▷ to make all personnel working on the project informed about environmental protection concerned and to ensure that all workers are familiar with response procedures when a spill occurs;
- ▷ to ensure that the activities carried out comply with the procedures, especially those regarding prevention of spills into the environment of pollutant substances;
- ▷ to provide continuous training to enable workers to perform their work in a safe and healthy manner.

For the particular activities potential source of incident, the general strategies described in the following subsections shall be adopted in order to prevent the most critical spills.

The activities are:

- ▷ Chemicals and Hazardous materials handling and storage
- ▷ Oil changes
- ▷ Chemicals/fuel transfer
- ▷ Construction equipment operation

Chemicals and Hazardous Material Handling and Storage

Properly label containers;

- Keep an updated inventory of all chemicals and hazardous materials stored on site;
- Keep Material Safety Data Sheets (MSDSs) at storage areas: handling and storage shall respect the recommendations defined in;
- Use appropriate chemical segregation practices where any potentially toxic or hazardous material will be stored;
- Manual handling of hazardous materials shall be minimized and the use of forklifts or cranes with pallet loads shall be preferred;
- Storage areas of hazardous materials/chemicals shall be sheltered from the sun, provided with a means to restrict access, located away from occupied buildings

and work areas, and properly sign posted (**Exhibit K.4**) - eg. “no smoking”, “hazardous material storage area”, etc”.

- All hazardous chemicals and materials will be stored in contained bounded areas with impervious flooring, or according to the most conservative of relevant government regulations and guidelines regarding safe handling, storage and transport;
- All chemicals storage tanks and drums shall be located on paved area or contained within a suitably sized concrete retention bound. In this case the bound shall be provided with a lockable valve. All drainage valves shall be kept closed. They shall be opened only after checking the absence of chemicals in water to be discharged.
- Waste oils and other liquid wastes shall be stored in sealed drums within a designated secondary containment area or in a temporary storage area consisting of an earth bound lined with plastic sheeting;
- All fixed fuel storage tanks will be contained within a suitably sized concrete retention bund (**Exhibit K.3**);

Exhibit K.3: Hazardous Storage Area and Diesel Tanks Containment Basin

- Stationary fuel storage tanks and dispensing areas will have a containment membrane underneath and a bund around;
- In the event of a significant leakage from the fuel tanks in the bund retained fuel will be pumped back into another tank or the repaired tank. Residual fuel on the bottom of the bund will be soaked up using appropriate spill kits or sand and disposed of in compliance with Waste Management Plan. This episode has to be considered a “near miss”;
- For transferring of fuel from a delivery tanker to a stationary storage tank:
- The hose coupling must be compatible,
- The use of improvised connections shall not be permitted,

- Shut off valves shall be available and easily closable in the event of hose or connection failure,
- The operation must be supervised at all times.
- According to ESIA, daily and weekly checks will be undertaken of the construction area including chemical and hazardous materials / waste storage area: these will be recorded in the daily and weekly site inspection reports.
- The access to potentially hazardous materials shall be granted only to qualified personnel: Hazardous materials will only be handled by trained personal.

Furthermore, environmental warning signboards shall be displayed at critical pollution point, in order to address the workers to adopt good environmental behavior and promote environmental awareness.

Exhibit K.4: Environmental Awareness Signboards

Maintenance and Refueling

The maintenance and refueling activities shall be carried out on a dedicated area, properly demarcated and with signboard (preferably an area for each activity). The Area shall be:

- Located safe in terms of position;
- Not close to site traffic access routes;
- Not place within 30 m of any hot work activity;
- Not on environmentally sensitive surface.

The area shall be paved; only if there is not availability of any paved area, a non-paved area can be used.

The maintenance vehicles shall perform the activity only in the Maintenance area and every vehicle shall be provided with:

- MSDS;
- Drip tray;
- Spill Response Kit;
- PPE;

- Fire extinguisher.

During Maintenance and Refueling, the following measures shall be strictly put in place in order to avoid any kind of contamination of the ground and ground water.

- Place retention tanks or drip trays below drum taps and fuel hoses to collect every drips and leaks and provide spill response kit
- Use portable tanks placed under engine drain points to prevent any spilling of oils during oil changes. The contents of these tanks will be transferred immediately to sealed drums within the designated waste oil storage areas;
- Place retention tanks or drip trays below all terminals and in-line connections (e.g. drum taps, fuel hoses, etc.) to collect drips and leaks. Couplings will be appropriate, shut off valves easily accessible;
- Check tanker delivery hose for residual fuel from last fuelling operation. If there is residual fuel, handle the delivery hose accordingly;
- Properly connect delivery pipes. Ensure the integrity of all terminal and in-line connections;
- Operator must control the dispenser at all times.

If there is some oil that spills inside the drip tray, it shall be put again in the tank or dispose as indicated in Waste management plan. This episode has to be considered a near miss.

Exhibit K.5: Drip Trays under Fuel Hoses and Drums Stored Temporarily

Construction Equipment Operation

- All welding machine, compressor units, water pumps, power generators (on wheels or not) - diesel and petrol operating construction equipment shall have drip trays placed under them during operation (any eventual spillage – that in this case has to be considered near miss- will be collected and disposed of as hazardous waste);
- Trucks transporting oils, greases and fuels for the earthmoving machinery shall be equipped with anti-spilling devices on distribution nozzles and pistols.

- Heavy vehicles and cranes shall be assisted during maneuvering to avoid incidents;
- All plants and vessels shall be maintained in an efficient state, efficient working order and in good repair;
- Vehicle maintenance and Routine inspections of components and systems shall be carried out as per the manufactures maintenance manual;
- Vehicles and equipment will be kept in designated areas away from sensitive environments.
- Pre start checkup and visual checks to be carried out to ensure the integrity of the plants/equipment.

Exhibit K.6: Equipment Washed in a Dedicated Area inside Drip Tray

General Response Action

This section provides a general overview of response options to deal with possible oil and chemical spills during site activities. These may include more significant spills arising from accidents, or spills resulting from leaking fuel tanks, chemical drums, etc., that can lead to large releases of material.

Any incidents where pollutant spills are involved require immediate response to stop the source of the discharge, to limit the spread of material and to ensure the safety of personnel and the sensitivity in the area where spill occurred.

During response operations, priority shall be given to the protection of health and safety of the personnel involved. Therefore, appropriate PPE shall be worn during the response activities.

The main objective of the response phase is to minimize the effects of any spill and, if necessary, to clean-up the site concerned.

In this phase, the organization assigned to manage the emergency has the following tasks:

- to guarantee the immediate identification of the spill;
- to take action to handle the emergency phases after the spill of polluting substances, and specifically to stop and contain the spill, taking the necessary

steps to protect personnel and the environment, thus minimizing the negative effects of such an occurrence;

- to take action to clean-up the impacted area.

Spill Identification

The first step after the occurrence of a spillage is the identification of its source. Once the spill has been assessed, response measures shall be immediately selected and undertaken in order to mitigate its effects. Any response action may depend on the spill severity.

Incident Evaluation

After spill identification, the severity of the spill shall be evaluated in order to select the proper response strategies.

In addition, the situation shall be assessed to determine whether evacuation is required. If necessary, traffic will also be re-routed.

Once these factors have been determined, the proper level of response will be determined. In any case, after stopping the release of material to the environment, containment shall likely be the next step of response process.

Spill Response Equipment

As rapid containment of any spill is desirable, the equipment for the clean – up shall be suitable for adequately respond to the type of substance spilled.

In particular, according to CEMP, spill kits shall be provided in the construction site in the area where a possible scenario of spill, as described, can occur.

Commercially are available different types of spill kit (**Exhibit K.7**), fit for the purpose (i.e. volume of spill, liquid involved, outdoor / indoor spill, etc). In the common spill kit the following items are provided:

- Absorbent pillows and granulate;
- Polypropylene adsorbent pad;
- Containment drip pans;
- Shovels;
- Protective gloves;
- Goggles / safety glasses;
- Heavy duty oil resistant storage bags;
- Duct tape.

Exhibit K.7: Spill Response Kit

The pollutant materials, arisen by clean-up actions, shall be disposed of in compliance with Waste Management Plan

All response and clean up material will be replaced as soon as practicable after it has been used.

After an incident, the effectiveness of the present Plan shall be assessed and, if necessary, the spill response procedure shall be properly improved and updated.

It is contractor and subcontractor duty to verify that their workers are equipped (and trained to use) with all PPE prescript on specific MSDS concerning each chemical substance used.

It is Contractor and subcontractor duty to include type of PPE to be used specifically to individual chemicals, as prescript on MSDS, on their HSE Plans. This information will be available before to the site activities and will be transmitted by HSE Manager.

Containment methods

Selection of appropriate control and containment techniques is dependent on site-specific conditions, such as:

- the nature of the substrate;
- the slope of the terrain;
- the amount of product;
- the time available to implement response action.

The following subsections describe **general containment** and **clean-up techniques** to treat pollutant spills that have impacted impermeable and permeable land surfaces.

The objective of surface containment is to prevent the spread of spilled material on soil surface and to intercept the horizontal movements in the subsoil. The most important containment techniques are:

- **surface containment**: to prevent spread of substances on soil surface or substrate surface and to prepare it for the recovery;

- **sorbent barriers**: to form a continuous barrier to limit spreading and collect the pollutant to allow recovering by physical removal of spent sorbents or by pumping.

Surface Containment

The method for surface containment of fuels, solvents, chemicals, and other dangerous or hazardous toxic materials on impermeable ground may consist of:

- block inlets/outlets to drains, pipes, sewage systems, and cable ducts to prevent explosion risk or contamination of sewage treatment plants or water courses (if any in the area);
- use sorbents to limit spreading;
- concentrate the material by brushing it in to a collecting area, or by creating an absorbent barrier that can be tightened around the pool, so that it can be transferred to a container.
- In case of a spill directly to permeable ground or if spilled material escapes a bermed area, one of the following approaches will be employed:
- for smaller spills, increase sorption capacity of surface layers by spreading absorbent material;
- use absorbent barriers to contain the spill;
- for larger spills or where movement is an issue, construct barriers, such as berms, dams, and trenches, to contain or divert the flow. These barriers can be constructed with readily available tools and equipment, such as shovels, earth-moving equipment, and sorbents;
- block all inlets, except the oily water drains, and let the pollutant flow enter an oil interceptor via the water drainage system and retain it there;
- in presence of oil spill, bulldoze or otherwise move any free oil and oil-saturated soil to the nearest natural or artificial impermeable surface.

The confinement operations should be started immediately to limit the amount of penetration of spilled material into the soil surface, thus containing the spill impacts.

The advantage of the containment methods is that confinement and damming can be achieved using easily available materials and are suggested if the pollutant is to be pumped and/or sucked up.

Sorbent Barriers

Sorbent materials may be stacked or piled to form a continuous barrier across the entire leading edge of the advancing pollutant mass to contain minor flow and recover a portion of the hazardous substance. Collected pollutant is recovered by physical removal of spent sorbents or by vacuuming or pumping when quantity exceeds absorption capabilities of the sorbents.

The application depends on the form of the sorbent; generally they are spread or applied over the slick and, after absorption, they are collected by various methods.

Clean-up, Recovery and Removal Methods

The appropriate clean-up technique to be used depends on the location of the incident, volume and type of the pollutant involved, and the amount of soil that has to be removed. For smaller spills, storage containers, such as lined drums or lined hauling trucks, will typically be sufficient for collection and transport of the recovered and waste materials. For larger spills or if insufficient storage containers are available, the removed material may be held, prior to disposal or treatment, in a lined excavated ditch prepared using a bulldozer.

Depending on the specific circumstances of the spill, the choice on how to conduct recovery depends on:

- the material spilled;
- the quantity spilled;
- the location of the spill and terrain of the surrounding area;
- potentially endangered resources;
- manpower and equipment resources available.

These factors define the possible impact of the spill and the options for cleanup. The expected benefits from using a particular technique must be weighed against the potential impact to the environment from the suitable clean-up techniques.

Possible recovery and removal strategies include:

- excavation;
- recovery pump system.

Excavation

It is used to remove impacted unsaturated soil and prevent contamination of the ground water.

Contaminated soil may be removed by mechanical excavation, using various types of earth-moving equipment, to prevent the contamination of the groundwater.

The method should not be used:

- if excavation will disturb or penetrate an impermeable natural layer;
- if there is a risk of damaging underground utilities such as pipes and electric cables;
- for large spills, because there is a danger of causing more damage and costs also rise steeply with increased depth: recovered material may cause disposal problems.

The advantage of the method is that early and successful excavation can save long-term recovery operations and it may be the most economic method of recovering high viscosity substances (heavy fuel oils, some crudes, etc), even though it may increase the volume of impacted materials for disposal.

At the end of clean-up operations the stored material will be disposed in accordance with the Waste Management Plan. Recovered waste materials will be collected and transported as specified in the above mentioned specification.

Recovery Pump System

It is used to remove pollutant from the water table. This strategy is generally applied to a site when the depth of the groundwater table is not significant.

K.3 Air Pollution Control Plan

K.3.1 Framework

Scope and Objective

The Air Pollution Control Plan ensures the implementation of the mitigation measures related to the air pollution control as identified in the ESIA. It also encourages incorporation of energy efficiency and renewable energy measures.

This Plan aims to reduce the sources and amounts of pollutants responsible for the loss of any air quality, acidification and global warming and to improve the quality of life, protecting their health risks from air pollution.

Responsibility and Timeline

The Contractor will devise the specific plan identifying the monitoring points and detail of the monitoring location in accordance with the clients and regulatory requirements.

K.3.2 Key Features

1. This Plan has also been the initial commitment of client to reduce dust, greenhouse gases (GHGs) emissions in a context of sustainable development with economic growth, social cohesion and environmental protection at the project level.
2. The plan should be considered in accordance with the other plans.

K.3.3 Guidelines

The strategic lines on which contractor should submit his detail plan is as follows:

- Having an optimal system of assessment and forecasting of air quality for monitoring PM10, PM2,5, SO2, NOx, CO
- Water will be sprinkled regularly to suppress dust emissions
- Stock piles from leveling will be appropriately located and dampened to avoid dust emissions
- All the equipment and machinery will be inspected regularly for any maintenance
- Contractor’s equipment and machinery will be properly maintained and provided with necessary noise reduction and control equipment such as silencers and mufflers

- Regulate speed of construction vehicles
- Reduce the sources and amounts of pollutants responsible for the loss of urban ambient air quality
- Achieve a level of air quality where concentrations of air pollutants do not pose a risk to human health and the environment.
- Improving awareness and promote a change in consumption and mobility habits.
- Improve coordination, exchange information and implement joint work with other public and private agencies related to air quality.
- Increasing transparency and keep the public informed about air quality.

K.4 Waste Management Plan

K.4.1 Framework

Scope and Objective

The scope of this plan should be to describe the main principles of Waste Management strategy and to describe how client wishes to deals with wastes generated by its activities, products and services (collection, handling, transportation, storage, treatment, disposal, records keeping, auditing). It should provide guidance to personnel and contractor for managing waste effectively and within the requirements of the applicable waste Laws and Regulations.

The purpose of the present Plan is to provide effective guidance for the management of all the Waste generated during Project execution.

Responsibility and Timeline

The Contractor will devise the specific plan identifying the sources of waste generation and different ways to minimize it before starting any activities on the project site.

Key Features

Following are the key features of the Waste Management Plan

1. A Waste Management Strategy should be provided within the Waste Management Plan
2. Waste minimization strategies shall be identified in the plan which includes material elimination, inventory control and management, material substitution, reduction in the consumption of natural resources, process modification, and improved housekeeping.
3. It should identify options which can reduce generation at the source.
4. The objectives related to Waste Management should be described. This will include solid waste and wastewater.

K.4.2 Guidelines

Following guidelines shall be followed while developing a Waste Management Plan

1. It should identify options including Reduce, Reuse, Recycle, Recovery (e.g. energy recovery), and Responsible Disposal
2. It should identify options which can reduce generation at the source.
3. It should promote the segregation of waste. Segregation shall be done in compliance with local requirements and in accordance with final destinations available options.
4. It should include the storage procedure for the waste. This shall include the storage area, supervision of storage area and maintenance of the storage area.
5. It should ask to maintain an up-to-date inventory of all wastes temporarily stored on the site, together with relevant health and safety information.
6. It should give particular attention to hazardous waste storage and collection
7. It should include guidelines to handle hazardous waste.
8. It should provide options and conditions for the waste transport.
9. It should ask for evidence of the NOC / permit available to the Environmental Manager prior of the waste transportation.
10. It should provide guidelines on the handling of the medical waste.
11. It should provide the a list of processes, parties and responsibilities for Waste Management
12. It should have a clause regarding the trainings for handling waste.
13. It should include details regarding inspections and audits.
14. It should ask for the reporting of waste produced, generation process and amounts generated and transported to the waste treatment/storage facility

Apart from the above guidelines the below sections provide the details of an expected Waste Management Plan

Waste Management Strategy

Waste management includes the collection, temporary storage, transportation, recovery/recycle, treatment and disposal of waste produced by activities in an effort to reduce their effects on human health and environment throughout the entire cycle of life of their products or processes.

Contractor and its Subcontractor shall take the necessary measures to ensure that waste management is carried out with the duty of care and without endangering human health, and harming the environment. In particular risks to water, air, soil, plants and animals, and nuisance through noise or odors shall be avoided.

The basic principles of waste management in activities are summarized as follow:

- Reduce
- Reuse
- Recycle
- Recovery (e.g. energy recovery)
- Responsible Disposal

This shall be considered as a hierarchy, which shall apply in a priority order in waste prevention activities and management taking into account the Best Environmental Practicable Option (BPEO) and Best Available Control Technology (BACT).

At all levels everyone shall take measures, as appropriate, to promote the application of this hierarchy in all activities.

Waste Minimization Strategy

Waste minimization (source reduction and reuse) helps to conserve resources and reduce pollution, including greenhouse gases that contribute to global warming. Moreover, it reduces waste disposal and handling costs, because it avoids the costs of recycling, municipal composting, landfilling, and combustion.

Source reduction is the practice of designing, manufacturing, purchasing, or using materials (such as products and packaging) in ways that reduce the amount and/or the toxicity of waste created. This process include, e.g.:

- material elimination
- inventory control and management
- material substitution
- reduction in the consumption of natural resources.
- process modification
- improved housekeeping

Reuse (without any treatment) is the way to stop waste at the source because it delays or avoids items entry in the waste collection and disposal system.

Client and contractor will dedicate all efforts dedicated towards minimizing waste generation at the source, by preventing the generation of waste and by selecting product and raw material alternatives of lesser damage to the environment.

Following some minimization actions that will be implemented:

- reduce the water consumption (and consequently the wastewater production) from accommodation camps through personnel awareness campaign and with the use of taps aerator and two-way flushing system
- reduce equipment and machinery wash water through awareness campaign of the involved personnel
- reduce packaging and packing material buying in bulk. Packaging and packing material will be reused for other purposes (shipping, etc.)

- used wooden planks will be reused for concrete formworks and scaffolds
- timber will be used for project sign boards, etc.
- empty drums will be used as waste bins
- metal scrap will be used for other purpose, as metal drip trays, etc.
- paper from office will be reduced with proper awareness campaign of the personnel (i.e. avoid printing, two-side printing, etc.)
- the use of small water bottles will be limited and use of water dispenser and reusable glasses will be enhanced, especially in offices. Water bottles may be refilled several times at the water dispenser
- soil cut material will be reused as filling material, if technically possible, or for unpaved road maintenance.

Opportunity for minimization will be identified and consequently prioritized during the entire execution of the project.

Waste Treatment

Substances or object that cannot be reused (waste) shall be properly treated before disposal where possible. Waste treatment refers to the activities required to ensure that waste has the least practicable impact on the environment.

According to waste hierarchy recycling/recovery is the first option of waste treatment. Recycling/recovery is the conversion of wastes into usable materials and/or extraction of energy or materials from wastes.

Waste Disposal

Responsible disposal is the depositing of waste on land (e.g. landfilling) trying to mitigate any negative impact to the environment. Disposal is the least desirable waste management option and shall be discouraged, and considered only for unused waste.

Waste Management Activities

Client is committed in the application of the strategy described above and in particular to ensure that efforts will be dedicated toward waste production minimization. Where feasible, the waste will be managed according to the described hierarchy.

The waste generator (Contractor and Subcontractors) is the owner of the waste and in thus responsible for the correct handling in accordance with applicable legislation until it reaches the approved waste management facilities.

Target and Objective

The objectives for the first year related to Waste Management are described in the following table (the objectives for the following years will be contained in other relevant document):

Exhibit K.8: SMART Objectives

Subject	*Specific*		*Measurable*	*Achievable*	*Responsibility*	*Timely*
	Description of objective	*Activity*	*Indicator*	*Target*	*Responsible Department*	*Time Frame*
Waste	Waste Segregation	Implement segregation on project sites	No of sites where segregation is done vs. total No of sites	100%	Construction	End
Waste water	Wastewater	Minimization of wastewater from camps	Wastewater discharged per person per day / 160 liters	1,00	Camp Boss / HSE	End
Solid Waste	Mixed solid waste	Minimization of mixed solid waste from camps	Mixed solid waste produced per person per day / 2 kg	0,90	Camp Boss / HSE	End

Waste Identification and Classification

The first step of a proper and effective waste management is the identification of waste streams arising from project activities and temporary offices/accommodation camps.

The waste shall be properly classified in order to select the best available management technique. According to applicable laws and regulations wastes are classified, shown in **Exhibit K.9**:

Exhibit K.9: Waste Identification and Classification

Classification	*Examples*
Solid Waste	Like domestic, industrial, agricultural, medical, construction and demolition wastes
Liquid waste	Effluents from residential, commercial and industrial premises and others
Gas, Fume, Vapor and Dust Wastes	Produced by crushers houses, bakeries, incinerators, factories, quarries, power stations, oil works, and transportation and commuting various means
Hazardous Wastes	The residual or ash of the various activities and operation having hazardous contents.
Non-Hazardous Waste	Other wastes that may not be classified as hazardous
Medical Wastes	Any wastes made in whole or part of human tissue, animal tissue, blood or other body liquids, secretions, drugs or other pharmaceutical products, bandages, syringes, needles or other medical sharp objects, or any other wastes whether contagious chemical or radioactive produced by medical activities, nursing, treatment, medical care, dental, veterinary or pharmaceutical or processed activities or others, tests, research works or study materials or sampling or storage of the same.

Should the classification of a waste is unknown (whether hazardous or non-hazardous), the Project HSE Site Coordinator and HSE Site Inspectors shall conduct initial field screening using portable testing equipment or monitors (e.g. LEL meter, PID monitors, pH testing equipment, etc.) on wastes to determine if they exhibit any hazardous characteristics. If an unknown waste is identified as hazardous or potentially hazardous, the material should be subjected to laboratory testing to guarantee its proper classification.

Waste Segregation and Collection

The segregation of different waste streams is a pre-requisite for implementing a good waste management system.

Wastes sorting shall be promoted at all level for a more efficient handling before treatment or disposal. Segregation shall be done in compliance with local requirements and in accordance with final destinations available options. To facilitate and improve recycling/recovery, waste shall be collected separately if technically, environmentally and economically practicable and appropriate to meet the necessary quality standards for the relevant recycling sectors, where available.

Waste shall not be mixed with other waste or other material with different properties. In any case hazardous waste shall not be mixed (or diluted), either with other categories of hazardous waste or with other waste, substances or material.

Wastes shall be collected in adequate containers (bins, skips, etc.) as they accumulate. A color code system shall be implemented in order to facilitate the segregation process. In all areas good housekeeping shall be maintained at all times. The number of categories of bins/skips shall be consistent with waste generated in the relevant areas. Clear signboards/placards shall be put on the skips/bins in all the collection points, in order to help identifying appropriate waste type and promote segregation.

Waste Storage

Specific areas for waste temporary storage shall be foreseen on construction sites and temporary yards. Waste temporary storage areas will be located at main and satellite Construction Camps

Temporary waste storage shall be conducted in a way to prevent risks to the environment (water, air, and soil) and public health, and without causing a nuisance through dust or odors. These locations shall meet the most stringent safety and environmental conditions.

Temporary waste storage areas shall be well identified by clear signboards and properly fenced. Waste removed from the various generation areas shall be collected, transferred and temporally stored in this main collection points for a definite period, before being sent off site. A dedicated competent person will be appointed to supervise the area in order to:

- Receiving wastes and ensuring they are placed in the correct area
- Ensuring all containers are properly marked with the relevant information
- Ensuring all wastes are properly packed/contained with adequate isle spacing between containers for inspection and emergency exit

- Regular inspection of the area to ensure integrity of all waste storage containers
- Control over the removal of wastes from the area by contractors or others
- Ensuring all containers are securely covered except when waste is being added or removed
- Receiving and issuing waste transfer consignment notes
- Maintenance of waste transfer records
- Security and cleanliness of the storage area.

An up-to-date inventory of all wastes temporarily store on site must be maintained, together with relevant health and safety information. Other kind of form, containing the same information may be proposed by subcontractor.

Particular attention shall be given to hazardous waste storage area and collection. Hazardous waste should be removed from sites/facilities as soon as practically possible and shall be handled by competent persons. Bins/skips provided for hazardous waste collection shall be identified by labels indicating the type of waste contained and shall be located in a paved area cover by a roof, if necessary. The Hazardous wastes shall be collected and stored in compliance with applicable legal requirements and recommendations of the relevant Material Safety Data Sheets (MSDSs), which shall be available on site. Fire-fighting and spill response provision shall also be available on site.

Liquid contaminated/hazardous waste shall be stored in secure fenced areas, with impermeable bounded base (covered by a roof). These areas shall have a suitable drainage control. Containers and storage tanks shall be designed of suitable/compatible material to contain the waste. Fire-fighting provision and spill response material shall be available on site.

The following practical criteria shall be kept into consideration, particularly while handling Hazardous Waste:

- Hazardous waste shall be stored in dedicated leak-proof containers provided with tight caps and seals with appropriate capacity;
- Clear marks shall be placed on hazardous waste storage containers stating the contents and indicating the hazards associated with handling and storage;
- Flammable substances must be kept separate from sources of ignition or oxidizing agents;
- Acids must be kept away from substances with which they may react, producing dangerous compounds e.g. cyanide;
- Strong corrosive agents must be kept away from gas cylinders or other containers;
- Volatile liquid waste should be safely stored in closed drums in a dedicated open area;
- Pressurized aerosol cans must be collected separately in a single, suitably marked container;
- Hazardous waste containers shall not be located in public areas at any times.

Applicable local legislation does not indicate any time/quantity limit related to hazardous/non-hazardous waste temporary storage area, anyway the maximum retention time for storage in site may not exceed 3 months and 10 m3, according to the best practice. In any case, putrescible waste shall be removed daily from the storage area.

Waste Transportation

Wastes produced during activities shall be treated or disposed to offsite facilities and areas.

No waste shall be given to a Third Party

Competent appointed personnel shall check if subcontractor complies with the following requirements:

- Any vehicle used to transport waste shall be constructed and maintained so as to prevent spillage of waste and equipped with all safety equipment
- Any container used to transport the waste shall be secured safely on the vehicle used to transport the waste
- Any vehicles used to transport waste shall be covered when loaded
- Any vehicles shall not overloaded
- Incompatible wastes shall not be mixed or transported together
- Any material segregated for recycling shall not be mixed with different waste during transportation
- Any vehicles shall be driven by trained licensed drivers
- Any vehicles shall display clear marks indicating the extend of danger of their loads (if any), and the best course of action in emergency cases.

To assure waste traceability, each shipment shall be documented as per local laws and regulations Waste traceability shall be assured for all waste typology by Contractor and Subcontractors, even if not specifically required by applicable law (log and register shall be used for all type of waste, the use of WTN also for non-hazardous waste will be assessed, if feasible).

Final Destination

In order to assure the proper management of waste treatment/disposal throughout all the waste cycle all waste shall have proper authorization by Competent Authority and, as a minimum, comply with applicable legislation for disposal site. Evidence of the NOC / permit shall be available to the Environmental Manager prior of the waste transportation.

Medical Waste Management

Medical waste shall be properly segregated into the categories and disposed of only in proper containers prepared to this purpose under the directions of the Ministry of Health.

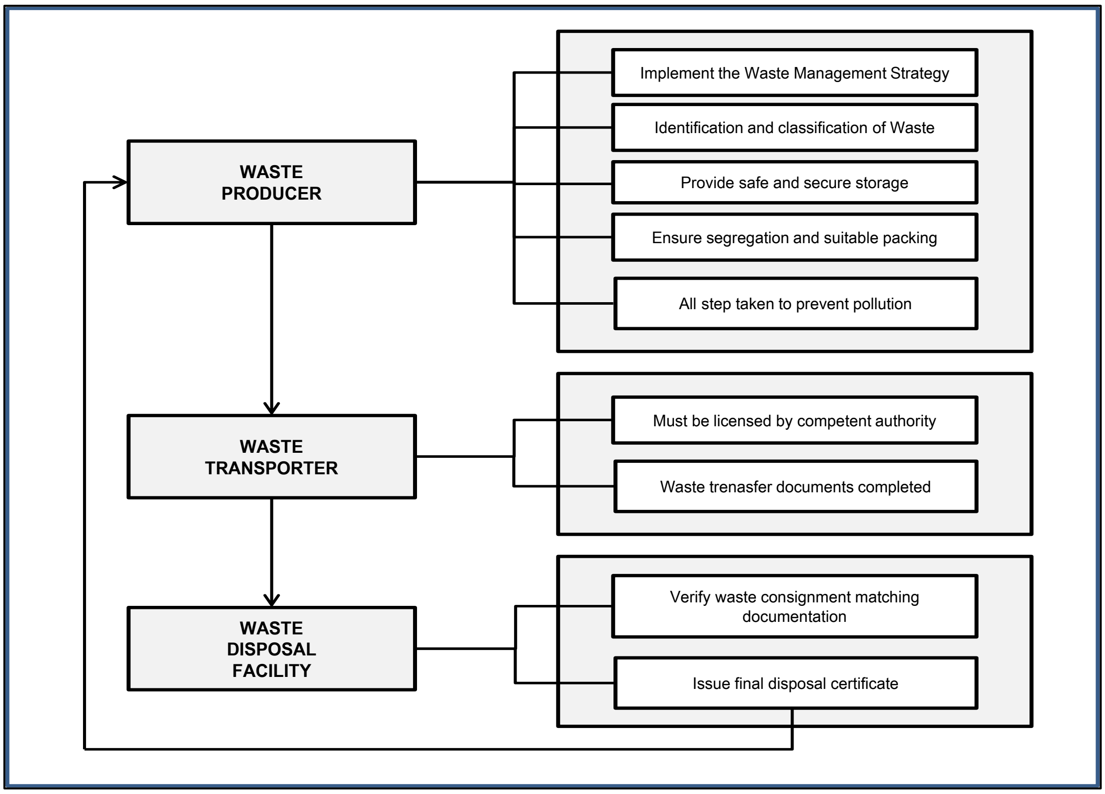
Duty of Care

Everyone who produced, handles, stores, transports or disposes of waste has a duty of care to ensure that:

- All reasonable steps are taken to ensure the waste is kept in a safe and secure state
- The waste does not cause pollution of the environment
- The waste does not harm people.

Duty of care process and parties responsibilities are summarized in **Exhibit K.10**.

Exhibit K.10: Process and Parties Responsibilities for Waste Management



Training

At all level personnel shall receive proper information about waste management requirements, in particular regarding waste prevention strategy and proper segregation.

Personnel involved with waste handling shall be provided with basic and/or specific information about most significant issues related to waste management. Workers engaged in the handling and management of the hazardous waste shall be properly trained (hazardous material handling) and competency assurance shall be guaranteed.

Inspection and Audit

Environment Department will undertake periodic waste management site inspections. All sites shall be duly inspected with reference to the generation, storage, transportation and disposal of all waste types.

An Inspection schedule (Daily, Weekly and Monthly) will be implemented and proper check lists will be prepared. Weekly inspection shall be undertaken on Temporary Waste Storage Areas.

Periodic Audit will be undertaken, and proper schedule will be prepared before commencement of construction activities. Internal Audit will be performed monthly while annual corporate audit will be also scheduled.

Reporting

Contactor and its subcontractors shall keep records or logs of waste produced, generation process and amounts generated and transported to the waste treatment/storage facility. The records shall include:

Full description of wastes showing their dangers and their physical and chemical characteristics

- Quantities
- Sources
- Collection rates and periods
- Transport means
- Treatment method

The name of the contractor to which these wastes are delivered

The Environment department shall prepare a weekly waste management report and send it to the Projects' Corporate function, as required in the Contract. The report should include the following:

- Total quantities/volumes of hazardous and non-hazardous wastes sent to each disposal facility;
- Total quantities/volumes of separated/recycled wastes;
- Sewage liquid quantity sent for disposal;
- Complaints received from the nearby sensitive receptors on odor or other nuisances as a result of generated wastes; and
- A summary of any waste incidents/spills reported during the year.
- Contractor and its subcontractors shall prepare the monthly report

K.5 Muck Disposal Plan

K.5.1 Framework

Scope and Objective

This plan provides the disposal plan for the Muck which will be generated from the project activities. The objective of this plan is to avoid soil and water contamination which may be caused by the muck produced at project site.

The details of the Muck excavation are provided in the **Section 3**.

Responsibility and Timeline

According to the waste management plan the producer has the responsibility of safe disposal of any waste which makes the contractor responsible for the disposal of Muck.

Key Features

The Muck Disposal Plan should include following things;

1. Should identify the options for muck disposal
2. Should encourage reuse of much as fill material.
3. Guidelines on the location of the disposal point.
4. Guidelines regarding the transportation of muck

K.5.2 Guidelines

Key issues related to the muck disposal plan to be submitted by the contractor should include

- According to the waste management plan the producer has the responsibility of safe disposal of any waste which makes the contractor responsible for the disposal of Muck.
- The muck disposal should be carried out in accordance with the client's environmental policy and legal requirement.
- The extent of possible reuse as fill material of the muck for the construction activity
- The location of the disposal point. The disposal point should be downwind to the habituation and water bodies
- All the relevant permits and documentary proof be obtained from the relevant authorities
- Clear route for transportation of muck to the identified and approved sites be identified and discussed in the plan
- Dust control measure identified in air pollution control plan be implemented and documented
- Proper roles and responsibilities of the concerned be identified

K.6 Traffic Management Plan

K.6.1 Framework

Scope and Objective

The Traffic Management Plan includes the construction related traffic issues which may pose a threat for the social receptors alongside the project area. The objective of this plan is to minimize the impact the project related traffic on the receptors.

Responsibility and Timeline

Every contractor should submit the traffic management plan and get a prior approval from the client before the commencement of any activity on the site.

Key Features

The plan at minimum should include the following mitigation measures

The traffic management plan should:

1. Be in line with the client requirement on the traffic management
2. Adhere to the local rules and regulation
3. Identify clear roles and responsibilities
4. Identify monitoring plan for management

K.6.2 Guidelines

- Contractor’s vehicle will follow strict speed limits within city and all applicable local traffic rules and regulations
- Contractor’s personnel will only use access routes assigned to them for project activities which will be finalized during the kickoff meeting with representatives of client, subcontractor and social receptors
- Movement of contractor’s vehicles for transportation of material and wastes from and to the site will be restricted to low traffic timings.
- Contractor’s vehicles and equipment will be parked at identified designated area. Vehicles and machinery should be appropriately parked/ placed to provide ample access to local commuters/pedestrians
- Diversion plans will be developed to minimize disturbance to local population during occasional high activity timings / days. These plans will be communicated to residents well in advance and proper diversion signs will be placed to inform locals.
- Prior communication to residents and safety signs will be installed well before the commencement of any activity at site

K.7 Health and Safety Plan

K.7.1 Framework

Scope and Objective

The Health and Safety plan is to be prepared in accordance with client’s requirement, IFC Performance Standard 4 Community Health and Safety (**Section 2.3**), which require that a plan is in place to effectively respond to emergencies associated with project hazards and that local communities are involved in the planning process and World Bank Group

General EHS Guidelines, Volume 3 and other relevant of the EHS Guidelines relevant to the Project.

Responsibility and Timeline

Contractor will submit a detailed Health and Safety Plan.

K.8 Emergency Preparedness and Response Plan

K.8.1 Framework

Scope and Objective

Emergency Preparedness, Response and Recovery Plan (EPRRP) will be prepared in accordance with IFC Performance Standard 4 Community Health and Safety (**Section 2.3**), which require that a plan is in place to effectively respond to emergencies associated with project hazards and that local communities are involved in the planning process and World Bank Group General EHS Guidelines, Volume 3 and other relevant of the EHS Guidelines relevant to the Project.

Responsibility and Timeline

The contractor will prepare and submit an EPRRP

Key Features

The EPRRP will at minimum contain the following elements:

- Planning and management commitment (Scope, Policy and regular update);
- Roles and Responsibilities;
- Internal Communication Protocol;
- Resources;
- Monitoring;
- Contingency Plan (in addition to shared SCP);
- Emergency response procedures for each emergency scenario;
- Mock emergency scenarios and drills schedule; and
- Review (to identify missing or weak elements, consistency with any regional and national disasters plans and compliance with relevant legislation and codes).

K.8.2 Guidelines

- In particular the emergency preparedness and response plan needs to include measures to be taken in the case of dam failure and flood, to ensure safety of downstream communities. Additionally, fencing and signage should be employed to ensure community safety in case of flood risk.

Appendix L: Biodiversity Action Plan

Hagler Bailly Pakistan

Gulpur Hydropower Project

Biodiversity Action Plan

Draft Report

HBP Ref.: D4BP4GHP

October 12, 2014

Mira Power Ltd (MPL)

Islamabad

Contents

Appendices:

Exhibits

1. Introduction

Where biodiversity values of importance to conservation are associated with a project site or its area of influence, the preparation of a Biodiversity Action Plan (BAP) and/or a Biodiversity Management Plan (BMP) provides a useful means to focus a project's mitigation and management strategy. The development of a BAP/BMP might be required under a company's own biodiversity policy, or International Finance Institutions (IFI or "Lenders") might request a BAP/BMP to help demonstrate compliance with Lender standards. Other parties, such as government agencies, conservation organizations or Affected Communities, might also be interested in the development of a BAP/BMP to address a specific topic of concern.[1]

This Biodiversity Action Plan (BAP) has been prepared to support the corporate commitments of Mira Power Ltd. for conserving biodiversity in the Poonch River basin in Azad Jammu and Kashmir (AJK).

1.1 Background and Rationale for Developing BAP

Mira Power Limited (MPL or the Company) is an Independent Power Producer (IPP) which is planning to develop Gulpur Hydropower Project (the Project) in the Azad Jammu & Kashmir (the AJK). The Project will utilize the flow of Poonch River, the full length of which within AJK has been notified as a national park by the AJK Wildlife and Fisheries Department.

The Project will be a run-of-the-river (RoR) type and will require construction of a 58 m dam on a bend of the Poonch River. A surface powerhouse would be located about 1 km downstream of the dam in the Poonch River. Two or three tunnels (depending on the number of units chosen) each about 180 m long, would connect the water inlet to the powerhouse. The water after passing through the powerhouse would be discharged back into the Poonch River.[2] As a result of Project operations, approximately 0.7 km of the river stretch between the dam and the power house will experience low water flow. A reservoir will be created upstream of the dam and the total submerged area (including the present river) will be approximately 5,884 kanals (2.95 km^2). There will be no flooding of occupied land. Details are provided in the ESIA of the Gulpur Hydropower Project.[3]

A Critical Habitat Assessment of the Project site was carried out in January 2014 according to the definition in IFC's Performance Standard 6[4]. It was determined that the

1 Policy on Social and Environmental Sustainability, January 2012. Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

2 Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd.

3 Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd.

4 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

Project is located in a Critical Habitat in view of its location in a National Park (Poonch River Mahaseer National Park) as well as the presence of two fish species of conservation importance: Mahaseer Tor putitora and Kashmir Catfish Glyptothorax kashmirensis listed as Endangered and Critically Endangered respectively in the IUCN Red List.[5] A summary of this assessment is outlined in **Section 2**.

According to IFC's Performance Standard 6, when any developmental project is located in a Critical Habitat, the client is advised to include a Biodiversity Action Plan as part of its mitigation strategy. This BAP should be designed to achieve net gains of those biodiversity values for which the Critical Habitat was designated. In addition, a letter from the Directorate of Wildlife and Fisheries, AJK (office of Director of AJK Wildlife and Fisheries Department) has granted permission to the Company to construct and operate the Project on the condition that the Project will "demonstrate achievement of betterment of the national park over the life of the Project compared to the prevailing baseline conditions" (**Appendix A**). Therefore, this Biodiversity Action Plan has been developed to address regional biodiversity concerns and to achieve net gain for the biological resources of the Poonch River basin as outlined in the IFC guidelines and as specified in the permission letter from the Department of AJK Wildlife and Fisheries (**Appendix A**).

While the EIA (Environmental Impact Assessment) contributes towards meeting regulatory requirements and helps Project proponents adhere to their commitment of minimizing the impact of their operations on the environment, a BAP focuses on conservation, protection and enhancement of the biological resources in the designated Study Area that provide important ecosystem services. In the case of the Poonch River, these resources include the aquatic and semi-aquatic species primarily the fish, macro-invertebrates, marginal and flood plain vegetation as well as Otter that are dependent on the river. The Environmental Impact Assessment (EIA) developed for the project has been submitted both to the AJK Environmental Protection Agency (EPA) and the International Finance Corporation (IFC).

1.2 Importance of Biodiversity

In simple terms biological diversity, or biodiversity, is the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems (UN Convention on Biological Diversity, Article 2). [6] Biodiversity provides us with a host of raw materials, foods and medicines and is the basis for the life support system of our planet by for example, underpinning the continued availability of clean air and fresh water. Interwoven with these functional aspects are spiritual, cultural and recreational elements. These elements are more difficult to value, but in many countries and cultures they are considered to be at least as important as the more functional aspects of biodiversity.

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5 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

6 The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is an international legally binding treaty. The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993.

The conservation of biodiversity is clearly important, both for the long-term and sustainable supply of raw materials and for the spiritual, cultural and recreational benefits that it brings. However, as the human population continues to grow, biodiversity is being lost at an increasing rate. Concern about this loss has prompted international, regional and national legislation, including the United Nations Convention on Biological Diversity[7] that engendered the target to reduce the rate of loss of biodiversity by 2010. The private sector, working with governments, NGOs, science and community partners, has a significant role to play in the conservation of biodiversity[8].

1.3 Scope of the Biodiversity Action Plan

A Biodiversity Action Plan is a "plan to conserve or enhance biodiversity", more specifically a set of future actions that will lead to the conservation or enhancement of biodiversity. BAP is a general term that is used worldwide and across a large number of sectors. The principal steps in developing and implementing a BAP are[9]:

- Deciding if a BAP should be done – understanding legal, biodiversity and business case drivers.
- Completing prerequisites – planning for integration with site or project management systems and management of resources.
- Preparing the BAP– establishing the priorities for conservation.
- Implementing the BAP– rolling out the necessary actions.
- Monitoring, evaluation and improvement – tracking implementation progress and effectiveness.
- Reporting, communication and verification of performance – upgrading engagement processes and building support with stakeholders and partners.

These steps are summarized in a flow chart in **Exhibit 1.1**. The flow chart was developed by International Petroleum Industry Environmental Conservation Association (IPIECA) for a typical oil and gas project but is applicable to a number of other development projects. It outlines the steps on whether a BAP is required and its preparation. The scope and relevance of each of these steps and the detail in which they are reported, will vary according to the nature of the project, type of site or operation and the environmental and social context in which the company's activities are taking place.

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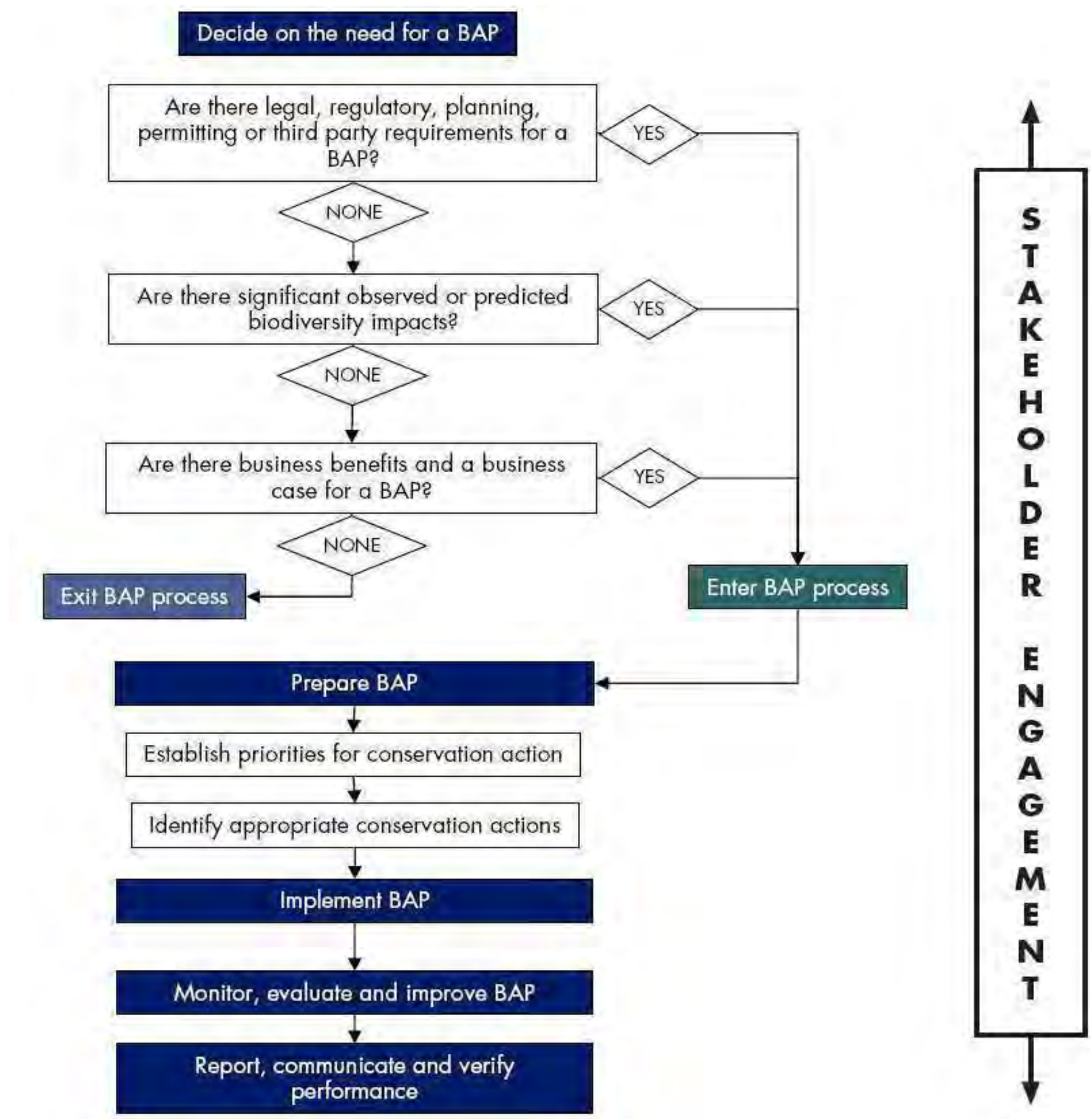
7 Convention on Biological Diversity. Text available at www.biodiv.org (Date Accessed December 17, 2012)

8 A Guide to Developing Biodiversity Action Plans for the Oil and Gas Sector. 2005. International Petroleum Industry Environmental Conservation Association (IPIECA) and the International Association of Oil and Gas Producers (OGP) through the joint Biodiversity Working Group.

9 Ibid.

Exhibit 1.1: Simplified Flowchart for Preparing and Implementing a BAP



Adopted from A Guide to Developing Biodiversity Action Plans for the Oil and Gas Sector (2005).

1.4 Objectives of Biodiversity Action Plan

The objectives of the Biodiversity Action Plan (BAP) are outlined below:

- To provide a high level baseline of the defined Study Area
- Comprehensive baseline biodiversity assessment.
- Establishment of priorities for conservation action
- Outline of actions and activities that should be undertaken to protect the biodiversity in the Poonch River Basin
- Budget and timelines for implementation

- Institutional partnerships for implementing the BAP
- An awareness raising and capacity building program of the relevant stakeholders including local communities and organizations involved in BAP implementation (government departments and local NGOs).
- A monitoring and evaluation plan to ensure that the measures outlined in the BAP are implemented.

1.5 Regulatory Framework

This section summarizes the international conventions and obligations as well as the national regulatory requirements for protection and enhancement of biodiversity.

1.5.1 International Conventions and Obligations

A list of international conventions that focus on biodiversity issues is given in **Exhibit 1.2**.[10] With shared goals of conservation and sustainable use of biological resources, the biodiversity-related conventions work to implement actions at the national, regional and international level. In meeting their objectives, the conventions have developed a number of complementary approaches (site, species, genetic resources and/or ecosystem-based) and operational tools (e.g., programs of work, trade permits and certificates, multilateral system for access and benefit-sharing, regional agreements, site listings, funds).

Exhibit 1.2: International Agreements on Biodiversity and Pakistan's Status

Convention	*Date of Treaty*	*Entry into Force in Pakistan*
Convention on Biological Diversity (CBD)	1993	26 Jul 1994
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1975	19 Jul 1976
Convention on Conservation of Migratory Species (CMS)	1979	01 Dec 1987
Convention on Wetlands of International Importance especially as Waterfowl Habitat	1971	23 Nov 1976
Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC)	1972	08 Dec 2011

Convention on Biological Diversity (CBD), Rio de Jeniero, 1993

Convention on Biological Diversity, known informally as the Biodiversity Convention covers ecosystems, species, and genetic resources and also the field of biotechnology. The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993.

The Convention has three main goals:

[10] Biodiversity related Conventions available at www.cbd.int (Date Accessed: December 17, 2012)

- conservation of biological diversity;
- sustainable use of its components; and
- fair and equitable sharing of benefits arising from genetic resources.

The objective of the convention is to conserve biological diversity, promote the sustainable use of its components, and encourage equitable sharing of the benefits arising out of the utilization of genetic resources. Such equitable sharing includes appropriate access to genetic resources, as well as appropriate transfer of technology, taking into account existing rights over such resources and such technology. In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington, 1975

The convention aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It protects certain endangered species from over-exploitation by means of a system of import/export permits. Through its three appendices, the Convention accords varying degrees of protection to more than 30,000 plant and animal species. Project construction and operation will increase the influx of personnel to Project site and vicinity and could improve access to the natural habitats. This may increase the likelihood of trade in wildlife and wildlife parts.

Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, 1979

The Convention on the Conservation of Migratory Species of Wild Animals also known as Bonn Convention aims to conserve terrestrial, marine and avian migratory species throughout their range. Parties to the CMS work together to conserve migratory species and their habitats by providing strict protection for the most endangered migratory species, by concluding regional multilateral agreements for the conservation and management of specific species or categories of species, and by undertaking co-operative research and conservation activities.

Convention on Wetlands of International Importance especially as Waterfowl Habitat, Ramsar, 1971

Popularly known as the Ramsar Convention, provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The convention covers all aspects of wetland conservation and wise use, recognizing wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities. There is no declared Ramsar site in the vicinity of the Project.

Indus Water Treaty

The Indus Waters Treaty is a water-sharing treaty between Pakistan and India, brokered by the World Bank (then the International Bank for Reconstruction and Development). The treaty was signed in Karachi on September 19, 1960 by Indian Prime

Minister Jawaharlal Nehru and President of Pakistan Ayub Khan (President of Pakistan).[11]

The Indus System of Rivers comprises three western rivers the Indus, the Jhelum and Chenab and three eastern rivers - the Sutlej, the Beas and the Ravi. The treaty, under Article 5.1, envisages the sharing of waters of the rivers Ravi, Beas, Sutlej, Jhelum and Chenab which join the Indus River on its left bank (eastern side) in Pakistan. According to this treaty, Ravi, Beas and Sutlej, which constitute the eastern rivers, are allocated for exclusive use by India before they enter Pakistan. However, a transition period of 10 years was permitted in which India was bound to supply water to Pakistan from these rivers until Pakistan was able to build the canal system for utilization of waters of Jhelum, Chenab and the Indus itself, allocated to it under the treaty. Similarly, Pakistan has exclusive use of the western rivers Jhelum, Chenab and Indus but with some stipulations for development of projects on these rivers in India. Pakistan also received one-time financial compensation for the loss of water from the eastern rivers. Since March 31, 1970, after the 10-year moratorium, India has secured full rights for use of the waters of the three rivers allocated to it. The treaty resulted in partitioning of the rivers rather than sharing of their waters.[12]

In the Final Award in the Permanent Court of Arbitration constituted in accordance with the Indus Waters Treaty 1960 between the Government of India and the Government of Pakistan, the following judgment was given by the court in December 2013 regarding environmental flows for Kishenganga Hydroelectric Power Plant in India and Neelum Jhelum Hydroelectric Power Plant in Pakistan:

“The Court acknowledges India’s point that the environmental sensitivity that Pakistan urges in these proceedings does not match Pakistan’s own historical practices, where the environmental flow has often been set at a low minimum, apparently using a “rule of thumb” approach. The Court will address the issue of the balance to be achieved between the environment and other uses of the Kishenganga/Neelum in subsequent subdivisions. With respect to the information brought to bear on decision-making, however, the Court sees no reason to remain wedded to past practices. On the contrary, more comprehensive and accurate information on the likely impacts of infrastructure projects can only benefit decision-making in both Pakistan and India. The Court urges both Parties to continue or expand their attention to environmental considerations at other projects, including the Neelum Jhelum Hydroelectric Power Project. In the Court’s view, such an approach is consistent with the acute need of both Parties for increased production of hydropower. Indeed, the Court’s ultimate decision on the minimum flow is informed by a deep awareness of the critical importance (and shortage) of electricity in both India and Pakistan. Meaningful development in this area need not be at odds with careful consideration of environmental effects.”Given the developments in Kishenganga project where environment has been recognized as an issue under the Indus Water Treaty (see Section 3.4, International Treaties and Conventions), environmental impacts related to hydropower developments on either sides of LoC can be discussed by the offices of the Pakistan Commission for Indus Waters (PCIW) and India Commission for Indus Waters

11 Text of 'Indus Water Treaty', Ministry of water resources, Govt. of India". Retrieved 2013-02-01.

12 "Indus Waters Treaty 1960" (pdf). Site Resources; World Bank. pp. 1–24.

(ICIW) established under the Indus Waters Treaty. The Biodiversity Action Plan prepared for the Project includes a provision for the project owner to share the Poonch River environmental monitoring data and reports with the PCIW, on the basis of which the PCIW could coordinate with the ICIW on management of environmental issues across the LoC.

1.5.2 National Regulatory Requirements

The Pakistan Environmental Protection Act, 1997 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. The Act's relevance to biodiversity conservation is primarily through its environmental assessment screening process for proposed projects which makes it mandatory to undertake the environmental assessment prior to initiation of developmental projects and address the biodiversity conservation and protection related issues. The national regulatory requirements relevant to biodiversity protection and enhancement are outlined below.

The National Biodiversity Action Plan, 2000

Pakistan is a signatory to the Convention on Biological Diversity, and is thereby obligated to develop a national strategy for the conservation of biodiversity. The Government of Pakistan constituted a Biodiversity Working Group, under the auspices of the Ministry of Environment, to develop a Biodiversity Action Plan for the country, which was completed after an extensive consultative exercise. The major aims of the Plan are to create a policy framework that fosters the sustainable use of biological resources; to strengthen and promote National Biodiversity Conservation Programs and develop international and regional cooperation; to create conditions and incentives for biodiversity conservation at the local community level; to strengthen and apply more broadly the tools and technologies for conserving biodiversity; and to strengthen human knowledge, will and capacity to conserve biodiversity.

National Environmental Policy, 2005

The National Environmental Policy was implemented in 2005 by the Ministry of Environment, Government of Pakistan. The basic goal of Policy was to protect, conserve and restore Pakistan's Environment in order to improve the quality of life of the citizens through sustainable development and to ensure effective implementation of Biodiversity Action Plan. The policy covers all sectors and a wide range of means for promoting conservation and environmental protection in water, air and waste management, forestry, and transport. The policy aims to promote protection of the environment, the honoring of international obligations, sustainable management of resources, and economic growth.

AJK Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2013

The AJK Wildlife (Protection, Preservation and Management) Ordinance 2013 was promulgated by the President of AJK in 2010 with an aim to consolidate the laws relating to protection, preservation, conservation and management of wildlife in Azad Jammu and Kashmir. It also endeavours to promote social, economic, cultural and ecological well-being of local communities in conformity with the concerns of the international communities. It outlines the roles and responsibilities of government organizations and departments primarily the AJK Wildlife and Fisheries Department (Department) that has the basic responsibility to ensure enforcement of the Act. The Ordinance also provides for the declaration of various categories of protected areas: wildlife sanctuaries, wildlife refuge, national parks, game reserves, biosphere reserves, biodiversity reserve, national natural heritage site (**Section 36–52**). It prohibits the dealing with any wildlife animal, dead or alive, for domestic or commercial use without a Certificate of Lawful Possession (**Sections 24**). Permits and trade license are necessary for the import, export and trade of wild animals of an endemic or exotic species (**Section 22**). The Ordinance also contains three Schedules listing the following: game animals, which shall only be hunted under the terms of a game shooting or game capture license; animals, trophies or meat, for the possession, transfer, or export for which a Certificate of Lawful Possession is required; and, protected animals, which shall not be hunted, captured or killed. The Ordinance recognizes that it is necessary to fulfil the obligations envisaged under the biodiversity related Multilateral Environmental Agreements ratified by the Government of Pakistan. The provisions in this Ordinance related to National Park are outlined in **Section 44** of Chapter VI (Protected Areas) and are outlined below:

National Park:

1. With a view to the protection and preservation of landscape, flora, fauna, geological features of special significance and biological diversity in the natural state, the government may, by notification in the official Gazette, declare any area to be a National Park and may demarcate it in such a manner as may be prescribed.
2. A National Park shall be accessible to public for recreation; education and research purposes subject to such restrictions as the government may impose.
3. The provision for access roads to and construction of rest houses, hostels and other, buildings in the national park along with amenities for public may be 50 made, as not to impair the object of the establishment of the National Park.
4. Any facility provided under Sub-Sections (2) and (3) shall be in conformity with the recommendations of the Environmental Impact Assessment or Initial Environmental Examination under AJ&K Environment Protection Act, 2001 and amendments made thereunder.
5. The following acts shall be prohibited in a National Park:

- Hunting, shooting, trapping, killing or capturing of any wild animal;
- Carrying of arms, pet animals, livestock, firing any gun or doing any other act which may disturb any wild animal or doing any act which interferes with the serenity and tranquility of the park and breeding places of wild animals;
- Logging, felling, tapping, burning or in any way damaging or destroying, taking collecting or removing any plant or tree;
- Grazing of livestock;
- Fishing;

- Clearing or breaking up any land for cultivation; mining or quarrying any stones for any other purpose;
- Polluting or poisoning water flowing in and through the National Park;
- Littering and dumping of waste;
- Writing, in scripting, carving, disfiguring, defacing, painting, chalking, advertising;
- Use of vehicular transport except on recognized roads;
- Blowing of pressure horns with in one kilometer radius of park boundary.
- Playing music, radios or making noise.

6. The Department may, however for the research purpose or betterment of the Park or for providing incentives or concessions to the communities for participatory management authorized doing of one or more acts mentioned in Sub-Section (5) on an explicit written request made to the head of the Department justifying the need for such an action or certifying that it does not impair the objectives of established park, in specific manner.
7. Whoever contravenes or fails to comply with any of the provision of the Section or abets in the commission or furtherance of any such act shall be punishable with imprisonment, which shall not be less than six months and may extend to one year or with fine which shall not be less than ten thousand rupees and may extend to rupees thirty thousands.
8. In case offense is proved to be followed by award of punishment by the court, all animals, tools, implements, carriages, including mechanically propelled vehicles, pack, animal, arms, ammunitions and other equipment and conveyances used in the commission or furtherance of an offence shall stand confiscated in favor of the government, in addition to the punishment awarded under this Section,
9. If a woman, is charged for any of the offense under this Ordinance, the court may, after the reasons to be recorded in writing, dispense with her physical presence before the court while permitting her to appear by an agent duly authorized in writing under the signature or thumb-impression of such accused having woman, attested by a respectable person of the area concerned.

As this Project is located in the Poonch River Mahaseer National Park notified in 2010 by the Department[13] and aims to achieve net gain for biodiversity consistent with IFC Guidelines[14] and will achieve betterment of the national park, Mira Power filed a written request to the Department for permission to construct and operate the Project under item

[13] Wildlife and forests according to constitution of the Islamic Republic of Pakistan are provincial subject. The principle has been applied in the case of the State of Azad Jammu and Kashmir (AJK) which is an autonomous territory administered by Pakistan. Notification of a national park in the AJK is therefore the prerogative of the government of AJK.

[14] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

6 above. This request has been approved and the letter received from the Directorate of Wildlife and Fisheries is included in **Appendix A**.

Despite the fact that the Poonch River Mahaseer National Park is a designated national park, extensive sand and gravel mining and illegal fishing continues at several locations in the River, due to ineffective protection and management (**Section 2**). As specified in Sub-Section 6 above, the ‘Department may.... for providing incentives or concessions to the communities for participatory management authorize doing of one or more acts mentioned in Sub-Section (5) on an explicit written request made to the head of the Department justifying the need for such an action or certifying that it does not impair the objectives of established park, in a specific manner.’ On this basis, the BAP proposes that subsistence fishing as well as sediment mining from the river be permitted in the Poonch River for allowing sustainable use of resources by the communities. Similarly, recreational activities including angling will be permitted to develop the recreational aspect of the Park as outlined in Sub-Section 2 above.

Jammu and Kashmir Forest Regulation 1930

Forests of Azad Jammu and Kashmir are managed according to the guidelines provided by Jammu and Kashmir Forest Regulations of 1930 (including amendments), generally known as Forest Law Manual. This regulation lays down the rules and regulations for both demarcated and un-demarcated forests, collection of drift and stranded wood as well as penalties and procedures for not abiding by these regulations.

Subject to finalization of the engineering design of the Project, some land in the ownership of the AJK Forest Department may have to be acquired from the GoAJK for the Project. There are no trees or forests on land owned by the Forest Department located in the Project footprint that is likely to be acquired.

Fisheries Act 1897

The Fisheries Act 1897 regulates fishing in the waters of Pakistan. Pakistan waters shall include the sea within a distance of one marine league off the seacoast. The provisions issued in this Act include: the prohibition to use explosives; the prohibition to use toxic and poisonous agents in fishing activities; the dimension and kind of nets used; the offences and relative penalties. Illegal fishing in the Poonch River including use of gill nets, dynamites and poisons is regulated by this Act.

1.6 Institutional Framework

The basic responsibility for managing and conserving the wildlife and fisheries of AJK lies with AJK Wildlife and Fisheries Department. This includes protecting and managing the river and river-dependent flora and fauna. The Wildlife and Fisheries Department works in conjunction with the Forest Department to manage the protected areas such as national parks, wildlife sanctuaries, the terrestrial forests and river-dependent forests.

1.6.1 AJK- EPA

AJK Environmental Protection Agency was established in July 1998 under the AJK Environmental Protection Act 2000, to provide for the protection, conservation, rehabilitation and improvement of the environment for the prevention and control of pollution and promotion of sustainable development. Presently AJK-EPA, is headed by the Director General of AJK-EPA, with its Head Office at Muzaffarabad.

Environment Unit was established in June 1994 under Northern Resource Management Project (NRMP) in Planning & Development Department (P&DD) headed by an Environmentalist (B-18). This Environmental Unit started its work in July 1994 on following three areas;

- To address and resolve the environmental issues of the State AJK.
- To work out the establishment of Provincial EPAs type State Environmental Protection Agency (AJK-EPA).
- To take initiative the Government for the promulgation of Environmental Protection Ordinance in AJK.

The proponent is responsible for preparing the complete environmental documentation required by the AJK-EPA and remain committed for getting clearance from it. Moreover, it is also desirable that once clearance from AJK-EPA is obtained, the proponent should remain committed to the approved project design. No deviation is permitted in design and scope of rehabilitation during project implementation without the prior and explicit permission of the EPAs.

1.6.2 AJK Wildlife and Fisheries Department

The AJK Wildlife and Fisheries Department (AJKFWD) or Department is headed by the Director of Wildlife and Fisheries. The aim of the Department as outlined on their official website[15] is to "protect, conserve and manage terrestrial and aquatic wild genetic resources to satisfy need of ecosystems and communities, on sustainable basis, through setting of a protected areas network, habitat protection / development, eco-tourism promotion and promotion of public private partnerships." The objectives of the Department are as follows:

- Promote eco-tourism through development of safaris, trophy hunting, sport hunting and checking illegal hunting.
- Enhancing the technical capabilities of the department by reorganizing and providing the technical staff in each district of AJ&K.
- Identifying more potential areas of biodiversity hotspots and establishing new protected areas for proper conservation and management.
- Preparation of Management Plans for each Protected Area and their effective implementation.
- Setting up of a well-designed monitoring system based on the measurable impact and performance indicators to ensure the sustainability of the biological diversity.

[15] Official website of AJK Fisheries and Wildlife Department available at: http://forest.ajk.gov.pk/index.php?option=com_content&view=article&id=54&Itemid=85. Accessed on 16 September 2013.

- Identification of the custodian communities dependent on the natural resources of the protected areas, organization them and involve them in the conservation and management practices.
- Reduce the pressure of the custodian communities on the natural resources through the provision of alternate livelihood resources and reduce the poverty by initiating activities of income generation.
- Survey of fish diseases and establishment of diagnostic laboratory.

1.6.3 AJK Forest Department

The AJK Forest Department is headed by the Chief Conservator Forests. The aim of the Department as outlined on their official website[16] is "scientific management of forestry resource on sustainable basis, ensuring environmental amelioration, checking sediment in*flow into water bodies."* The salient features of present forest management are to:

- Maintain and improve the existing forest for the purpose of soil and water conservation.
- Bring the partially stocked forest to its full capacity by natural as well as artificial regeneration measures.
- Extract the forest according to the principles of forest health.
- Provide the legitimate requirements of local population for grazing and other forest produce.
- Maximize the production without causing permanent damage to the forest crop.
- Improve existing conditions of rangelands and wildlife habitat
- Create a balance between the utilization of forest resource and the conservation of its environment.

1.7 ADB's Safeguard Policy Statement 2009

Built upon the three previous safeguard policies on the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998) and the Environment Policy (2002), the Safeguard Policy Statement was approved in 2009. The safeguard policies are operational policies that seek to avoid, minimize or mitigate adverse environmental and social impacts including protecting the rights of those likely to be affected or marginalized by the developmental process.

According to Section 8, Biodiversity Conservation and Sustainable Natural Resource Management of ADB's Safeguard Policy Statement 2009, "the borrower/client will assess the significance of project impacts and risks on biodiversity and natural resources as an integral part of the environmental assessment process. The assessment will focus on the major threats to biodiversity, which include destruction of habitat and introduction of invasive alien species, and on the use of natural resources in an unsustainable manner.

[16] Official website of AJK Forest Department available at : http://forest.ajk.gov.pk/index.php?option=com_content&view=article&id=54&Itemid=85 Accessed on 16 September 2013

The borrower/client will need to identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity."

Critical Habitat is defined by ADB's SPS 2009 as follows: Critical habitat is a subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities. Critical habitats include those areas either legally protected or officially proposed for protection, such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites.

No project activity will be implemented in areas of critical habitat unless the following requirements are met:

- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.
- The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
- Any lesser impacts are mitigated in accordance with para. 27 (Mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous. Peoples or traditional communities, and compensation to direct users of biodiversity).

When the project involves activities in a critical habitat, the borrower/client will retain qualified and experienced external experts to assist in conducting the assessment.

ADB's safeguard policy framework consists of three operational policies on the environment, indigenous peoples and involuntary resettlement. A brief detail of all three operational policies has been mentioned below:

Environmental Safeguard: This safeguard is meant to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process.

Involuntary Resettlement Safeguard: This safeguard has been placed in order to avoid involuntary resettlement whenever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre- project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.

Indigenous Peoples Safeguard: This safeguard looks at designing and implementing projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems and cultural uniqueness as defined by the Indigenous Peoples themselves so that they receive culturally appropriate social and economic benefits; do not suffer adverse impacts as a result of projects; and participate actively in projects that affect them.

Information, Consultation and Disclosure: Consultation and participation are essential in achieving the safeguard policy objectives. This implies that there is a need for prior and informed consultation with affected persons and communities in the context of safeguard planning and for continued consultation during project implementation to identify and help address safeguard issues that may arise. The consultation process begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle. It provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people and is undertaken in an atmosphere free of intimidation or coercion. In addition, it is gender inclusive and responsive and tailored to the needs of disadvantaged and vulnerable groups and enables the incorporation of all relevant views of affected people and other stakeholders into decision making. ADB requires the borrowers/clients to engage with communities, groups or people affected by proposed projects and with civil society through information disclosure, consultation and informed participation in a manner commensurate with the risks to and impacts on affected communities. For projects with significant adverse environmental, involuntary resettlement or Indigenous Peoples impacts, ADB project teams will participate in consultation activities to understand the concerns of affected people and ensure that such concerns are addressed in project design and safeguard plans.

1.8 IFC’s Requirements

This section summarizes the IFC’s requirements and standards that the client is to meet throughout the life of an investment by IFC or other relevant financial institution.

1.8.1 IFC's Performance Standards on Social and Environmental Sustainability

International Finance Corporation applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, the eight Performance Standards establish standards that the client is required to meet throughout the life by IFC or other relevant financial institution.

- Performance Standard 1: Social and Environmental Assessment and Management System
- Performance Standard 2: Labor and Working Conditions
- Performance Standard 3: Pollution Prevention and Abatement
- Performance Standard 4: Community Health, Safety and Security

- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

PS 1 Social and Environmental Assessment and Management System- It establishes the importance of integrated assessment to identify the social and environmental impacts, risks, and opportunities in the project's area of influence. PS 1 requires Social and Environmental Assessment and Management Systems for managing social and environmental performance throughout the life cycle of this Project and runs through all subsequent PSs. The main elements of PS 1 includes following elements: (i) Social and Environmental Assessment; (ii) Management program; (iii) organizational capacity; (iv)training; (v) community engagement; (vi) monitoring; and (vii) reporting.

PS 2 Labor and working conditions- requires that worker-management relationship is established and maintained, compliance with national labor and employment laws and safe and healthy working conditions are ensured for the workers.

PS 3 Pollution prevention and Abatement- outlines approach to pollution prevention and abatement in line with Internationally disseminated technologies and practices with objectives to a) avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from activities; and b) promote the reduction of emissions that contribute to climate change. It requires a project to avoid, minimize, or reduce adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.

PS 4 Community health, safety and security- concentrates on the responsibility that must be undertaken by the client to avoid or minimize the risks and impacts to the community's health, safety and security that may arise from project activities.

PS 5 Land Acquisition and Involuntary Resettlement- This standard requires that project does not result in involuntary resettlement or at least if unavoidable it is minimized by exploring alternative project designs. In addition, the project will ensure that social and economic impacts from land acquisition or restrictions on affected persons' use of land are mitigated.

PS 6 Biodiversity Conservation and Sustainable Natural Resource Management- aims at protecting and conserving biodiversity, the variety of life in all its forms, including genetic, species and ecosystem diversity and its ability to change and evolve, is fundamental to sustainable development. This PS addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as incorporate sustainable management of renewable natural resources.

The PS6 defines a Critical Habitat as outlined below.

Critical Habitat is designated by the International Finance Corporation (IFC) Performance Standards 6[17] and is described as having a high biodiversity value, as defined by:

- Habitat of significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted-range species;
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision will be evaluated on a case-by-case basis. Examples are as follows:

- Areas required for the reintroduction of CR and EN species and refuge sites for these species (habitat used during periods of stress (e.g., flood, drought or fire)).
- Ecosystems of known special significance to EN or CR species for climate adaptation purposes.
- Concentrations of Vulnerable (VU) species in cases where there is uncertainty regarding the listing, and the actual status of the species may be EN or CR.
- Areas of primary/old-growth/pristine forests and/or other areas with especially high levels of species diversity.
- Landscape and ecological processes (e.g., water catchments, areas critical to erosion control, disturbance regimes (e.g., fire, flood)) required for maintaining critical habitat.
- Habitat necessary for the survival of keystone species.
- Areas of high scientific value such as those containing concentrations of species new and/or little known to science.

In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;12

[17] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

In such cases where a client is able to meet the requirements defined in paragraph, the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains[15] of those biodiversity values for which the critical habitat was designated. In instances where biodiversity offsets are proposed as part of the mitigation strategy, the client must demonstrate through an assessment that the project's significant residual impacts on biodiversity will be adequately mitigated to meet the requirements outlined above.

PS 7 Indigenous Peoples- acknowledges the possibility of vulnerability of indigenous people owing to their culture, beliefs, institutions and living standards and that it may further get compromised by one or other project activity throughout the life cycle of the project. The PS underlines the requirement of minimizing adverse impacts an indigenous people in the project area, respecting the local culture and customs, fostering good relationship and ensuring that development benefits are provided to improve their standard of living and livelihoods.

PS 8 Cultural Heritage- aims to protect the irreplaceable cultural heritage and to guide clients on protecting cultural heritage in the course of their business operations.

The applicability of these Performance Standards is established during the Social and Environmental Impact Assessment process, while implementation of the actions is necessary to meet the requirements of IFC, the Performance Standards are managed through the owner's Social and Environmental Management System.

GHPP will have to follow all the Performance Standards of IFC for this project and should ensure that the contractors / subcontracts (subcontractors of the contracts) appointed by MPL all follow the IFC performance standards on Environmental and Social Sustainability.

1.9 Outline of BAP

This Biodiversity Action Plan has been developed for Mira Power Ltd. to conserve and protect the biological resources in the Poonch River Mahaseer National Park.

Section 2 provides an outline of the ecological setting of the Poonch River basin

Section 3 provides an overview of the flora and fauna in the Study Area

Section 4 provides a brief overview of concerns expressed by the institutional and community stakeholders regarding the biodiversity of the area.

Section 5 identifies the priorities for conservation and outlines necessary action measures

Section 6 presents the necessary steps for protection and conservation of the biological resources

Section 7 outlines the measures for awareness-raising of the local communities and visitors to the National Park.

Section 8 provides guidelines for monitoring and evaluation of the BAP to ensure that the outlined measures are implemented.

2. Ecological Setting

This section outlines the ecological setting and the importance of the Poonch River in terms of its biological resources. The threats to the ecological resources of the Poonch River, including over-exploitation of fish as well as sand and gravel extraction are also presented.

Information for this section has been derived from literature review of relevant scientific journals, ESIA report for the Project, books, websites and biodiversity assessment reports compiled by NGOs and government organizations.

2.1 Regional Overview

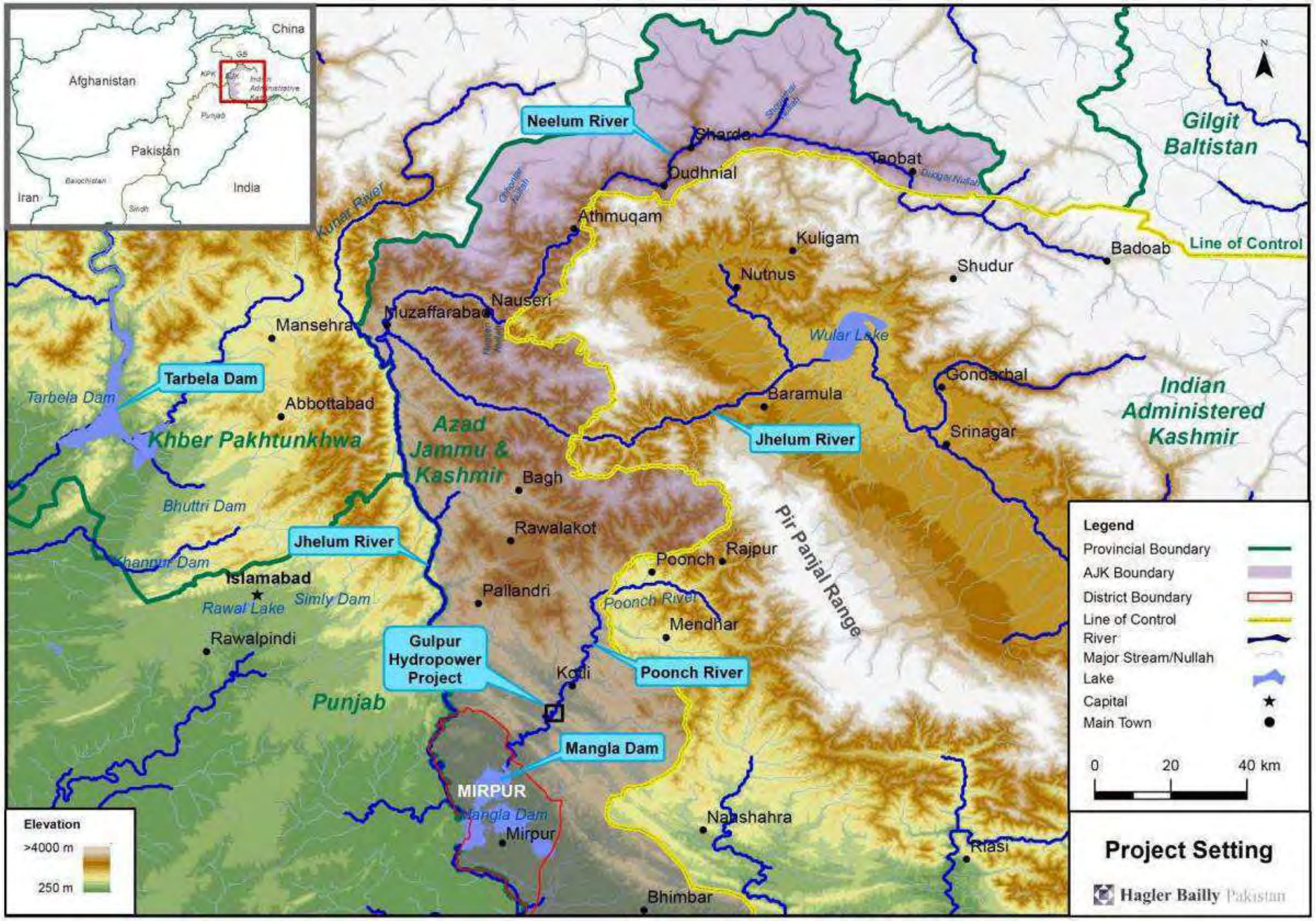
The Area of Azad Jammu and Kashmir is drained by three main rivers viz., Neelum, Jhelum and Poonch, all draining into Mangla Reservoir. The Mangla Dam is the twelfth largest dam in the world. It was constructed in 1967 across the Jhelum River in Mirpur district of Azad Kashmir (**Exhibit 2.1**).

Mangla Dam, which became operational in 1967, was a major intervention, which has altered the river ecology downstream as well as upstream of the reservoir. The rivers draining into Mangla Reservoir have different characteristics as they originate from areas having different geographical and physical features. The Poonch River originates in the western foothills of Pir Panjal Range. The steep slopes of the Pir Panjal form the upper catchment of this river. It is a small gurgling water channel in this tract and descends along a very steep gradient until it reaches in the foothill areas. The river widens as more and more tributaries from both sides enter into the main river. The valley too opens up, Poonch River begins to flow with a more gentle current in its middle, and lower reaches. The upper catchment is covered by dense forests while the vegetation of the middle and lower region is under intense biotic pressure. Poonch River from the line of control to Kotli town has steep slope (6.9-8.3 m/km) and the valley is narrow. Below Kotli, the river gradient is relatively mild (3.7m/km). The river ultimately joins the Mangla Lake near Chomukh in Mirpur district of Azad Jammu and Kashmir.

The Poonch River is a warm water river and the water temperature approaches almost 30^{o} C during the summer months. Water in the Jhelum River has the intermediate temperature reaching 25^{o} C during the summer months. These variable temperature regimes give the Mangla reservoir a unique physic-chemical characteristic having different temperature regimes, both, on horizontal as well as on vertical scales. Different pockets in the Mangla reservoir have different temperature regimes. The depth of the dam gives temperature stratification throughout its depth. The Jhelum River is deep with fast water flows all along the river. It flows through a “V” shaped valley. On the other hand, the Poonch River is shallow, open, flat and the water flows with a moderate speed. The fish fauna in these water bodies is therefore distributed according to their requirements of temperature and other physic-chemical and factors. The vast lake environment of Mangla reservoir has facilitated large commercial fishes to be established in the dam area while the typical river fish fauna is distributed in the two rivers according to their requirements of the physic-chemical factors[18].

[18] Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

Exhibit 2.1: Project Setting



The Jhelum River, Poonch River and Mangla Reservoir show variations in diversity of fish fauna. The Mangla Reservoir and Jhelum River differ from each other and the Poonch River falls in between these two water bodies . The physic-chemical factors and the fish fauna studied previously also revealed similar results. Poonch River is in between the Jhelum River and Mangla Reservoir in terms of water temperature, nature of habitat, physical conditions of the breeding grounds, water speed, water volume, relative length of the river and topography of the area of three water bodies (Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012).

Cluster Analysis also showed that the three water bodies can be divided into three distinct groups on the basis of their fish fauna at 65% similarity level (**Exhibit 2.2**). The Poonch and Jhelum Rivers are somewhat similar due to the flowing water conditions in both of the water bodies and having similar impact of the Mangla Reservoir at least in their lower reaches. Moreover, most of the fish fauna found in the Mangla Reservoir, specially the commercially important fish fauna, are distributed in the downstream areas of the lake in the rivers of Punjab. Construction of the dam has changed the ecosystem from a flowing one to that of a large stagnant water body. The fish fauna of the Indus plain are distributed throughout the whole stretch of the Poonch in AJK while it is distributed in the River Jhelum to variable extant due to comparatively cold water of the river (Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012).

The River Poonch also shares a number of fish fauna with the Jhelum River. All the cool water fish fauna found in the river Poonch are also represented in the River Jhelum. A total of 15 species are common between the two rivers. The River Poonch, therefore, shares its 52% fish fauna with the river Jhelum. The River Jhelum on the other hand shares 47% of its fish fauna with the Poonch River. The fish fauna of River Jhelum common with the Poonch River is distributed in the lower reaches of the River Jhelum which mainly migrates from Mangla Reservoir upstream in the River Jhelum during the summer season. Out of 62 species found in the Mangla Reservoir and 32 in the Jhelum River, only twenty species are common in both these water bodies. Poonch River is the main breeding area for the fish in the Mangla Reservoir, which is an important area for commercial fishery in the AJ&K, and is a source of revenue for the government[19].

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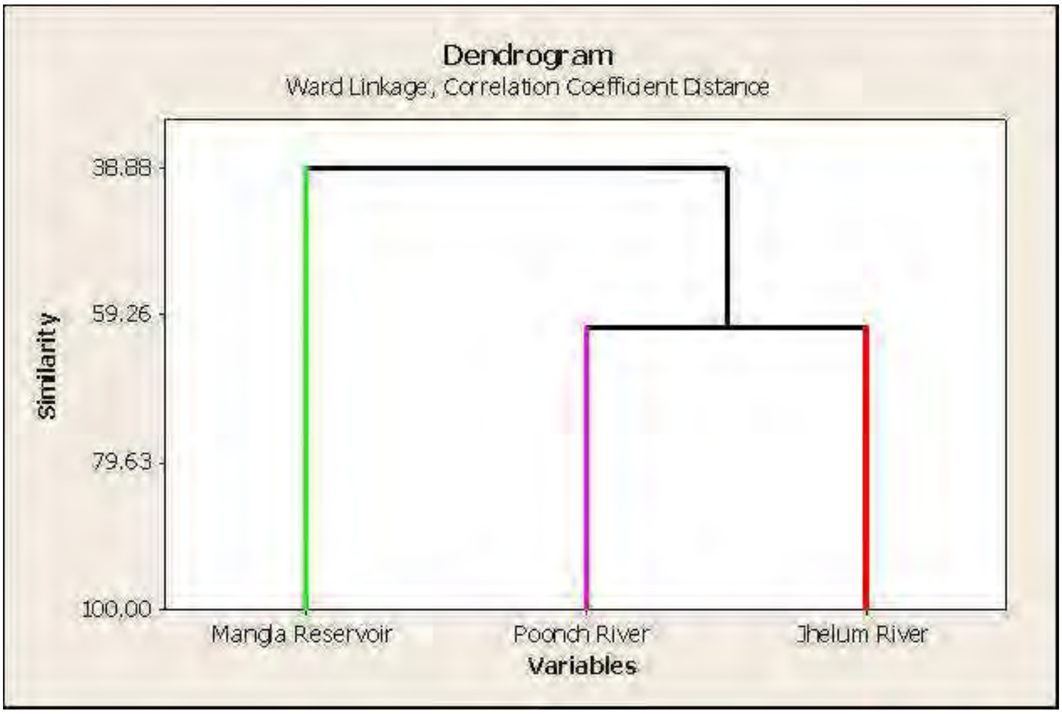
19 Rafique, M., Qureshi, M. Y. (1997). A contribution to the fish and fisheries of Azad Kashmir. In: S. A. Mufti, C. A. Woods and S. A. Hasan, (eds.), Biodiversity of Pakistan. Pak. Mus. Nat. Hist. Islamabad and Fl. Mus. Nat. Hist. USA, p 335-343.

Exhibit 2.2: Similarity Between different Water bodies based on Cluster Analysis Techniques



2.2 Ecological and Socio-economic Significance of Poonch River

The Poonch River is a warm water river and the water temperature approaches almost 30° C during the summer months. A total of 37 fish species have been recorded from the Poonch River[20] [21]. The diversity is higher in the area where the River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer. The reason is the topography and water temperature of the River Poonch. The Poonch flows gently in a vast and flat valley, which provides numerous breeding grounds for the reproduction of fish. High temperature and gravely, rocky and the sandy river bed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival. The completion of Mangla dam in 1967 created a barrier in the Jhelum River and isolated the Poonch River from the segment of Jhelum downstream of the dam. Mangla dam also created a barrier to movement of riffle dwelling smaller fishes such as the Kashmir Catfish Glyptothorax kashmirensis and the Twin–Banded Loach Botia rostrata between the Jhelum and Poonch rivers.

[20] Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

[21] HBP, November 2013, Draft Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

The fish species Mahaseer Tor putitora is an important food and sport fish found in the Poonch River. The largest and most stable population of this fish in the country is found in this River that also forms a breeding ground for this fish. Keeping in view its declining population and threats to survival, the Mahaseer Tor putitora has been declared Endangered in the IUCN Red List 2013.

The entire stretch of the Poonch River and its tributaries inside AJK have been declared as a national park. The main reason for this notification is the high fish diversity and importance of supporting fish of both conservation and economic importance particularly the Endangered fish (in IUCN Red List 2013) Mahaseer Tor putitora that is important both from the conservation and commercial viewpoint.

The ecological importance of the Poonch River has been summarized in the Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012. These are listed below.

1. **Last Refuge for Mahsheer Fish:** Mahaseer Tor putitora has been a widely distributed fish in Pakistan during sixties and seventies. It was flourishing in the five rivers of Punjab and breeding in the Himalayan foothill areas. Due to damming of the water bodies, ecological fragmentation of the water bodies, pollution, water diversion, habitat destruction and indiscriminate hunting, its population has been continuously declining in its natural habitat. Its distribution range in the country, therefore, continued squeezing and presently it is almost non-existent in the rivers of Punjab. Recently (2010), IUCN has declared it as an "Endangered species". The Poonch River, however, is still having a reasonably good population of Mahaseer. It is still successfully breeding in its upper and middle reaches. The main centers of Mahaseer breeding are the Ban Nullah, Rangar Nullah, Nail Nullah, Hajeera Nullah, Meander Nullah and the Titri Note area where river is wide to its maximum extant. It is the Poonch River where anglers still can catch a fish of 100 cm weighing 10 Kgs.
2. **Habitat for Critically Endangered Kashmir Catfish Glyptothorax kashmirensis:** The species Glyptothorax kashmirensis, previously only reported from Jhelum River, has been captured from the Poonch River during the October 2013 fish surveys for the Biodiversity Baseline Assessment of the Gulpur Hydropower Project[22].
3. **Breeding ground for the Fish Fauna of Mangla Reservoir:** Poonch River terminates and drains directly into the Mangla reservoir. The river serves as an important breeding ground for most of the fish fauna of the Mangla reservoir, which breeds in flowing water conditions. Most of the commercially important cyprinid and catfish breed in backwaters of the reservoir in the Poonch River. The side nullahs (streams) meeting to Poonch River form the major breeding grounds for these fishes. These nullahs also serve as nursery grounds for the fishes breeding in these side streams. Two of these nullahs, namely the Rangar Nullah and Ban Nullah, will experience inundation and change in habitat from riffle to a

[22] Hagler Bailly Pakistan (HBP), April 2014, Draft Biodiversity Baseline Report of Gulpur Hydropower Project.

reservoir in the last few kilometers from the point of their present confluence with the Poonch River. Given the length of these Nullahs which extends to over 50 km, this inundation will not impact have any significant impact on the extent of breeding habitat available in them. Furthermore, the breeding fish as well as the offspring will be able to freely move through the water column.

4. **Natural Reserve for Twin-banded Loach, Botia rostrata:** Twin banded loach is a beautiful aquarium fish. It has almost the same story as that of Mahaseer. The fish has been quite common in the Himalayan foothill areas but presently its population in the foothill areas is almost depleted or non-existent. The Poonch River has a very good population of this loach and is a hot spot area for this fish.
5. **Supporting Healthy Population of Labeo dyocheilus:** Poonch River holds the largest population of Labeo dyocheilus as compared to any other river in the country. This fish has maximum size in this river and a fish weighing 3-4 kg is commonly caught in the nets.
6. **Supporting Healthy Population of Garra gotyla:** The fish Garra gotyla is also a fish of sub-mountainous areas but it is also found in plains. Its population in plain areas has decreased over the last 20 years and hardly one comes across any fish while sampling. Once upon a time it was very common in Potowar areas but it is no more seen in any of these areas except a few localized places. Poonch River has very healthy population of this fish throughout its length in AJK.
7. **Supporting High Fish Diversity as Compared to its Size:** The Poonch is the smallest river in AJK as compared to other two rivers, the Jhelum and the Neelum. It, however, has a very good fish diversity of 29 species as compared to other rivers of AJK. It is due to optimum water temperature, pristine breeding grounds, wide river valley, and network of side nullahs (tributaries) with suitable physic-chemical environment."

2.3 Causes for Decline in Fish Resources

A description of the fish resources of the Poonch River is given in **Section 3 (Overview of Ecological Resources**). Fishing not only provides food for local consumption but is also a source of livelihood for individuals involved in commercial fishing. Fish are also important for recreation and sport fishing and boost tourism.

Fishing is extensive along the entire length of Poonch River and is widespread in the areas of Kotli, Hil Kalan up to confluence of Poonch River and Ban Nullah, as well as in some areas near Kohali and Gulpur. Extensively fishing is also practiced in the River upstream and downstream of Rajdhani (**Exhibit 2.4**). Sport fishing is common, while commercial fishing is also prevalent especially during the summers, when the fish collect near the shallow banks of the river. Some locals are involved in subsistence fishing and catch fish to supplement household food supply.

The fish population in Poonch River has undergone a decline in recent years due to urbanization, illegal encroachment, over fishing and chemical and physical alterations of the natural habitat of fish. While the water of the Poonch River is not used for irrigation, the stress on the fish population is due to its over exploitation, rise in developmental activities in the basin associated with increase in population, and the growing number of hydroelectric and irrigation projects such as the Mangla dam downstream which have fragmented and deteriorated the natural habitat (Ecological Baseline Study of Poonch River, 2012). Fish are sensitive to physical and chemical variations in the water as well as to changes in river flows and volumes. They are, therefore, vulnerable to changes caused by the construction and operation of hydropower projects and dams.

The reasons for decline of fish resources, particularly the Endangered Mahaseer Tor putitora are listed below and have been summarized from the Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012.

- Capture of breeders, juveniles and poaching during the closed breeding season when fish migrates upstream for spawning,
- Intensive fishing during the pre-monsoon period when river water levels are low
- Unscientific capture of fishes by building temporary stone dams across hill streams and using fine- mesh net or cloth by village people,
- Use of dynamite or hand grenades to kill shoals of large brooder fish for food. This practice is more intensive during winter season when the fish are concentrated in pools along the river,
- Poisoning of streams and rivulets by local poisons (extracts of Derris, Chenapadium, Euphorbia, Artimisia, Cratan etc.) to kill and catch whole schools of Mahaseer and other fishes,
- Destruction of the breeding grounds of Mahaseer and other fish species due to large-scale collection of stones, gravel, pebbles, sand etc. from the river banks especially during the dry season when water volumes in the river are low.
- Construction of dams that form a barrier to fish migration and cause habitat fragmentation especially during the summer season when water volumes are low.
- Liquid and solid waste pollution of the river.

Photographs in **Exhibit 2.3** illustrate the threats to the fish fauna in the Poonch River basin.

Exhibit 2.3: Photographs of Threats to Fish in the Poonch River Basin

Dynamite Sticks Used for Killing Fish

Electric Wire Used for Electrocuting Fish

Nets Confiscated from Illegal Fishing

Extraction of Gravel and Sand from River Bed

Water Pumping from River

Pollution in the River by Solid Waste

Source of Photographs: Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahaseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

2.4 Ecosystem Destruction due to Sand and Gravel Mining

Sand and gravel mining and illegal fishing are the main sources of habitat and ecosystem destruction in the Poonch River basin.

Sand and gravel extraction activities are extensively undertaken along the Poonch River and are widely practiced in the areas of Kotli, Hil Kalan up to confluence of Poonch River and Ban Nullah, in some parts of the river stretch near Kohali and Gulpur, as well near Rajdhani and upstream of Rajdhani (**Exhibit 2.5**).

Sand mining and gravel extraction is more common during the winter months (September to March) than in summers, since during low flows the sand is easier to mine along the exposed river-beds. The mining techniques are crude, and the sand, mined using shovels and spades, is loaded onto trolley-carts, horses and donkeys. The sand and gravel is then collected near the roadside and sold to residents of the nearby villages and construction contractors to be used as construction material. Photographs of sand and gravel extraction are shown in **Exhibit 2.4**.

Exhibit 2.4: Photographs of Sand and Gravel Extraction in Poonch River Basin

Sand and Gravel Extraction at Khuairatta

Sand Dumping Area near confluence of Poonch River and Ban Nullah

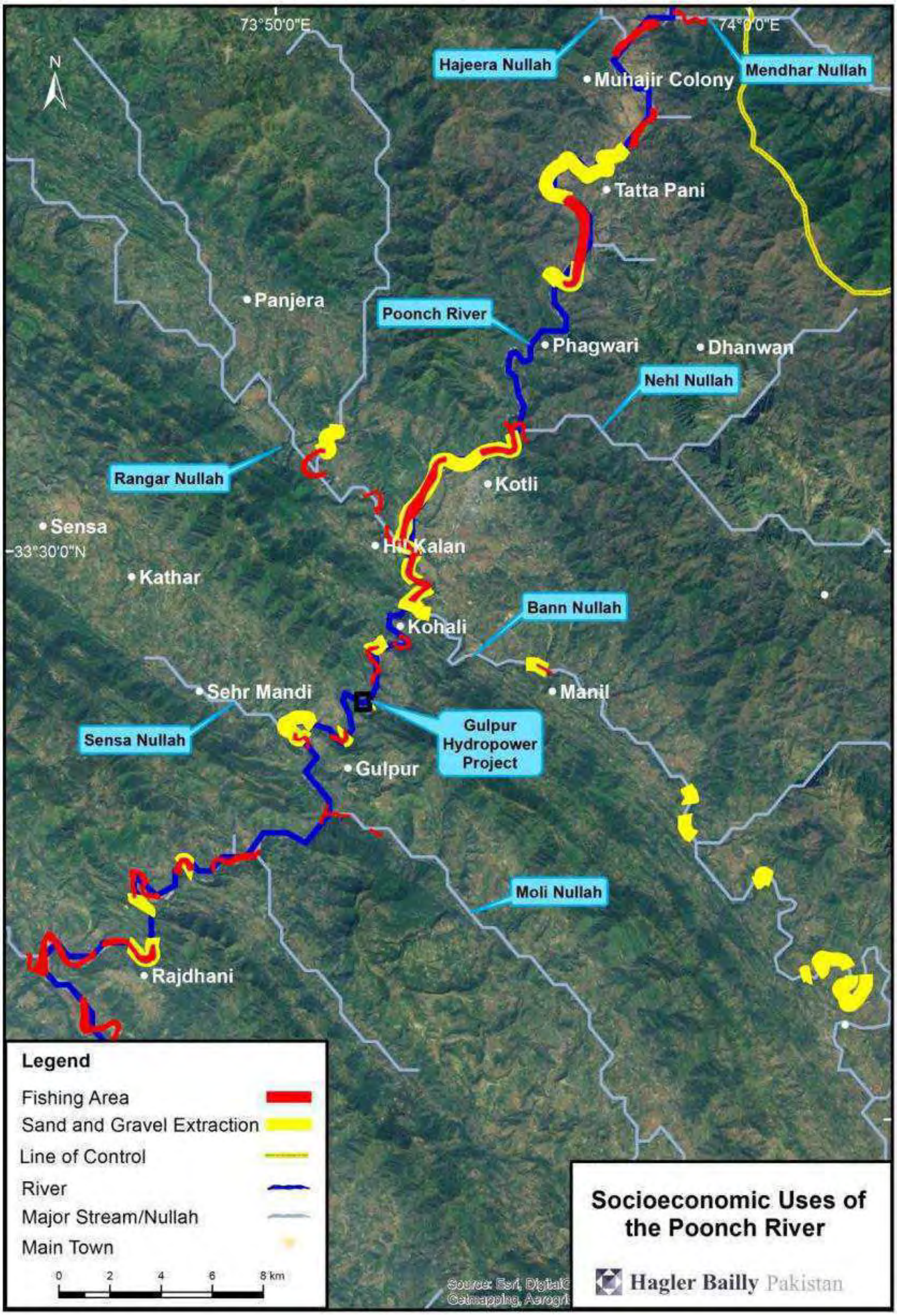
Gravel Extraction near Naroch Colony

Sand Dumping on Road Side near confluence of Poonch River and Ban Nullah

Gravel collected for Crushing near confluence of Poonch River and Ban Nullah

Gravel Extraction in Poonch River north-west of Kotli

Exhibit 2.5: Socio-Economic Uses of the Poonch River



2.5 Critical Habitat Assessment

The Critical Habitat Assessment of the Project was completed in September 2013[23]. Given below is a brief summary of this Critical Habitat Assessment as defined by the IFC's PS6[24] and paras 28-29, SR1, ADB SPS. [25]

Critical habitat is described as having a high biodiversity value, as defined by:

- Areas protected by the International Union for Conservation of Nature (Categories I-VI);[26]
- wetlands of international importance (according to the Ramsar convention);[27]
- important bird areas (defined by Birdlife International);[28] and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;[29]

The following additional characteristics are used in Critical Habitat Assessment.

- Habitat of significant importance to Critically Endangered and/or Endangered species;
- Habitat of significant importance to endemic and/or restricted–range species;
- Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision would be evaluated on a case–by–case basis.

2.5.1 Aquatic Study Area

The Project Site for the Gulpur Hydropower Project is located on the Poonch River and the Aquatic Study Area was determined to be located in a Critical Habitat on the basis of two criterion outlined in the Performance Standard 6.

Criterion 1: Habitat of significant importance to Critically Endangered and/or Endangered species

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23 HBP, January 2014, Critical Habitat Assessment of Gulpur Hydropower Project, Hagler Bailly Pakistan.

24 Guidance Note 6, January 2012, Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group

25 ADB's 2009 Safeguard Policy Statement (SPS) – Safeguards Requirement (SR) 1 on Environment,

26 IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.

27 Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

28 Birdlife International, UK

29 Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

The Poonch River provide habitat for two fish species of conservation importance: Kashmir Catfish Glyptothorax kashmirensis listed as Critically Endangered and Mahaseer Tor putitora listed as Endangered in IUCN Red List.

In addition, fish species Common Carp Cyprinus carpio, Snow Carp Schizothorax plagiostomus (richardsonii) and Twin–banded Loach Botia rostrata listed as Vulnerable in the IUCN Red List have also been observed in the Poonch River.

According to IFC's Guidance Note 6, Tier 1 sub-criteria for Criterion 1 are defined as follows[30]:

- Habitat required to sustain ≥ 10 percent of the global population of an IUCN Red-listed CR or EN species where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species.
- Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.

Tier 2 sub-criteria for Criterion 1 are defined as follows:

- Habitat that supports the regular occurrence of a single individual of an IUCN Red-listed CR species and/or habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species.
- Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species.
- As appropriate, habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent national/regional listing.

Concerning the Endangered Mahaseer Tor putitora, the Poonch River triggers Critical Habitat based on the first and third criterion of the Criterion 1, Tier 2 i.e. "habitat containing regionally-important concentrations of an IUCN Red-listed EN species where that habitat could be considered a discrete management unit for that species; and habitat containing nationally/regionally-important concentrations of an EN, CR or equivalent *national/regional listing."* This is because the largest population of Mahaseer fish Tor putitora, in Pakistan is found in the Poonch River (approximately 80%) and the Poonch River and its tributaries serve as an important breeding ground for this fish species.[31] However, the Mahaseer Tor putitora does not fulfill the second criterion in Criterion 1, Tier 2 i.e. habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. This is because

[30] Guidance Note 6, January 2012, Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group

[31] Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

according to the IUCN Red List,[32] Tor putitora is a widely distributed species in south and south-east Asia, with a restricted area of occupancy. The species has been reported from across the Himalayan region and elsewhere in south Asia and south-east Asia, ranging from Afghanistan, Pakistan, India (Darjeeling to Kashmir), Nepal, Bangladesh, Bhutan, Sri Lanka, Myanmar, western Iran to eastern Thailand. Moreover, the Mahaseer Tor putitora does not trigger Critical Habitat based on Criterion 1 Tier 1 since according to information available, it is widely distributed in south and south-east Asia even though the area of occupancy is limited (IUCN Red List) and more than 10% of the global population of this species is not found in the Poonch River.

Kashmir Catfish Glyptothorax kashmirensis is a rare and Critically Endangered (IUCN Red List 2013) fish. According to IUCN Red List it is reported only from the Jhelum River. However, specimens of this fish species have been caught from the Poonch River during the October 2013 survey It triggers Critical Habitat based on Criterion 1 Tier 1. This is because the fish has a very restricted range of occupancy (Jhelum and Poonch River) and is endemic to Kashmir. Keeping in view the predominantly riffle habitat of the Poonch River, which are the preferred habitat of this fish as well as the shallow waters particularly in the winter season, it is likely that more than 10% of the population of Kashmir Catfish Glyptothorax kashmirensis is found in the Poonch River. In addition, there are fewer than 10 management sites of this species globally. Thus it fulfills the requirements of Criterion 1 Tier 1. In addition, the Kashmir Catfish Glyptothorax kashmirensis also fulfills all three requirements to trigger Criterion 1 Tier 2 of Critical habitat since the Poonch River provides habitat containing regionally important concentrations of this Critically Endangered fish and loss of such a habitat could potentially impact the long term survivability of the species.

The other fish species of special importance found in Poonch River are listed in **Exhibit 3.7**. None of these species are listed as Endangered or Critically Endangered in the IUCN Red List 2013. The six indicator fish species selected to study the impact of Project impacts on the aquatic resources of the Poonch River and details of expected impacts and mitigation measures are outlined in **Section 6, Environmental Flow Assessment** of the ESIA of Gulpur Hydropower Project.

Criterion 2: Areas that meet the criteria of the IUCN's Protected Area Management Categories Ia, Ib and II, although areas that meet criteria for Management Categories III–VI may also qualify depending on the biodiversity values inherent to those sites[33]

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[32] Jha, B.R. & Rayamajhi, A. 2010. *Tor putitora*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **08 April 2014**.

[33] IUCN Protected Areas Categories System

IUCN protected area management categories classify protected areas according to their management objectives. The categories are recognized by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

Ia Strict Nature Reserve

Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphical features, where human visitation, use and impacts are strictly controlled and

The Poonch River and tributaries was declared a national park in a letter from the AJK Secretariat Forest/AKLASC/Fisheries (ref no: SF/AV 11358-7/2010 dated 15 December 2010).. Even though the official notification does not specify the basis for the designation, the objective for declaring the Poonch River as a national park was to protect the aquatic ecological resources of the Poonch River. The ecological and socio-economic significance of the Poonch River is outlined in the Ecological Baseline Study of the Poonch River[34].

The Poonch River was declared a National Park based on the definitions given in the AJK Wildlife Act 2010[35]. It has not been designated any official protected area category by IUCN. However, it also seems to fit the IUCN category II definition which is "Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities."

It was therefore concluded that the Aquatic Study Area of the Project lies in a Critical Habitat as designated by IFC's Performance Standard 6.

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limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring

Ib Wilderness Area

Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park

Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

III Natural Monument or Feature

Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area

Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape

A protected area where the interaction of people and nature over time has produced an area of distinct charcter with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources

Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

[34] Ecological Baseline Study of Poonch River, AJ&K, with special emphasis on Mahseer Fish. January 2012. Prepared for World Wide Fund for Nature (WWF-P) by Himalayan Wildlife Foundation.

[35] Azad Jammu and Kashmir Wildlife (Protection, Preservation and Management) Act 2010.

Determination: The Aquatic Study Area lies in a Critical Habitat.

2.5.2 Terrestrial Study Area

The Terrestrial Study Area does not meet any of the following criteria of a Critical Habitat.

- Areas protected by the International Union for Conservation of Nature (Categories I-VI);[36]
- wetlands of international importance (according to the Ramsar convention);[37]
- important bird areas (defined by Birdlife International);[38] and
- biosphere reserves (under the UNESCO Man and the Biosphere Programme;[39]

The following additional characteristics were used in the Critical Habitat Assessment

Habitat integral to the survival of critically endangered or endangered species: Two of the bird species recorded from the Ecological Study Area are included in the IUCN Red List 2013. These are the White–backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus listed as Critically Endangered and Endangered respectively. Even though these birds use the Terrestrial Study Area for feeding and resting, their main breeding areas are at least 10 km away from the Project site. There is nothing in the literature reviewed nor in the information gathered that would imply that the Study Area habitat is integral to the survival of these vulture species;

A list of the species of conservation importance reported from the Study Area and the locations where sighted is included in the Biodiversity Baseline of Gulpur Hydropower Project.[40]

Areas having special significance for endemic or restricted-range species: The habitats found on Study Area are homogenous and widespread. Even though some endemic herpeto-faunal species have been reported from the Terrestrial Study Area, their distribution is not limited to any specific site or habitat type, and their distribution is widespread. Therefore, the Study Area does not hold any significance for the survival of endemic or restricted range species; or

Areas critical for the survival of migratory species: Even though there are some migratory birds reported from the Study Area, the major staging ground for these birds is the Mangla Lake or Mangla Reservoir. According to investigations, most of the migratory birds do not use the Study Area as a breeding and nesting area but merely as a resting ground on their way to the Mangla Lake where greater food and habitat is available. Moreover, no mammal species depends on the area for its migration.

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[36] IUCN. 1994. Guidelines for *Protected Areas* Management *Categories*. *IUCN*, Cambridge, UK.

[37] Ramsar Convention, or Convention on the Wetlands of International Importance, Administered by the Ramsar Secretariat, Geneva, Switzerland

[38] Birdlife International, UK

[39] Administered by International Co-ordinating Council of the Man and the Biosphere (MAB), UNESCO.

[40] Hagler Bailly Pakistan (HBP 2014), Biodiversity Baseline, Final Report, Gulpur Hydropower project

Areas with unique assemblages of species or which are associated with key evolutionary processes or provide key ecosystem services. This situation is not present on the Study Area. While all species are functioning components of ecosystems, there are no unique assemblages of species or association of key evolutionary processes in the Terrestrial Study Area; or

Areas having biodiversity of significant social, economic or cultural importance to local communities. Although the area is of importance to residents in terms of ecosystem services (such as water, vegetation for grazing and fuel wood), it has no unique biodiversity value of social, economic or cultural importance to the community.

Determination: The Terrestrial Study Area does not lie in a Critical Habitat.

2.6 Present Ecological Condition

The categories used to describe the Poonch River's present ecological condition are based on modification from the natural, with the natural condition seen as the reference condition (**Exhibit 2.6**). Based on these definitions, the specialist team from Hagler Bailly Pakistan were requested to estimate the present ecological state (PES) of the three sites selected for assessment[41] as natural (Category A), slightly changed (Category B), moderately changed (Category C), or extensively changed (Category D) using expert judgement (**Exhibit 2.8**), and provided explanations as to why these scores were given (**Exhibit 2.8**).

Exhibit 2.6: Definitions of the Present Ecological State Categories
(after Kleynhans 1996)

Ecological Category	*PES % Score*	*Description of the Habitat*
A	90–100%	Still in a Reference Condition.
B	80–90%	Slightly modified from the Reference Condition. A small change in natural habitats and biota has taken place, but the ecosystem functions are essentially unchanged.
C	60–80%	Moderately modified from the Reference Condition. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40–60%	Largely modified from the Reference Condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	20–40%	Seriously modified from the Reference Condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0–20%	Critically/extremely modified from the Reference Condition. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

[41] For the ESIA of the Gulpur Hydropower Project, see Section 6.2 of the ESIA.

Exhibit 2.7: Summary of Present Ecological Status (PES) of EFlow Sites

Driver Components	*Component PES*	*Present Ecological status of Eflow Sites*
Hydrology	A	
Hydraulics	A	
Geomorphology	B	
Water Quality	B	
Riparian Vegetation	D	C
Algae	B	
Macro–invertebrates	C	
Fish	C	
River Dependent Wildlife	D	

Exhibit 2.8: Explanations for the Present Level of Ecological Health Assigned to Each Ecosystem Component

Ecosystem Component	*Present Ecological State*	*Explanation*
Hydrology	A	No storage has been constructed as yet on either the main Poonch River or any of its tributaries. River flows are thus largely unobstructed and natural.
Hydraulic	A	No weirs, dams, or obstructions have been constructed as yet on either the main Poonch River or any of its tributaries. River hydraulics and sediment movement are thus largely natural.
Geomorphology	B	Sand and gravel extraction from river bed and banks has resulted in geomorphology degradation
Water Quality	B	While there is no industrial activity and the population and vehicular traffic levels are low, domestic discharges and limited use of artificial fertilizers may have had some impact on the quality of the water in the main Poonch River.
Riparian Vegetation	D	There has been extensive clearing and extraction by communities. These changes are unrelated to flow
Algae	B	There has been a decline in water quality and increase in non–selective fishing
Aquatic macro–invertebrates	C	Non–selective fishing in the Poonch River has negative impact on aquatic macro–invertebrates
Fish	C	Fish resources have declined due to over harvesting, selective and non–selective fishing pressures, decline in water quality as well as sand and gravel extraction from the river bed and banks.
River dependent Wildlife	D	Illegal hunting and habitat degradation has resulted in decline in the abundance of river dependent animals such as Otter.

3. Overview of Ecological Resources

Information for this section has been drawn from the ESIA of the Gulpur Hydropower Project. It provides a summary of the terrestrial and aquatic ecological resources in the Ecological Study Area focusing on fish fauna, macro–invertebrates, floral diversity and habitats, mammals, reptiles, and birds. Information presented in this section was collected during three ecological surveys of the Ecological Study Area to study the abundance and diversity of the ecological resources in the fall, winter and spring season respectively. The October 2013 (fall survey) survey was conducted from 26th September 2013 to 3rd October 2013 while the December 2013 survey (winter survey) was conducted from 24th December 2013 to 28th December 2013 (winter survey). The May 2014 survey (spring survey) was conducted from 30th April to 4th May. Detailed data, analysis, and discussion of results of the surveys are included in Biodiversity Baseline Report for Gulpur Hydropower Project[42].

The Ecological Study Area was defined for the ESIA of the Project that adopted a basin wide approach and focused on the river reaches likely to be impacted by Project operations. The Biodiversity Action Plan, however, includes measures to protect the ecological resources of the entire Poonch River from LOC to Mangla.

3.1 Ecological Study Area

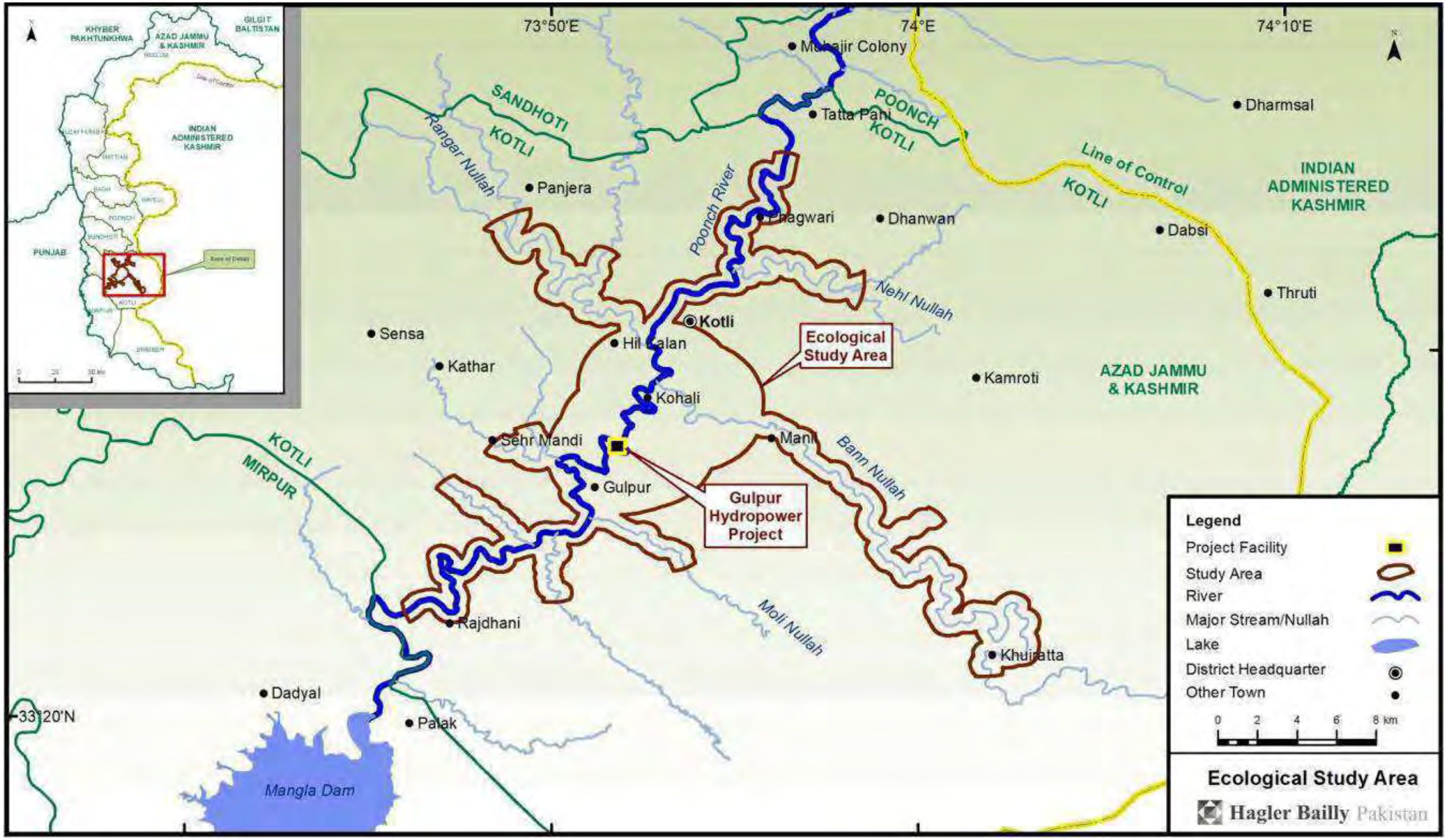
The Aquatic Study Area for sampling the aquatic resources consists of the stretch of Poonch River from Kallar Bridge to just downstream Rajhdani, as well as the main tributaries of the Poonch River including Ban Nullah, Rangar Nullah and Nehl Nullah. The river banks and areas within 500 m on either side of the river have been included in the Aquatic Study Area and sampling for vegetation, mammals, herpeto-fauna and birds has been conducted in these riparian habitats.

The Study Area for sampling the terrestrial ecological resources was demarcated keeping in view the location of Project facilities such as power house, dam, camping sites etc. and a 3 km potential impact zone around each facility. The Terrestrial Study Area was demarcated by combining all these potential impact zones to account for an area in which the ecological resources may be impacted by Project related activities such as habitat loss, sound, vibrations etc.

The term ‘Ecological Study Area’ is used to jointly refer to both the Aquatic and Terrestrial Study Areas and is shown on a map in **Exhibit 3.1**: .

[42] Hagler Bailly Pakistan (HBP), April 2014, Biodiversity Baseline Report of Gulpur Hydropower Project.

Exhibit 3.1: Ecological Study Area



3.2 Scope

The specific tasks covered under this ecological baseline study included:

- A review of the available literature on the biodiversity of the Ecological Study Area.
- Field surveys including:
  - Qualitative and quantitative assessment of flora, mammals, reptiles, birds and invertebrates.
  - Identification of key species, their population and their conservation status in the country and worldwide.
  - Reports of wildlife sightings in the Ecological Study Area by the resident communities.
- Analysis of ecological interaction of selected species with the environment.
- Analysis was also carried out to further develop the basis for evaluating the potential impacts of Project related activities on the biodiversity, specifically seeking any potential critical habitat and ecosystem services in the Ecological Study Area.

3.3 Methodology

The methodology for the field survey was compiled to obtain objective data, and to determine the baseline conditions for assessment of the resulting impacts of the Project for the data collected. During the October 2013 survey, sampling was conducted at 26 points. During the December 2013 survey, sampling for Otter sightings and signs was conducted at six locations, sampling for fish was conducted at 4 locations while sampling for vegetation, mammals and birds was conducted at three (3) sampling locations. Since the herpeto–fauna hibernate in the winter months, reptile and amphibian sampling was not conducted during the December 2013 survey. During the May 2014 survey, sampling of fish was carried out at 9 sampling locations including sites of potential future hydropower projects. Sampling for vegetation in the May 2014 survey was repeated at the same sampling locations as the December 2014 survey i.e. the terrestrial habitats that will be occupied by the Project infrastructure.

The timing, location, and scope of the surveys are summarized in **Exhibit 3.2.** The sampling methodology used, coordinates of sampling locations and field data collected for the surveys is presented in the Draft Biodiversity Baseline Report for Gulpur Hydropower Project[43]. The sampling locations are shown on a map in **Exhibit 3.3** and **Exhibit 3.4**. The fish sampling locations for the May 2014 survey are shown in **Exhibit 3.5**.

[43] Hagler Bailly Pakistan (HBP), April 2014, Draft Biodiversity Baseline Report of Gulpur Hydropower Project.

Exhibit 3.2: Timing, Location, and Scope of Surveys in the Ecological Study Area

Survey Period	*Area Studied*	*Scope*	*Comments*
October 2013	River, tributaries, and terrestrial habitats in the Aquatic and Terrestrial Ecological Study Area	Aquatic/River dependent: fish, macroinvertebrates, macrophytes, marginal vegetation, mammals, birds,and herpeto–fauna.	A total of eight sampling locations were selected for aquatic sampling in the river and its tributaries. The river biotopes at each sampling location were identified and sampling for fish and macro–invertebartes was conducted ensuring sampling in each biotope. Sampling of vegetation, mammals, reptiles and birds was conducted on the riparian habitats within 500 m on either side of the river.
		Terrestrial: vegetation, mammals, birds and herpeto–fauna	A total of eighteen sampling locations were selected for terrestrial sampling of vegetation, mammals, herpeto–fauna and birds. A grid of 2x2 km was drawn on a map of the Terrestrial Study Area and the sampling points were marked. The points were then adjusted to ensure habitat representation, accessibility, with a focus on the areas to be impacted. Seven trapping sites for small mammals were selected.
December 2013	River, and terrestrial habitats at the proposed Project location.	Aquatic/River dependent: fish, Otter Terrestrial: vegetation, mammals and birds	A total of 4 sampling locations were selected for aquatic sampling of fishes . A total of 6 sampling locations were selected for observing Otter sightings and signs. A total of 3 sampling locations were selected for terrestrial sampling of vegetation, mammals, herpeto–fauna and birds at the proposed Project location. One trapping site for small mammals was selected.
May 2014	River, and terrestrial habitats at the proposed Project location	Aquatic/River dependent: fish Terrestrial: vegetation	A total of 9 sampling locations were selected for aquatic sampling of fishes . A total of three sampling locations were selected for terrestrial sampling of vegetation at the proposed Project location.

Exhibit 3.3: Aquatic Ecological Sampling Locations

Exhibit 3.4: Terrestrial Ecological Sampling Locations

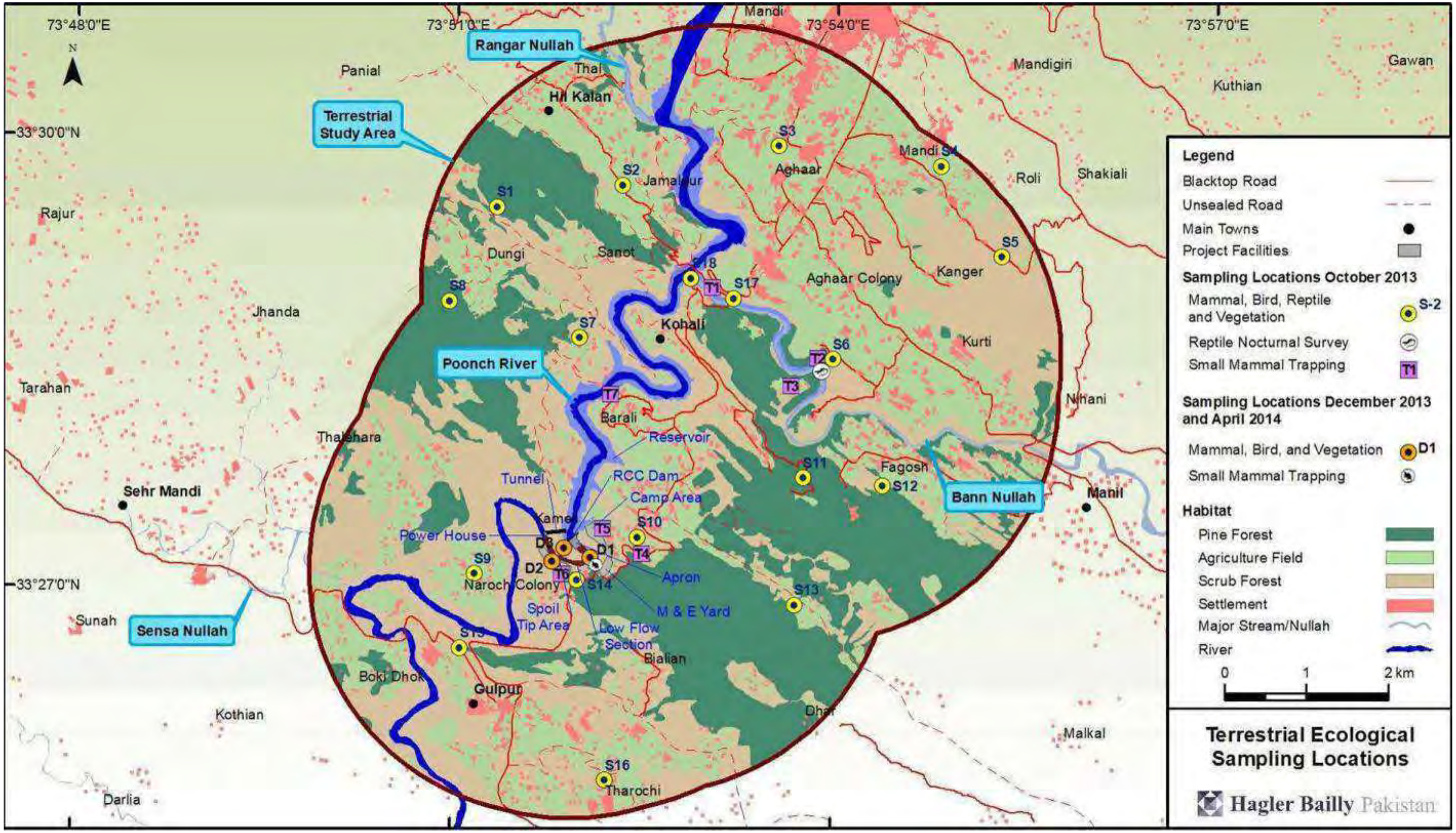
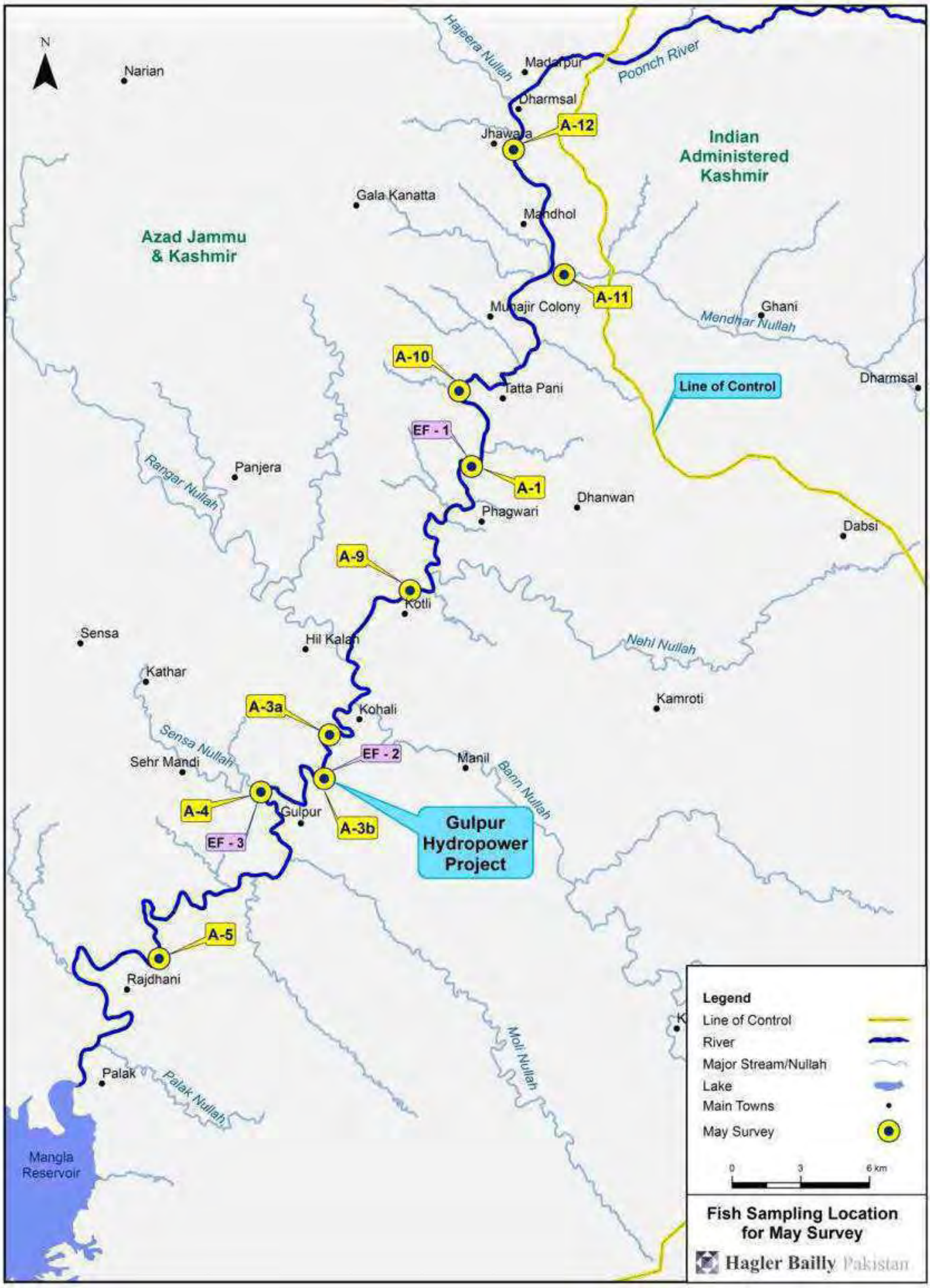


Exhibit 3.5: Fish Sampling Locations for May 2014 survey



3.4 Aquatic Ecological Resources

This section presents an overview of the aquatic ecological resources in the Ecological Study Area including fish fauna and macro-invertebrates.

3.4.1 Fish

Overview of Fish Fauna

The Poonch River is a warm water river and the water temperature approaches almost 30° C during the summer months. A total of 37 fish species have been recorded from the Poonch River (**Exhibit 3.6**)[44] [45]. The diversity is higher in the area where the River Poonch makes its confluence with Mangla Reservoir. This diversity is quite high for a river of this size as compared to other rivers of AJK, the Neelum and Jhelum, which are bigger and longer. The reason is the topography and water temperature of the River Poonch. The Poonch flows gently in a vast and flat valley, which provides numerous breeding grounds for the reproduction of fish. High temperature and gravely, rocky and the sandy river bed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival. The completion of Mangla dam in 1967 created a barrier in the Jhelum River and isolated the Poonch River from the segment of Jhelum downstream of the dam. Mangla dam also created a barrier to movement of riffle dwelling smaller fishes such as the Kashmir Catfish Glyptothorax kashmirensis and the Twin–Banded Loach Botia rostrata between the Jhelum and Poonch rivers.

Of the fish species recorded from the Poonch River, 16 species are species of special importance because of their economic importance or conservation status (endemic or included in IUCN red List). These include Barilius pakistanicus, Schistura punjabensis, Cirrhinus reba, Labeo dero, Labeo dyocheilus, Tor putitora, Schizothorax plagiostomus (richardsonii), Cyprinus carpio, Botia rostrata, Sperata seenghala, Clupisoma garua, Ompok bimaculatus, Glyptothorax naziri, Ompok pabda, Glyptothorax kashmirensis and Mastacembelus armatus. The species Glyptothorax kashmirensis, previously only reported from Jhelum River, has been captured from the Poonch River during the October 2013 survey and is discussed below. The species of special importance recorded from the Poonch River are listed in *Note: ND: Not Determined; LC: least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; EW: Extinct in the wild; EX: Extinct.

Exhibit 3.7.

[44] Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahaseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

[45] HBP, November 2013, Draft Baseline Biodiversity Assessment Report for Gulpur Hydropower Project, Hagler Bailly Pakistan.

Exhibit 3.6: Fish Fauna Recorded from the Poonch River

No	*Scientific Name*	*Common Name*	*Distributional Status*	*IUCN Status 2013**	*Commercial Value*
	Cyprinidae				
1.	*Chela cachius*	Silver hatchet chela	Wide	LC	Low
2.	*Salmophasia bacaila*	Large razorbelly minnow	Wide	LC	Low
3.	*Aspidoparia morar*	Aspidoparia	Wide	LC	Low
4.	*Barilius pakistanicus*	Pakistani Baril	Endemic	ND	Low
5.	*Esomus danricus*	Flying Barb	Wide	LC	Low
6.	*Cirrhinus reba*	Reba Carp	Wide	LC	Fairly good
7.	*Cyprinion watsoni*	Cyprinion	Wide	ND	Low
8.	*Labeo dero*	Kalbans	Wide	LC	Fairly good
9.	*Labeo dyocheilus*	Pakistani Labeo	Wide	LC	High
10.	*Osteobrama cotio*	Cotio	Wide	LC	Low
11.	*Puntius chola*	Swamp Barb	Wide	LC	Low
12.	*Puntius sophore*	Spotfin Swamp Barb	Wide	LC	Low
13.	*Puntius ticto*	Two spot Barb	Wide	LC	Low
14.	*Tor putitora*	Mahaseer	Wide	EN	Very high
15.	*Crossocheilus latius*	Gangetic Latia	Wide	LC	Low
16.	*Garra gotyla*	Sucker Head	Wide	LC	Low
17.	*Schizothorax plagiostomus (richardsonii)*	Snow Carp	Wide	VU	High
18.	*Securicula gora*	Gora Chela		LC	Low
19.	*Cyprinus carpio*	Common Carp	Exotic	VU	High

No	Scientific Name	Common Name	Distributional Status	IUCN Status 2013*	Commercial Value
	Noemacheilidae				
20.	*Acanthocobitis botia*	Mottled Loach	Wide	LC	Low
21.	*Schistura punjabensis*	Hillstream Loach	Endemic	ND	Low
	Cobitidae				
22.	*Botia rostrata*	Twin–banded Loach	Wide	VU	Low
	Bagridae				
23.	*Sperata seenghala*	Giant river cat fish	Wide	LC	Very high
	Schilbeidae				
24.	*Clupisoma garua*	Garua Bachwaa	Wide	LC	Very high
	Siluridae				
25.	*Ompok bimaculatus*	Butter Catfish	Wide	NT	Low
	Sisoridae				
26.	*Glyptothorax pectinopterus*	Flat head catfish	Wide	LC	Low
	Channidae				
27.	*Chanda nama*	Elongate glass–perchlet	Wide	LC	Low
28.	*Parambasis baculis*	Himalayan glassy perchlet	Wide	LC	
29.	*Parambasis ranga*	Indian glassy fish	Wide	LC	
	Botidae				
30.	*Botia almorhae*	Pakistani Loach		LC	Low
	Chandidae				
31.	*Channa gachua*	Dwarf Snakehead		LC	Low

No	Scientific Name	Common Name	Distributional Status	IUCN Status 2013*	Commercial Value
	Sisoridae				
32.	*Glyptothorax cavia*	Heart Throat Catfish		LC	Low
33.	*Glyptothorax kashmirensis*	Kashmir Catfish		CR	Low
34.	*Glyptothorax naziri*	Nazirs' Catfish	Endemic	ND	Low
35.	*Gagata cenia*	Clown Catfish		LC	Low
	Siluridae				
36.	*Ompok pabda*	Pabdah Catfish		NT	Low
	Mastacembelidae				
37.	*Mastacembelus armatus*	Tire–track spiny eel	Wide	LC	High

*Note: ND: Not Determined; LC: least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; EW: Extinct in the wild; EX: Extinct.

Exhibit 3.7: Species of Special Importance Found in the Poonch River, Azad Kashmir

No	Scientific Name	Distributional Status	IUCN Status 2013	Commercial Value	Max. Length (cm)	Max. Weight (kg)
1.	*Barilius pakistanicus*	Endemic	–	–	–	–
2.	*Cirrhinus reba*	–	–	Fairly good	30	0.3
3.	*Labeo dero*	–	–	Fairly good	75	0.2
4.	*Labeo dyocheilus*	–	–	High	90	5
5.	*Tor putitora*	–	**Endangered**	Very high	275	54
6.	*Schizothorax plagiostomus (richardsonii)*	–	Vulnerable	High	60	2.5
7.	*Cyprinus carpio*	–	Vulnerable	High	110	40.1
8.	*Botia rostrata*	–	Vulnerable	High	–	–
9.	*Sperata seenghala*	–	–	Very high	150	10
10.	*Clupisoma garua*	–	–	Very high	61	0.5
11.	*Ompok bimaculatus*	–	Near Threatened	Fairly good	45	0.2
12.	*Glyptothorax kashmirensis*	Endemic	**Critically Endangered**	Low	11.7	–
13.	*Glyptothorax naziri*	Endemic	Not Evaluated	Low		
14.	*Ompok pabda*		Near Threatened	Low		
15.	*Schistura punjabensis*	Endemic	Not Evaluated	Low		
16.	*Mastacembelus armatus*	–	–	High	90	0.5 g

Indicator Species

A total of six indicator species were chosen to study the impact of Project induced changes in the river flow on the fish fauna[46]. Details are provided in the Environmental and Social Impact Assessment of Gulpur Hydropower Project. The indicator fish species were chosen on the basis of their conservation importance as well as socio–economic importance for the local communities. Also taken into consideration was the fish size and adequate representation of the major fish families recorded from the Poonch River. The following fish species were chosen as indicators:

- Mahaseer Tor putitora
- Alwan Snow Trout Schizothorax plagiostomus (richardsonii)
- Kashmir Catfish Glyptothorax kashmirensis
- Garua Bachwa Clupisoma garua
- Pakistani Labeo Labeo dyocheilus
- Twin–banded Loach Botia rostrata

Distribution and Abundance of Fish Fauna in the October 2013 Survey

The river habitats observed in the Poonch River included pools and glides, riffles and rapids. The dominant habitat is riffles followed by pools and glides.

During the October 2013 survey, fish fauna were collected from the selected sampling points using cast nets. Different micro–habitats (biotopes) of the river such as pools, riffles and backwater were sampled to understand habitat preferences of the indicator species. The fish species observed in the Ecological Study Area during the October 2013 survey are listed in **Exhibit 3.8**. Fish abundance and diversity observed during the survey is presented in **Exhibit 3.9**. The distribution of the indicator fish species in the river habitats at each sampling point is given in **Exhibit 3.10** and represented in **Exhibit 3.11**. Photographs of some of common fish species found in the Ecological Study Area are shown in **Exhibit 3.12.** Principal observations of the October 2013 surveys are summarized below.

- A total of 253 fish specimens belonging to 26 fish species were collected.
- Fish abundance was highest at Sampling Point A3 (River at Borali Bridge) where 57 fish specimens belonging to 16 fish species were collected. Gangetic Latia Crossocheilus latius was the most abundant fish species collected at this sampling point, followed by Mahaseer Tor putitora and Twin–banded Loach Botia rostrata.
- Fish species richness was highest at Sampling Point A5 (River at Billiporian Bridge, near Rajdhani) where 18 fish species were collected. Gangetic Latia Crossocheilus latius was the most abundant fish species collected at this sampling point, followed by Mahaseer Tor putitora and Pakistani Labeo Labeo dyocheilus.
- The most abundant fish species was the Gangetic Latia Crossocheilus latius with 63 specimens collected. The second most abundant fish species was Mahaseer Tor

46 Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project.

putitora followed by Pakistani Baril Barilius pakistanicus with 42 and 21 specimens collected respectively.

- The least abundant fish species collected included Dwarf Snakehead Channa gachua, Common Carp Cyprinus carpio, Elongate Glassy Perchlet Chanda nama and Butter Catfish Ompok bimaculatus.
- The fish abundance and species richness was generally higher in the main River compared to the tributaries (**Exhibit 3.9**).

Exhibit 3.8: Fish Fauna Observed During October 2013 Survey of the Ecological Study Area

No		*Sampling Locations*	*A1*	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*A8*	*Total*
		EF – Sites	*EF – 1*	*–*	*EF – 2*	*EF – 3*		*–*	*–*	*–*	
		Location	*River at Kallar Bridge*	*River at Confluence with Rangar Nullah*	*River at Borali Bridge*	*River at Gulpur Bridge*	*River at Billiporian Bridge near Rajdhani*	*Rangar Nullah (Tributary)*	*Bann Nullah near Manil Tributary (Tributary)*	*Bann Nullah near Khuiratta (Tributary)*	
		Location with reference to Gulpur Hydropower Project	*Upstream Project Site*	*Proposed submerged area*	*Proposed unindated area*	*Downstream outlet*	*Downstream Project*	*Upstream Project Site*	*Upstream Inlet*	*Upstream Inlet*	
	Scientific Name	*Common name*									
1.	*Tor putitora*	Mahaseer	6	4	6	4	6	11	3	2	**42**
2.	*Labeo dyocheilus*	Pakistani Labeo	2	3	3	–	4	1	–	–	**13**
3.	*Crossocheilus latius*	Gangetic Latia	5	5	10	5	9	11	7	11	**63**
4.	*Garra gotyla*	Sucker Head	2	1	2	1	1	1	2	6	**16**
5.	*Botia rostrata*	Twin–banded Loach	1	1	5	2	1	1	–	–	**11**
6.	*Botia almorhae*	Pakistani Loach	2	–	3	1	2	–	–	–	**8**
7.	*Glyptothorax pectinopterus*	Flat Head Catfish	1	1	3	–	–	1	–	–	**6**
8.	*Glyptothorax kashmirensis*	Kashmir Catfish	2	–	2	–	–	–	–	–	**4**
9.	*Glyptothorax cavia*	Heart Throat Catfish	3	2	5	2	3	–	–	–	**15**
10.	*Mastacembelus armatus*	Tire–track Spiny Eel	1	1	2	–	2	1	–	–	**7**
11.	*Barilius pakistanicus*	Pakistani Baril	–	2	3	1	3	6	2	4	**21**
12.	*Acanthocobitis botia*	Mottled Loach	–	2	–	–	1	–	–	–	**3**
13.	*Ompok pabda*	Pabdah Catfish	–	1	–	–	–	–	–	2	**3**
14.	*Channa gachua*	Dwarf Snakehead	–	1	–	–	–	–	–	–	**1**

No		Sampling Locations	A1	A2	A3	A4	A5	A6	A7	A8	Total
		EF – Sites	EF – 1	–	EF – 2	EF – 3		–	–	–	
		Location	River at Kallar Bridge	River at Confluence with Rangar Nullah	River at Borali Bridge	River at Gulpur Bridge	River at Billiporian Bridge near Rajdhani	Rangar Nullah (Tributary)	Bann Nullah near Manil Tributary (Tributary)	Bann Nullah near Khuiratta (Tributary)	
		Location with reference to Gulpur Hydropower Project	Upstream Project Site	Proposed submerged area	Proposed unindated area	Downstream outlet	Downstream Project	Upstream Project Site	Upstream Inlet	Upstream Inlet	
15.	*Labeo dero*	Kalbans	–	–	2	1	–	–	–	–	**3**
16.	*Schistura punjabensis*	Punjab Loach	3	–	1	–	–	3	–	–	**7**
17.	*Glyptothorax naziri*	Nazirs' Catfish	–	–	3	–	–	–	–	–	**3**
18.	*Gagata cenia*	Clown Catfish	–	–	5	–	–	–	–	–	**5**
19.	*Clupisoma garua*	Garua Bachwa	–	–	2	–	1	–	–	–	**3**
20.	*Salmophasia bacaila*	Large Razorbelly Minnow	–	–	–	1	1	3	–	3	**8**
21.	*Cyprinus carpio*	Common Carp	–	–	–	–	1	–	–	–	**1**
22.	*Aspidoparia morar*	Chilwa	–	–	–	–	2	–	–	–	**2**
23.	*Securicula gora*	Gora Chela	–	–	–	–	3	–	–	–	**3**
24.	*Parambassis ranga*	Glassy Fish	–	–	–	–	3	–	–	–	**3**
25.	*Chanda nama*	Elongate Glassy Perchlet	–	–	–	–	1	–	–	–	**1**
26.	*Ompok bimaculatus*	Butter Catfish	–	–	–	–	1	–	–	–	**1**
	Total Abundance		**28**	**24**	**57**	**18**	**45**	**39**	**14**	**28**	**253**
	Richness		**11**	**12**	**16**	**9**	**18**	**10**	**4**	**6**	

Exhibit 3.9: Fish Abundance and Richness at Sampling Points. Surveys Conducted October 2013 Survey

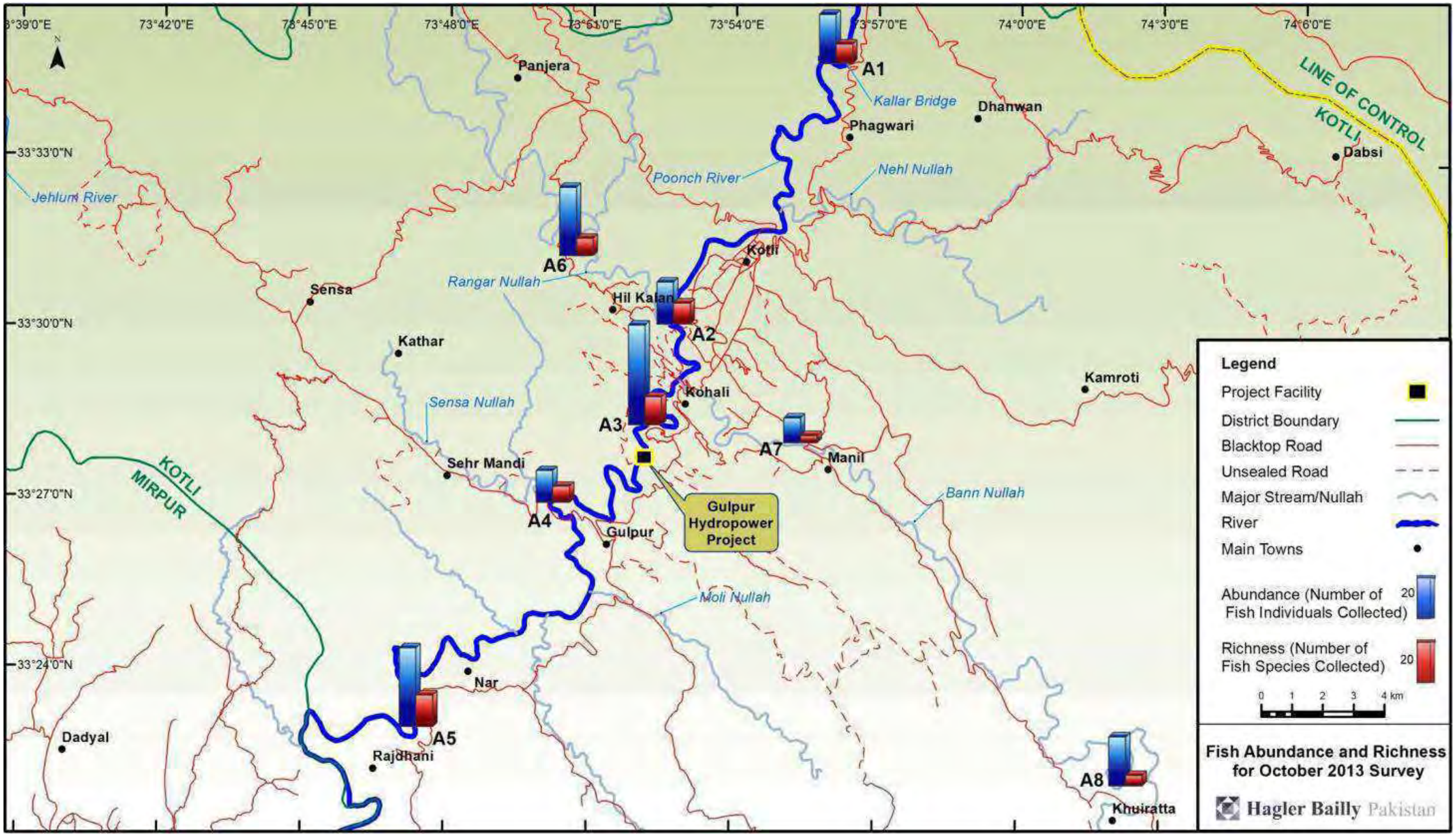


Exhibit 3.10: Distribution of Indicator Fish Species during October 2013 Survey at Sampling Locations

No			*Sampling Locations*																																**Total**
			A1				*A2*				*A3*				*A4*				*A5*				*A6*				*A7*				*A8*				
		EF – Sites	*EF – 1*				*–*				*EF – 2*				*EF – 3*				*EF – 4*				*–*				*–*				*–*				
		Location	*River at Kallar Bridge*				*River at Confluence with Rangar Nullah*				*River at Borali Bridge*				*River at Gulpur Bridge*				*River at Billiporian Bridge near Rajdhani*				*Rangar Nullah (Tributary)*				*Bann Nullah near Manil Tributary (Tributary)*				*Bann Nullah near Khuiratta Tributary*				
		Location with reference to project	*Upstream Project Site*				*Proposed submerged area*				*Proposed unindated area*				*Downstream outlet*				*Downstream Project*				*Upstream Project Site*				*Upstream Inlet*				*Upstream Inlet*				
		Biotopes	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	
	Scientific Name	*Common Name*																																	
1.	*Tor putitora*	Mahaseer	3	2	1	6	2	2	–	4	3	3	–	6	2	2	–	4	3	1	2	6	3	5	3	11	2	1	–	3	1	1	–	2	**42**
2.	*Labeo dyocheilus*	Pakistani Labeo	–	1	1	2	2	1	–	3	1	2	–	3	–	–	–	–	1	3	–	4		1	–	1	–	–	–	–	–	–	–	–	**13**
3.	*Botia rostrata*	Twin–banded Loach	1	–	–	1	1	–	–	1	5	–	–	5	2	–	–	2	1	–	–	1	1	–	–	1	–	–	–	–	–	–	–	–	**11**
4.	*Glyptothorax kashmirensis*	Kashmir Catfish	2	–	–	2	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**4**
5.	*Clupisoma garua*	Garua Bachwa	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**3**
6	*Schizothorax plagiostomus*	Alwan Snow Trout	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**–**
	Total Abundance		**6**	**3**	**2**	**11**	**5**	**3**	**–**	**8**	**13**	**5**	**–**	**18**	**4**	**2**	**–**	**6**	**5**	**5**	**2**	**12**	**4**	**6**	**3**	**13**	**2**	**1**	**–**	**3**	**1**	**1**	**–**	**2**	**73**

Exhibit 3.11: Number of Indicator Fish Species Collected in the Ecological Study Area During October 2013 Survey

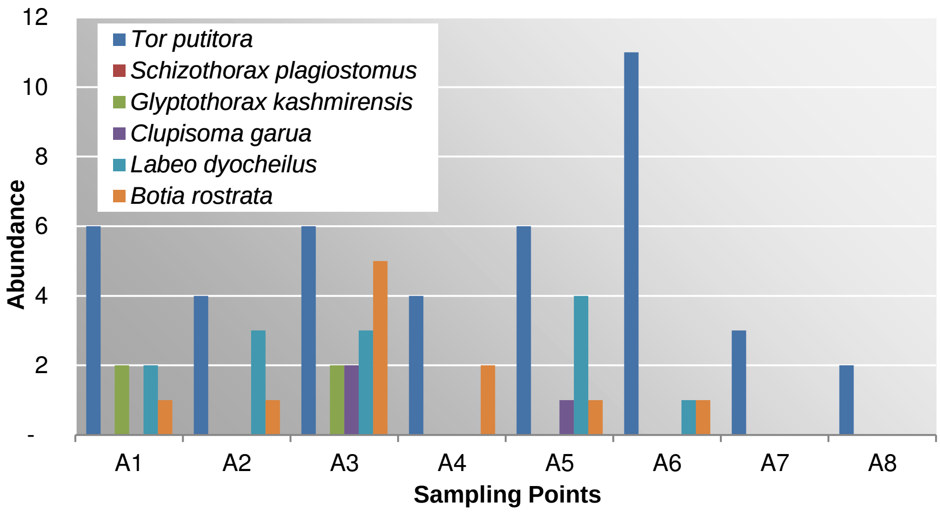


Exhibit 3.12: Photographs of Indicator Fish Species in the Ecological Study Area

Golden Mahaseer *Tor Putitora*

Twin–banded Loach *Botia rostrata*

Kashmir Cat fish *Glyptothorax kashmirensis*

Pakistani Labeo *Labeo dyocheilus*

Garua Bachwa *Clupisoma garua*

Alwan Snow Trout *Schizothorax plagiostomus*

December 2013 survey

During the December 2013 survey, sampling for fish resources was conducted at four sampling locations: EF site 1, EF site 2 (new), EF site 3 and EF site 4 (**Exhibit 3.3)**.

No fish were found in the main River channel using cast nets. However, deep pools ranging from 10–20 m were sampled using the gill nets and some large sized fish species were collected. The results are summarized below and summarize in **Exhibit 3.13**.

- During the winter, small sized fish species such as Twin–banded Loach Botia rostrata move into crevices or beneath the boulders available in and on the river edges.
- Large sized species like Labeo dyocheilus and Tor putitora had moved into deep pools for overwintering and were collected by gill nets. The species Labeo dyocheilusis was found in the pools in the Ecological Study Area but Tor putitora had moved further down and was seen in the pools downstream Gulpur area.
- The main river channel was occupied by the cold water fish Schizothorax plagiostomus from mid–October to mid–March. This fish inhabits the upper cold reaches of the river during summer season and can be seen in the Ecological Study Area during winter season. The optimum water temperature for this fish is 15–20°C and therefore it occupies deep pools and crevices during extreme cold months.
- The commercially important species Clupisoma garua was not seen in the Ecological Study Area during the December 2013 survey (winter survey) as it migrates down to the Mangla Reservoir for overwintering.
- The fish Tor putitora occupies the main pools in the Poonch River with rocky bottoms and there is very little migration to the Mangla Reservoir for overwintering as the bed of the reservoir is highly muddy and silty and is not a favorable habitat for this fish. It is concentrated in river pools upstream the Mangla Reservoir.

The Poonch River becomes shallow during the low flow period in the winter season. Stones, boulders and cobbles in the river bed are clearly visible. Water temperature of the river drops to 9–11oC. Fish fauna, which mainly consists of warm water species, cannot withstand this low temperature and move to available refuges. The river is characterized by having series of deep pools of variable sizes and rocky edges, with deep crevices serving as wintering places for fish.

During the winter season, fish activity in the main river channel is almost nonexistent and almost all the species migrate into refuges for over wintering. Overwintering is a surviving strategy as maintenance of the viable populations in the river system makes it necessary for the fish fauna to move away from areas where conditions become unfavorable for survival. It helps the fish to conserve their stored energy reserves and maintain fitness for enhancing growth and reproductive output when conditions become favorable. Thus, during the winter months, fish move to pools where water is deep enough to buffer the cold temperature of winter. These migrations are mainly dependent on the availability of suitable habitats. If suitable refuges are available within the fish individual's normal home ranges, then migration is unnecessary and the fish takes refuge in locally available pools and crevices in the rocks. Therefore, with the onset of the winter season, many fishes move downstream from shallow areas that are warm and productive in summer but which are associated with low water temperature in winter, to deeper slower pools further downstream. Such migrations are not always in the downstream direction but depend on the availability of refuge habitat. These movements are not as conspicuous or concerted in time and space as compared to the breeding migrations. Metabolic activity, swimming capacity, and digestive ability of many fishes is severely reduced during low temperature of winter. Under these circumstances feeding activity may be very low or nonexistent, even when plentiful food is available.

Exhibit 3.13: Fish Fauna Observed During December Survey

No.		*Sampling Location*	*A-1*	*A-3b*	*A-4*	*A-5*
		EF-Site	*EFlow site 1*	*Eflow site 2*	*EFlow site 3*	*EFlow site 4*
		Biotopes	*Pools*	*Pools*	*Pools*	*Pools*
	Scientific Name	*Common Name*				
1	*Schizothorax plagiostomus*	Snow Carp	2	0	0	0
2	*Tor putitora*	Mahaseer	2	3	5	7
3	*Labeo dyocheilus*	Pakistani Labeo	4	6	4	3

May 2014 survey

During the May 2014 survey, sampling was carried out at nine sampling locations, five sites that were sampled in the October 2013 survey and four additional sites – sites under consideration for future hydropower projects in the Poonch River. Results of sampling for the May 2014 survey are shown in **Exhibit 3.14**. Fish abundance and diversity during the May survey is shown in **Exhibit 3.15**.

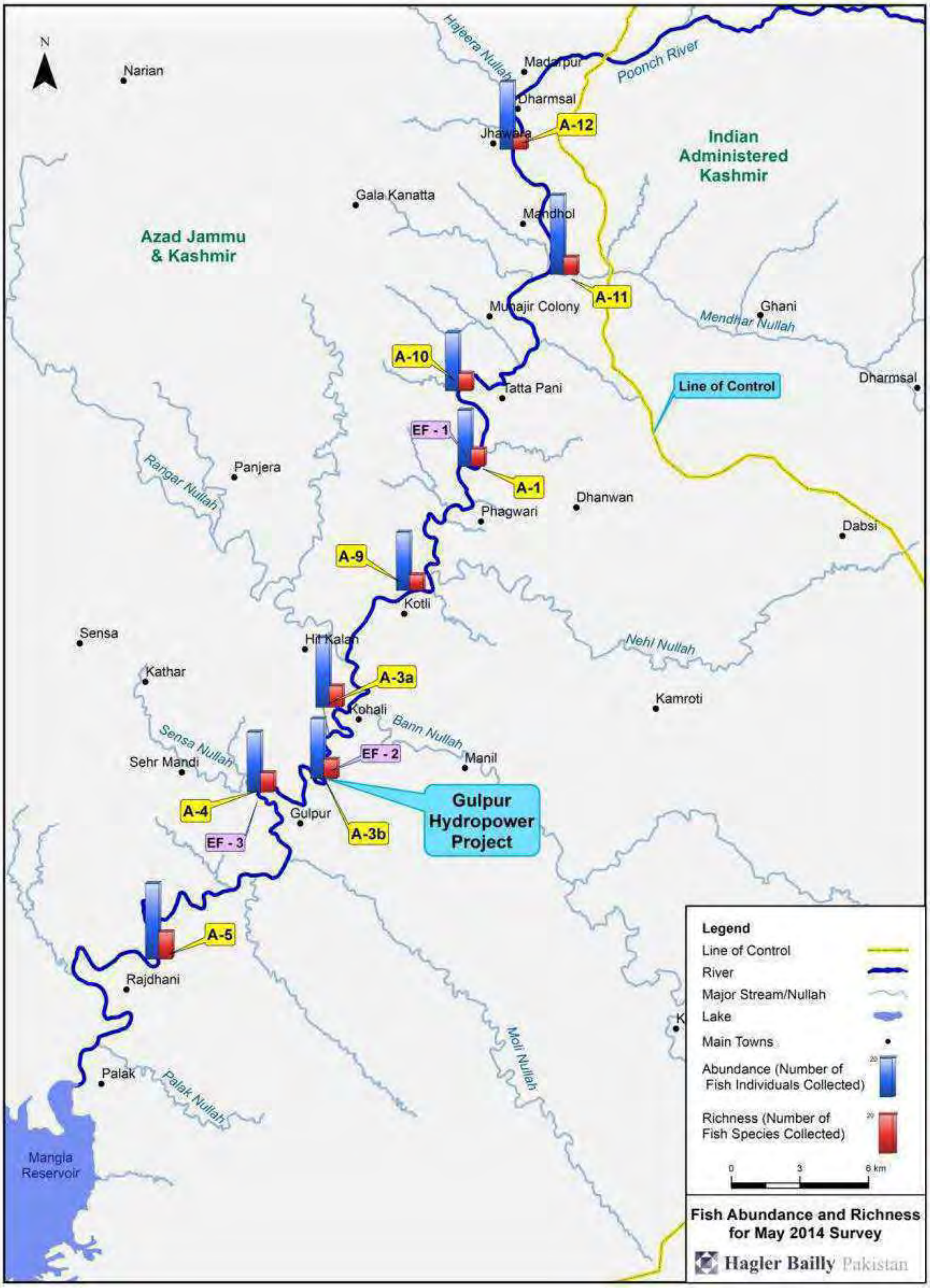
- A total of 302 fish belonging to 21 species were collected during the May 2014 survey.
- At this time of the year, the river water was cold (15°C) as compared to tributaries (20°C) due to snow melt in the river. Moreover, there was a clear difference of turbidity between the river water and tributaries. The river water was turbid due to increase in sediment caused by snow melt while the water in the tributaries was clear.
- A higher abundance of fish fauna was observed in the river compared to the tributaries. Concentration of the fish in the river at this time of the year can be attributed to the reproductive triggers provided by snowmelt water, associated turbidity and new flow regime in the river. With the onset of the Monsoon Season (July/August), the temperature, flow and turbidity regimes will change and the fish will migrate into suitable breeding grounds in the river and the tributaries.
- Most of the fish species observed were common other than Clupisoma garua. It is likely that the river waters are too cold from snowmelt to allow upstream migration of this fish from the Mangla reservoir.
- The fish species caught did not show sexual maturity since it was pre-breeding season.
- Schizothorax plagiostomus is a cold water fish and migrates to occupy the cold water of the upper reaches of the river during summer season. It was observed only at Sampling Point A-12 (**Exhibit 3.5**) indicating that this fish has already left the downstream reaches of the river with the beginning of the summer season.
- Mahaseer fish was found in good numbers in almost all the sites but fish was not yet sexually fully mature. The fish was evenly distributed in all the microhabitats of the river indicating that it is actively feeding and moving towards its breeding grounds.
- Upstream migration of the fish species found in the Mangla Reservoir was not very prominent at this time of the year. With increasing temperatures in the summer season, this migration will increase.

Exhibit 3.14: Fish Fauna Observed During May 2014 Survey

		Sampling Locations																																			
	Sampling Location	A-12				A-11				A-10				A-3b				A-1				A-9				A-3a				A-4				A-5			
	EF – Sites													EFlow Site 2				EFlow Site 1												EFlow Site 3				EFlow Site 4			
	Location	Sehra Dam Site				Meander Nullah				Sehra Hydropower Project Site				Gulpur Hydropower Project Site				(Kotli Dam Site)				Kotli Hydropower Project Site (Kotli)				River at Barali Bridge				River at Gulpur Bridge				River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,			
	Biotopes	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**	Riffles	Pools	Backwater	**Total**
Scientific Name	Common Name																																				
Aspidoparia morar	Chilwa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2
Barilius pakistanicus	Pakistani Baril	–	–	–	–	2	4	2	8	1	2	3	6	1	–	1	2	2	3	1	6	–	–	–	–	–	–	1	1	2	2	–	4	–	–	–	–
Botia almorhae	Pakistani Loach	4	–	–	4	3	–	–	3	2	–	–	2	1	–	–	1	1	1	–	2	3	–	–	3	3	–	–	3	3	1	–	4	2	–	–	2
Botia rostrata	Twin–banded Loach	5	–	–	5	4	–	–	4	4	–	–	4	4	–	–	4	3	–	–	3	3	1	–	4	1	1	–	2	2	2	–	4	2	–	–	2
Chanda nama	Elongate glass–perchlet	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3
Clupisoma garua	Garua bachwaa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	–	2	–	2	1	1	–	2
Crossocheilus latius	Gangetic latia	1	3	1	5	2	3	1	6	–	1	2	3	1	3	1	5	2	1	2	5	2	2	–	4	1	1	–	2	–	1	–	1	–	1	2	3
Gagata cenia	Clown Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	3	–	9	–	–	–	–	–	–	–	–
Garra gotyla	Sucker Head	6	–	–	6	5	–	–	5	4	–	–	4	2	2	–	4	2	1	–	3	3	1	–	4	3	–	–	3	2	–	–	2	1	–	–	1
Glyptothorax cavia	Heart Throat Catfish	–	–	–	–	2	–	–	2	3	–	–	3	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Glyptothorax kashmirensis	Kashmir Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	3	–	–	3
Glyptothorax naziri	Nazirs' Catfish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–
Glyptothorax pectinopterus	Flat head Catfish	–	–	–	–	3	–	–	3	1	–	–	1	–	–	–	–	2	–	–	2	4	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–
Labeo dero	Kalbans	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–
Labeo dyocheilus	Pakistani Labeo	2	3	–	5	3	1	–	4	1	2	–	3	2	2	1	5	–	3	–	3	2	4	–	6	2	2	–	4	2	2	1	5	2	1	1	4
Mastacembelus armatus	Tire–track spiny eel	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	2	–	–	2	1	–	–	1	–	–	–	–	1	1	–	2	1	–	–	1
Parambassis ranga	Indian glassy fish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	4
Salmophasia bacaila	Large razorbelly minnow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	3
Schizothorax plagiostomus	Snow Carp	2	2	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

		Sampling Locations																																				
	Sampling Location	*A-12*				*A-11*				*A-10*				*A-3b*				*A-1*				*A-9*				*A-3a*				*A-4*				*A-5*				
	EF – Sites													*EFlow Site 2*				*EFlow Site 1*												*EFlow Site 3*				*EFlow Site 4*				
	Location	*Sehra Dam Site*				*Meander Nullah*				*Sehra Hydropower Project Site*				*Gulpur Hydropower Project Site*				*(Kotli Dam Site)*				*Kotli Hydropower Project Site (Kotli)*				*River at Barali Bridge*				*River at Gulpur Bridge*				*River at Billiporian Bridge near Rajdhani (Rajdhani Dam Site,*				
	Biotopes	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	*Riffles*	*Pools*	*Backwater*	***Total***	
Securicula gora	Gora Chela	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	4	
Tor putitora	Mahaseer	3	2	1	6	3	3	–	6	2	2	–	4	3	1	–	4	1	2	–	3	2	1	1	4	3	1	–	4	3	1	–	4	3	2	–	5	
Abundance (No of Fish Individuals collected)					**35**				**41**				**30**				**31**				**29**				**30**				**36**				**31**				**39**	**302**
Richness (No of Fish Species Collected)					**7**				**9**				**9**				**10**				**9**				**8**				**11**				**10**				**14**	

Exhibit 3.15: Fish Abundance and Richness Observed During May Survey



3.4.2 Macro–invertebrates

During the October 2013 survey, a total of eight (8) locations were sampled to determine the abundance and richness of macro–invertebrate fauna in the Ecological Study Area. The points were located in the main Poonch River as well as the tributaries. The location of these sampling points is shown in **Exhibit 3.3**.

A total of 37 macro–invertebrate taxa were identified in the Ecological Study Area during the October 2013 survey. Some of these were identified up to the genus level while others could only be identified up to family / sub–family level.

Exhibit 3.16 shows the average abundance/m^2 of macro–invertebrates seen at each sampling point during October 2013 survey. The Sampling Points A1, A2, A3, A4, A5 were located on the main Poonch River while the Sampling Points A6, A7 and A8 were located in tributaries (nullahs).

- The average abundance of macro–invertebrates was generally higher in the tributaries (with the exception of Sampling Point A5) compared to the main river. This is because the low water velocity in nullahs and streams allows better opportunities for macro–invertebrate to attach to substrates in the river. In addition, the low water velocities promote growth of algae that provide food for macro–invertebrates.
- The maximum average macro–invertebrate abundance/m^2 was seen at Sampling Point A5 (River at Billiporian Bridge) where 441 macro–invertebrate specimens/m^2were observed. Large cobbles of approximately 1 foot diameter were present in the riverbed at this location that provided suitable substrate for macro–invertebrate attachment. Moreover, the predominant water biotope at this location was riffles (even though some pools were present) that is the preferred biotope of macro–invertebrates.
- The second highest average abundance/m^2 was seen at Sampling Point A8 (Bann Nullah at Khuiratta) where 422 macro–invertebrate specimens/m^2 were observed. This sampling point is located on Ban Nullah. The low water velocity in nullahs and streams allow better opportunities for macro–invertebrate to attach to substrates in the river and also promote algal growth.
- The least average macro–invertebrate abundance was seen at Sampling Point A2 (River at confluence with Rangar Nullah) where 113 specimens/m^2 were observed. The likely reason for the low abundance at this sampling point is the comparatively higher pollution levels in the River due to proximity to Kotli city.
- The most abundant macro–invertebrate taxon observed during October 2013 survey was Chironimidae with average abundance/m^2 of 580 followed by Choroterpes sp. and Stenonema sp with an average abundance/m^2 of 349 and 237 respectively.

Exhibit 3.17 shows the richness of macro–invertebrate taxa observed at each sampling point during October 2013 survey.

Similar to abundance, richness of macro–invertebrates observed was higher in the tributaries compared to the river due to lower water volume and velocity in the nullahs.

Maximum richness of macro–invertebrate taxa was seen at Sampling Point A8 (Bann Nullah near Khuiratta) where 22 taxa were seen during the October 2013 survey. Chironimidae was the most abundant taxon seen at this sampling point followed by Choroterpes sp. and Baetis sp.

Least richness of macro–invertebrate taxa was seen at Sampling Points A1 (Poonch River at Kallar Bridge) and A6 (Rangar Nullah) where 14 taxa were seen at each sampling point during the October 2013 survey. The low macro–invertebrate diversity at Sampling Point A1 (Poonch River at Kallar Bridge) was due to the high water turbidity at this location. Sampling Point A6 (Rangar Nullah) had a low diversity of macro–invertebrates but the average abundance observed was high.

Exhibit 3.16: Macro-invertebrates Abundance at Sampling Points during October 2013 Survey

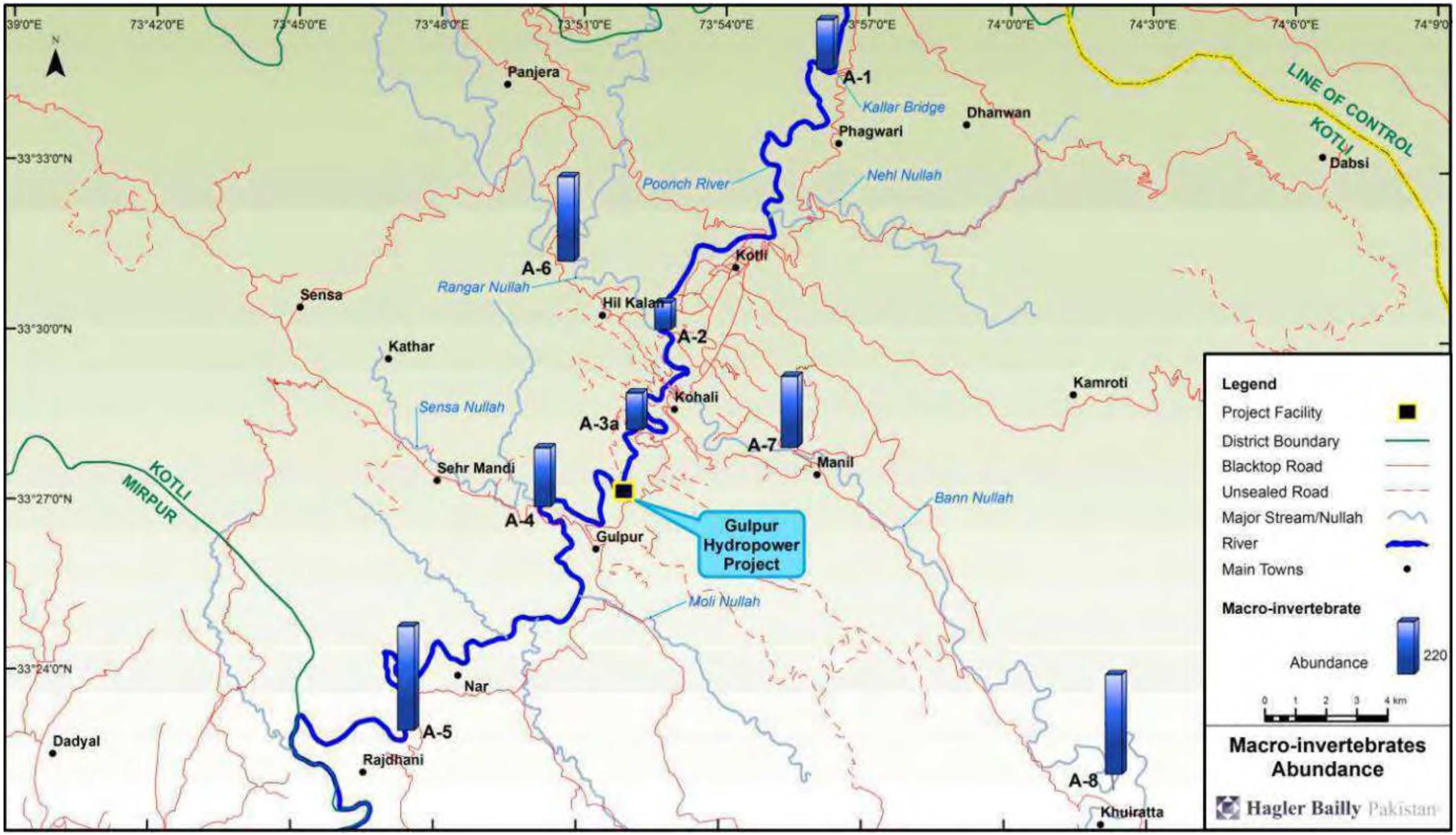
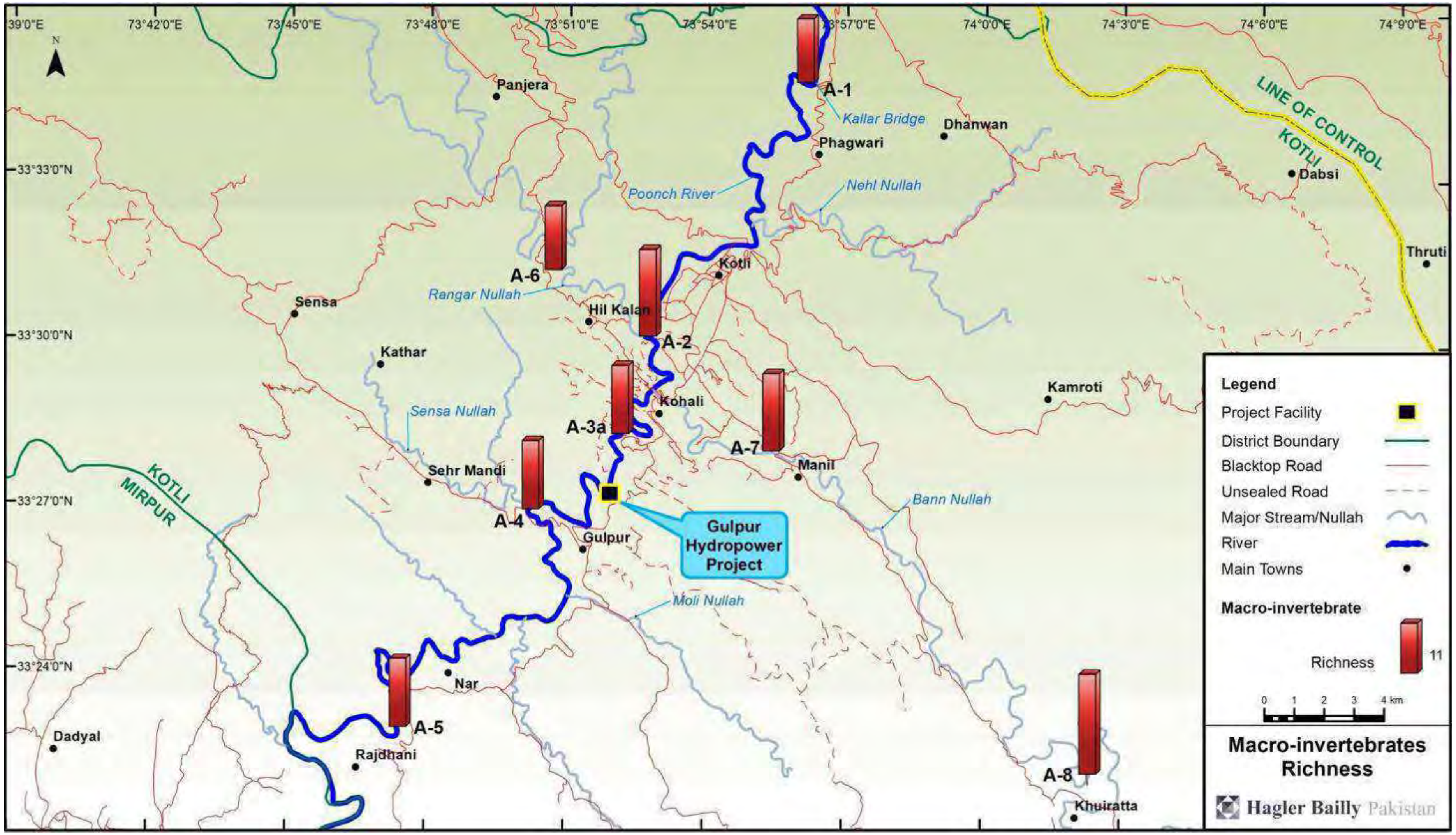


Exhibit 3.17: Macro-invertebrates Richness at Sampling Points during October 2013 Survey



3.4.3 Otters

Otters are the only water mammals associated with the Poonch River. Keeping in view the habitat available, the species likely to be found in the Ecological Study Area is the Common Otter Lutra lutra. The Otter lives in a wide variety of aquatic habitats, including highland and lowland lakes, rivers, streams, marshes, and swamps. This species is considered to be Near Threatened (IUCN Red List 2013) due to an ongoing population decline over the years. The aquatic habitats of otters are extremely vulnerable to man–made changes. Canalization of rivers, removal of bank side vegetation, dam construction, draining of wetlands, aquaculture activities and associated man–made impacts on aquatic systems are all unfavorable to otter populations[47].

Otter sampling was carried out at six sampling locations in the Ecological Study Area during the December 2013 survey (**Exhibit 3.18).** Each sampling location was surveyed for sightings as well as signs of the species including dens (holts), tracks, spraints (droppings). In addition, locals were interviewed regarding the presence of the Otter in their areas.

No Otter signs were observed in disturbed areas near the river, especially areas of sand and gravel extraction. Otter signs were also not observed in the areas where suitable habitat in the form of dense vegetation, deep pools and boulders or broken rocks on the river side were absent. Otters were found to be active (based on the observation of foot–prints and droppings) in the vicinity of deep and long pools in the river containing wintering fish species.

Otter signs were observed at the following sampling locations: A1, A3, A4 and Nar area. Otter signs were absent at D1 (Project location) and Sampling Point A5. Three Otters were sighted on 17 February, 2014 by Hagler Bailly's Socio-economic survey team, about 1 km upstream of Sampling Point A4. The otters were sitting on a rock in the River about 3 meters from the left bank (**Exhibit 3.18**). A summary of the survey findings are presented in **Exhibit 3.19**.

Areas where an abundance of Otter signs were observed or where the Otter was sighted can be designated as Otter hotspots. These are shown in **Exhibit 3.20**.

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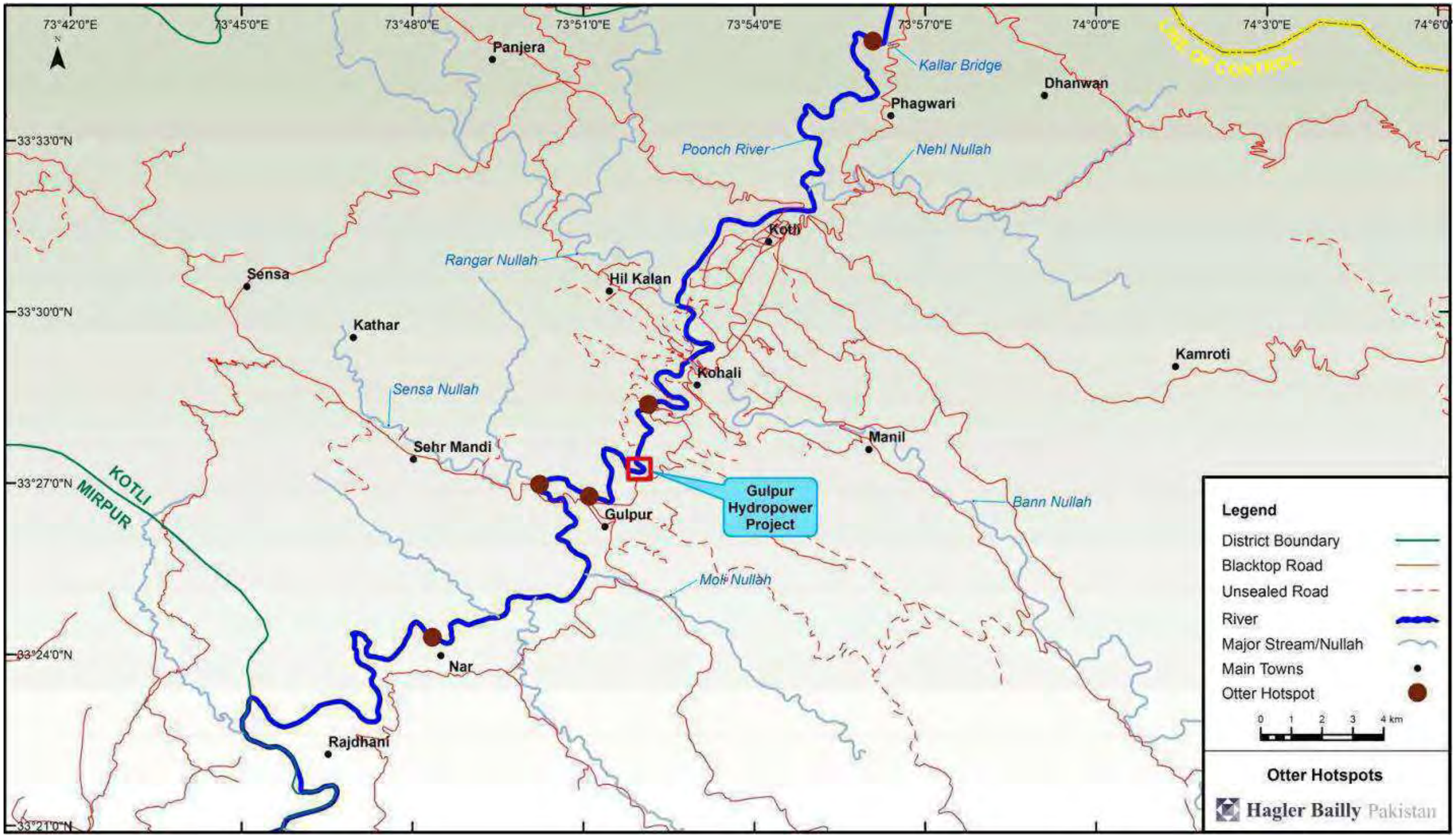
47 Ruiz–Olmo, J., Loy, A., Cianfrani, C., Yoxon, P., Yoxon, G., de Silva, P.K., Roos, A., Bisther, M., Hajkova, P. & Zemanova, B. 2008. *Lutra lutra*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **02 January 2014**.

Exhibit 3.18: Otter Sampling Locations. Surveys Conducted in December 2013

Exhibit 3.19: Summary of Signs in Ecological Otter Study Area. Surveys conducted December 2013

	Sampling Locations						
	A1	*A3,*	*D1 (Project Location)*	*A4*	*Narr Area*	*A5*	*Upstream A4*
Otter Signs – holts (dens)	1	2	No	1 (On the right bank of River along Sensa Nullah)	2	No	No
Otter Signs – Tracks	yes	yes	No	Yes (On the right bank of River along Sensa Nullah)	yes	No	No
Otter Signs – Spraints	yes	yes	No	Yes (On the right bank of River along Sensa Nullah)	yes	No	No
Results of Interviews with Locals regarding Otter sightings and signs	3 persons – yes 1 person – No	No one was interviewed	2 persons – No	2 persons – yes	3 persons– yes	2 persons – No	No
Otter Sightings	No	No	No	No	No	No	Yes (during February 2014)
General Habitat observed	Caves, crevices, broken rocks, deep pools, disturbance level high at most places	Thick riverside vegetation, deep pools, Huge boulder piles, broken rocks, least disturbance in area one km downstream bridge	No proper otter habitat, disturbance level very high	Limited otter area along the water fall at the confluence of Sensa stream with the Poomnch River. Highly disturbed area.	The best Otter habitat with very long and deep pool reportedly full of fish, thick side vegetation, broken rocks, gentle slope, less disturbance	Disturbed area due to sand mining and monkeys habitat	Rocks present in river. Good otter habitat.

Exhibit 3.20: Otter Hotspots in Study Area



3.5 Terrestrial Ecological Resources

3.5.1 Terrestrial Habitat Classification

Habitat classification approaches are subjective in nature, devised to assist in the understanding of ecological systems, the functions of those systems, and the interrelationship with species. Classically, wildlife habitat is described as containing three basic components: cover, food, and water (Morrison et al 2006)[48] with vegetation as the core descriptive component.

Habitats in the Ecological Study Area were classified relying primarily upon geomorphology, vegetation type and soil texture. Following this classification approach, four types of habitats were defined: Riverbank/Riparian, Agricultural Fields, Scrub Forest and Pine Forest. **Google Earth™** images were used to initially delineate spatial distribution of habitat types within the Ecological Study Area and this habitat characterization was confirmed during the field surveys.

The spatial distribution of habitat types in the Ecological Study Area is given in **Exhibit 3.21** and shown on the map in **Exhibit 3.4.** Photographs of these habitats are given in **Exhibit 3.22.**

Exhibit 3.21: Spatial Distribution of Different Habitats in the Ecological Study Area

No.	*Habitat Types*	*Area (Sq km)*	*Habitat in Percentage*
1.	Riverbank/Riparian	2	3%
2.	Agricultural Fields	24	35%
3.	Scrub Forest	19	28%
4.	Pine Forest	21	30%
5.	Settlements	3	4%
	Total	**69**	**100.0%**

Exhibit 3.22: Photographs of Different Habitats in the Ecological Study Area

a. *Agricultural Fields*

b. *Pine Forest*

48 Morrison, M.L, Marcot, B., Mannan, W. 2006. *Wildlife–Habitat Relationships: Concepts and Applications*. Island Press, Washington, D.C.

c. *Riverbank/Riparian*

d. *Scrub Forest*

3.5.2 Vegetation

The Ecological Study Area is mostly composed of hilly areas and riparian area along the Poonch River and tributaries. The vegetation of the area is characterized by the presence of subtropical broad leaved forest (Shaheen et al., 2011a)[49] and mainly consist of Chirpine forest type (Malik & Malik, 2004)[50].

A total of 32 plant species were observed in the Ecological Study Area. The vegetation at high altitude is mainly dominated by Pinus roxburghii. The vegetation at the lower altitude is scrub forest dominated by Dalbergia sissoo, Ziziphus mauritiana, Dodonaea viscosa and Carissa opaca. The vegetation of the riparian areas is mainly dominated by Dalbergia sissoo, Parthenium hysterophorus, Xanthium strumarium and Ricinus communis.

Most of the observed plant species were common and found in more than one habitat. No threatened or endemic plant species were observed in the Ecological Study Area during the surveys or from the literature available.

Photographs of some of common plant species found in the Ecological Study Area are shown in **Exhibit 3.23.**

October 2013 Survey

The four main habitats found during October 2013 survey are briefly discussed below:

Riverbank/Riparian

Riverbank/Riparian constitutes 3% of the habitat of the Ecological Study Area (**Exhibit 3.21**). The range of vegetation cover observed in this habitat during October 2013 survey is from 0.5% to 10.9% while average count is 25. The floral diversity in this habitat is 2 species per sampling point (**Exhibit 3.24**). The dominant plant species in this habitat are Dalbergia sissoo, Parthenium hysterophorus, Saccharum sp and Dodonaea viscosa.

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[49] Shaheen H, Qureshi, R.A. & Shinwari, Z.K., 2011, Forest structure, vegetation dynamics and anthropogenic impact on lesser Himalayan Subtropical forests in Bagh District, Kashmir. Pak. J. Bot., 43(4): 1861–1866.

[50] Malik, N., & Malik, Z. (2004). Present status of subtropical Chir–Pine vegetation of Kotli Hills, Azad Jammu and Kashmir. Journal of Research Science, 5(1), 85–90.

3.5.3 Agriculture Fields

Agriculture Fields are the most dominant habitat, constituting 35% of the habitat of the Ecological Study Area (**Exhibit 3.21**). The agricultural fields mostly lie in the plains. The range of vegetation cover in this habitat during October 2013 survey is from 0.5% to 16.5%, while average count is 33. The floral diversity in this habitat is 3 species per sampling point (**Exhibit 3.24**). The dominant plant species in this habitat are Broussonetia papyrifera, Parthenium hysterophorus, Dalbergia sissoo and Malvastrum coromandelianum.

3.5.4 Scrub Forest

Scrub Forest constitutes 28% of the total habitat of the Ecological Study Area (**Exhibit 3.21**). This habitat is characterized by vegetation dominated by shrubs with some trees, grasses and herbs. The range of vegetation cover in this habitat during October 2013 survey is from 0.4% to 15% while average count is 43. The floral diversity in this habitat is 3 species per sampling point (**Exhibit 3.24**). The dominant plant species of this habitat include Ziziphus mauritiana, Dalbergia sissoo, Parthenium hysterophorus and Imperata cylindrica.

Pine Forest

Scrub Forest is the second most abundant habitat, constituting 30% of the total habitat of the Ecological Study Area (**Exhibit 3.21**). This habitat is characterized by vegetation dominated by Pine trees. The range of vegetation cover in this habitat during October 2013 survey is from 1.9% to 25.9% while average count is 199. The floral diversity in this habitat is 3 species per sampling point (**Exhibit 3.24**). The dominant plant species of this habitat include Imperata cylindrica, Pinus roxburghii, Dalbergia sissoo and Dodonaea viscosa.

December 2013 Survey

During the December 2013 survey, three locations in Scrub Forest were sampled. A total of 13 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 1.5% to 4.3% while average count was 36. The floral diversity in this habitat was 4 species per sampling point (**Exhibit 3.24**). The dominant plant species of this habitat include Dalbergia sissoo, Dodonaea viscosa and Acacia Modesta.

May 2014 Survey

During the May 2014 survey, three locations in Scrub Forest were sampled. A total of 9 plant species were seen during the survey. The range of vegetation cover in this habitat during the survey was from 3.9% to 10.1% while average count was 50. The floral diversity in this habitat was 3 species per sampling point (**Exhibit 3.24**). The dominant plant species in this habitat were Dalbergia sissoo, Dodonaea viscosa and Nerium oleander.

Exhibit 3.23: Photographs of Common Plant Species of the Ecological Study Area

a. *Dodonaea viscosa*

b. *Ricinus communis*

c. *Parthenium hysterophorus*

d. *Ipomea carnea*

e. *Xanthium strumarium*

f. *Euphorbia hirta*

Exhibit 3.24: Vegetation Cover, Plant Count and Diversity by Habitat Types, Survey Conducted October 2013,December 2013 and May 2014

Habitats	*Plant Cover*			*Plant Count*			*Diversity*
	Average	*Maximum*	*Minimum*	*Average*	*Maximum*	*Minimum*	
October 2013 Survey							
Riverbank/Riparian	4.3%	10.9%	0.5%	25	30	17	2
Agricultural Fields	8.4%	16.5%	0.5%	33	49	23	3
Scrub Forest	5.5%	15.0%	0.4%	43	129	24	3
Pine Forest	13.5%	25.9%	1.9%	199	844	35	3
December 2013 Survey							
Scrub Forest	2.5%	4.3%	1.5%	36	49	28	4
May 2014 Survey							
Scrub Forest	6.3%	10.1%	3.9%	50	58	42	3

3.5.5 Mammals

A total of 26 locations were sampled in the October 2013 survey to study mammalian abundance and diversity in the Ecological Study Area while 3 locations were sampled during the December 2013 survey to study mammalian abundance and diversity at the proposed project location. The location of these sampling points is shown in **Exhibit 3.3** and **Exhibit 3.4** respectively.

Exhibit 3.25 provides a summary of sampling points by habitat type. It presents the signs and sightings data for mammals (excluding rodents), abundance and diversity by habitat type for the October 2013 and December 2013 survey.

Exhibit 3.25: Signs/Sightings Data for Mammals (excludes Rodents) Abundance and Diversity by Habitat Type, Surveys Conducted October 2013 and December 2013

Habitat	*No. of Sampling Points*	*Total Signs/ Sightings*	*Signs/ sightings per Sampling Point (Density)*	*No. of Species*
October 2013				
Pine Forest	5	14	2.8	9
Scrub Forest	8	11	1.3	5
Agricultural Fields	5	11	2.2	6
Riverbank/Riparian	8	71	8.8	11
Total	**26**	**107**		
December 2013				
Scrub Forest	3	16	5.3	3
Total	**3**	**16**		

October 2013 Survey

The highest density of signs/sightings was seen in Riverbank/Riparian habitat while no significant difference in mammalian density was evident in the other three habitats.

The mammal most commonly observed was the Rhesus Monkey Macaca mulatta. A total of 50 Rhesus monkeys were seen at Sampling Point A5 near Rajdhani. Four specimens of the Common Red Fox were observed. Also sighted was the Indian Grey Mongoose Herpestes edwardsii.

Signs of the following mammals were observed: Asiatic Jackal Canis aureus, Indian Crested Porcupine Hystrix indica, Common Red Fox Vulpes vulpes and a cat species Felis sp. None of these mammals are included in the IUCN Red List 2013.[51]

The Common Leopard Panthera pardus was not observed during the October 2013 survey. However, locals report that it is present in the vicinity of the Ecological Study Area. The abundance of this species in the area has not been assessed. The Common Leopard Panthera pardus is listed as Near Threatened in the IUCN Red List 2013.

December 2013 Survey

During December 2013 survey, 3 locations were sampled in Scrub Forest habitat. Signs and sightings of three mammal species were observed.

One specimen each of the Indian Grey Mongoose Herpestes edwardsii was seen at Sampling Points D–1 and D–3. One specimen of the Asiatic Jackal Canis aureus was sighted at Sampling Point D–3.

Signs of Asiatic Jackal Canis aureus and Fox Vulpes sp. were seen at all three sampling points, while the signs of Indian Grey Mongoose Herpestes edwardsii were only seen at Sampling Point D–1.

3.5.6 Small Mammals

Seven trapping sites were selected for trapping of small mammals (rodents) in the Ecological Study Area during the December 2013 survey and these are indicated on a map in **Exhibit 3.4**.

Exhibit 3.26 provides the results for small mammals trapped in the Ecological Study Area (using Sherman Live Traps)[52].

For the October 2013 survey, the House Mouse Mus Musculus is the most common species with a trapping success of 33% followed by Indian Field Mouse Mus Booduga (28% of trappings), House Shrew Suncus Murinus (22% of trappings) and House Rat Rattus rattus (17% of trappings).

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51 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on **21 October 2013**.

52 EIAO Guidance Note No. 10/2004. Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys, Environment Protection Department, Hong Kong.

Exhibit 3.26: Trapping Success for Rodents in the Ecological Study Area, Survey Conducted October 2013

Scientific Names	*Common Names*	*Captured/100 Trap Nights*	*Percent of Trapping*
October 2013			
Mus booduga	Indian Field Mouse	1.79	28%
Mus musculus	House Mouse	2.14	33%
Rattus rattus	House Rat	1.07	17%
Suncus murinus	House Shrew	1.43	22%
Total			**100%**

During the December 2013 survey, small mammal trapping was carried out only at Sampling Point D2 located in Scrub Forest. Two specimens of House Shrew Suncus Murinus were trapped.

3.5.7 Herpeto–fauna

A total of 26 locations were sampled in the October 2013 survey to study herpeto–fauna abundance and diversity in the Ecological Study Area. The location of these sampling points is shown in **Exhibit 3.3** and **Exhibit 3.4**. In addition, nocturnal trapping of reptiles was conducted at Sampling Point S6. No herpeto–faunal sampling was carried out in December 2013.

Exhibit 3.27 provides a summary of sampling points by type of habitat, number of sightings, and the number of species sighted.

Exhibit 3.27: Herpeto–fauna Abundance and Diversity by Habitat Type, Survey Conducted October 2013

	No.of Sampling Points	*Total Sightings*	*Density (Sightings per sampling Point)*	*No. of Species*
October 2013				
Pine Forest	5	36	7.2	8
Agricultural Fields	5	66	13.2	9
Riverbank/Riparian	8	102	12.7	10
Scrub Forest	9	84	9.3	13
Total	**27**	**288**		

A total of 288 reptile and amphibian specimens belonging to 18 species were observed in the Ecological Study Area during the October 2013 survey (**Exhibit 3.27**). The greatest density of herpeto–fauna was observed in the Agricultural Fields (13 sightings per sampling point), while the greatest diversity of herpeto–fauna was seen in Scrub Forest where 13 herpeto–faunal species were seen.

The maximum abundance of herpeto–fauna was observed at Sampling Point S13 where 38 specimens of herpeto–fauna were observed. The most abundant amphibian seen here was the Skittering Frog Euphlyctis cyanophlyctis. The second highest abundance was seen at Sampling Point A4 where 23 specimens of herpeto–fauna were observed. The Skittering Frog Euphlyctis cyanophlyctis was also the most abundant herpeto–faunal species seen at this location.

The highest herpeto–faunal diversity was recorded at Sampling Points A3 in River–bank/Riparian habitat and Sampling Point S9 in Scrub Forest as well as during the nocturnal survey at Sampling Point S6. A total of five herpeto–faunal species were observed at each of these locations.

Five herpeto–faunal species were observed during the nocturnal survey at Sampling Point S6. These included Rohtas Fort Gecko Cyrtopodion rohtasfortai, Asian Grass Frog Fejervarya limnocharis, Agror Valley Agama Laudakia agrorensis, Swat Green Toad Pseudepidalea p. pseudoraddei and Indian Burrowing Frog Sphaerotheca breviceps.

Photographs of some of common reptile species found in the Ecological Study Area are shown in **Exhibit 3.28**.

Exhibit 3.28: Photographs of Common Reptilian Species of the Ecological Study Area

a. *Striped Grass Mabuya Eutropis dissimilis*

b. *Punjab Snake Eyed Lacerta Ophisops jerdonii*

c. Rohtas Fort Gecko *Cyrtopodion rohtasfortai*

d. Bengal Monitor *Varanus bengalensis*

3.5.8 Birds

A total of 26 locations were sampled in the October 2013 survey to study bird abundance and diversity in the Ecological Study Area while 3 locations were sampled during the December 2013 survey to study bird abundance and diversity at the proposed Project location. The location of these sampling points is shown in **Exhibit 3.3** and **Exhibit 3.4** respectively.

Exhibit 3.29 provides a summary of Sampling Points by habitat type. It presents the bird abundance and diversity by habitat type for the October 2013 survey and December 2013 survey.

Exhibit 3.29: Bird Abundance and Diversity by Habitat Type, Surveys Conducted October 2013 and December 2013

Habitat	*No. Sampling Points*	*Total Sightings*	*Density*	*No. of Species*
October 2013				
Agricultural Fields	5	252	50.40	22
Pine Forest	5	203	40.60	19
Riverbank/Riparian	8	197	24.63	24
Scrub Forest	8	323	40.38	31
Total	**26**	**975**		
December 2013				
Scrub Forest	3	165	55	23
Total	**3**	**165**	**55**	

October 2013 Survey

A total of 975 birds belonging to 45 species were observed in the Ecological Study Area. Maximum abundance of the birds was seen in the Agricultural Fields.

The maximum abundance of birds was observed at Sampling Point S10 located in Agricultural Fields. Abundant bird species observed at this location included the Common Myna Acridotheres tristis and Himalayan Bulbul Pycnonotus leucogenys. The maximum diversity of bird species was observed at Sampling Point S16 in Scrub Forest where 16 bird species were observed.

Abundant bird species of the Ecological Study Area included Jungle Babbler Turdoides striata followed by House Sparrow Passer domesticus, Common Myna Acridotheres tristis, Jungle Crow Corvus macrorhynchos and Himalayan Bulbul Pycnonotus leucogenys.

Two of the bird species recorded from the Ecological Study Area are included in the IUCN Red List 2013. These are the White–backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus. They are listed as Critically Endangered and Endangered respectively due to a rapid population decline in India and Pakistan resulting from poisoning by the veterinary drug Diclofenac combined with several long–term declines in Europe and West Africa (BirdLife International 2011)[53].

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[53] BirdLife International and Durham University (2011) Species factsheet: *Neophron percnopterus*. Downloaded from http://www.birdlife.org on 18th October 2011.

A total of 17 specimens of the White–backed Vulture Gyps bengalensis were seen in the Ecological Study Area at Sampling Points A2, S17 and S18 while 65 specimens of the Egyptian Vulture Neophron percnopterus were seen mostly at Sampling Points S17 and S18. The vultures were concentrated near Kotli city's waste dumping site and the waste outlet of Kotli slaughter house, both of which are located near Sampling Point S18 (**Exhibit 3.30**). According to information provided by the locals, the breeding area for most of the vulture population is inside the Pir Lasura National Park located about 12 km from the Ecological Study Area. However, many of them feed and rest on the hills in the vicinity of the Ecological Study Area particularly near Sampling Point S18, at the confluence of Poonch River and Bann Nullah. The main resting and feeding area for vultures near the Ecological Study Area is shown in **Exhibit 3.30**.

A total of two (02) vulture nests were found in the Ecological Study Area at Sampling Point S1 and S18. The spatial distribution of these nests is shown in **Exhibit 3.30**. Photographs of vultures and their nests seen in the Ecological Study Area are shown in **Exhibit 3.31.**

December 2013 survey

During December 2013 survey 3 locations were sampled in Scrub Forest habitat. A total of 23 birds species were seen during the survey. Maximum bird abundance was seen at Sampling Point D2, while the minimum bird abundance was seen at Sampling Point D3 (**Exhibit 3.4**).

Abundant bird species of observed during the December 2013 survey included Jungle Babbler Turdoides striata followed by Common Myna Acridotheres tristis, Himalayan Bulbul Pycnonotus leucogenys Great Tit Parus major and Red–vented Bulbul Pycnonotus cafer.

Exhibit 3.30: Spatial Distribution of Vultures in the Ecological Study Area, Surveys Conducted October 2013

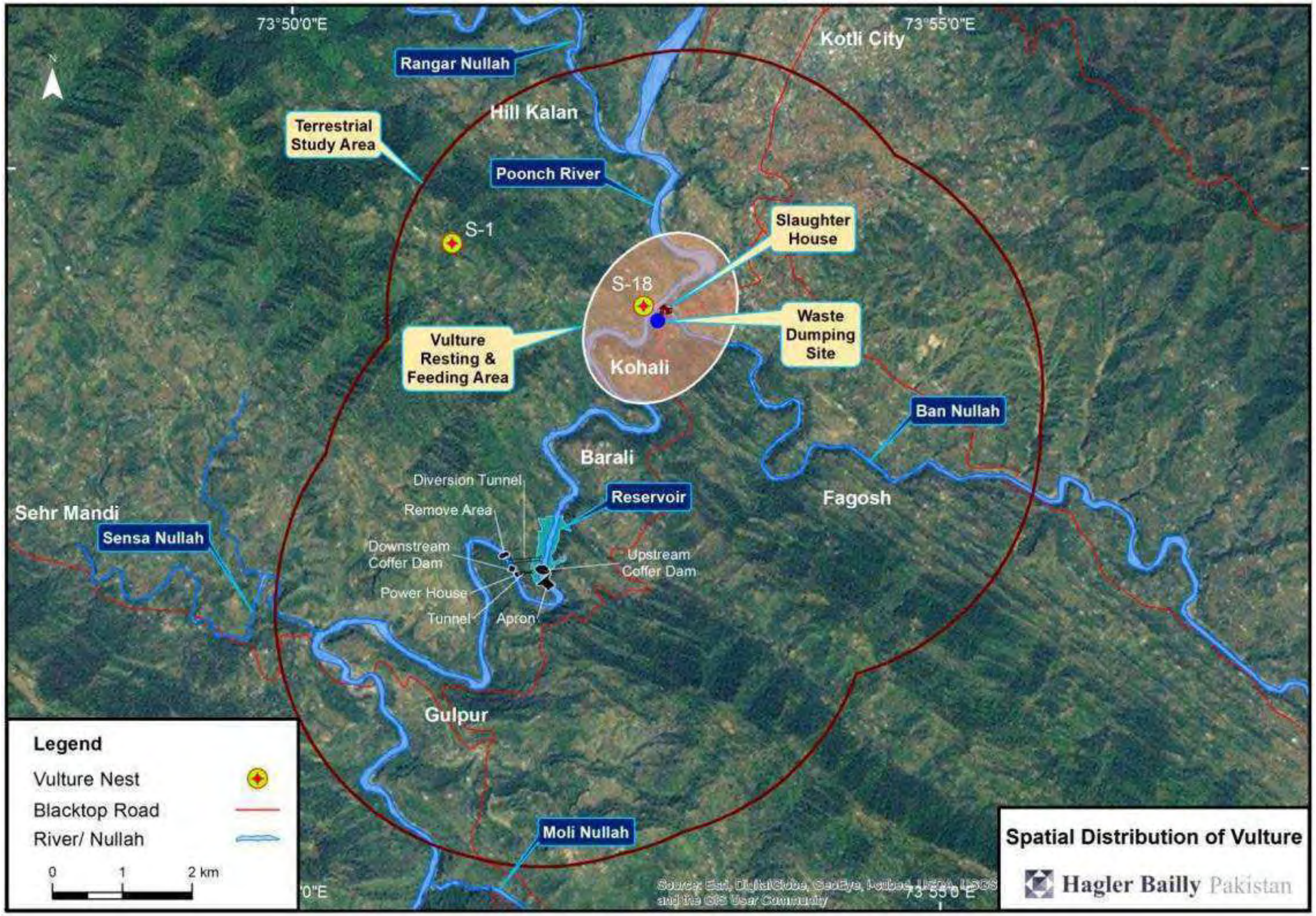

Exhibit 3.31: Photographs of Vultures and Vulture Nests in the Ecological Study Area Survey conducted October 2013

Vulture Nest on a Pine Tree at Sampling point S1

Egyptian Vulture Neophron percnopterus at Sampling Point S18

Egyptian Vulture Neophron percnopterus at the Garbage dumping site near S18

White–backed Vulture Gyps bengalensis near Sampling point S17

3.6 Poonch River Mahaseer National Park

The Poonch River and tributaries was declared a national park in a letter from the AJK Secretariat Forest/AKLASC/Fisheries (ref no: SF/AV 11358-7/2010 dated 15 December 2010). Poonch River is unique in having warm water in its lower and middle reaches and cold water in its upper reaches. It ends at Mangla Reservoir which is one of the major fish producing water body in the country. Many channels join it in its way giving the fishes a lateral access for breeding and feeding.

The Poonch River was declared as a national park due to its high fish diversity and importance of supporting fish of both conservation and economic importance particularly the Endangered fish species (IUCN Red List 2013) Mahaseer Tor putitora that is important both from the conservation and commercial viewpoint. The Tor putitora has undergone a dramatic decline in population in the last few years and the largest stable population of this fish in the country is found in the Poonch River that also provides a breeding ground for it. In addition, the Poonch River provides a breeding ground for the commercially important fish species of the Mangla Reservoir.

3.7 Basis for Determination of Conservation Status of Species and Performance Standard for Preparation of the Baseline

The conservation status of the species identified were determined using criteria set by the IUCN Red List of Threatened Species (IUCN Red List, 2013) [54] , Pakistan's Mammals National Red List 2006[55], the Convention on International Trade in Endangered Species (CITES) appendices (as of November 2013) (CITES, 2013)[56]. The baseline was developed to address the requirements of the Equator Principles[57] and International Finance Corporation (IFC) Performance Standards[58].

3.8 Endangered and Threatened Species

Vegetation

No threatened plant was determined to be present in the Ecological Study Area.

Large Mammals

Two large mammals reported from the Ecological Study Area are included in IUCN Red List 2013. These are the Common Leopard Panthera pardus and Common Otter Lutra lutra, both of which are listed as Near Threatened in the IUCN Red List 2013. There are some species that are included in the CITES Species List and in the Pakistan Mammals National Red List 2006. However, none of the mammal species observed or reported from the Ecological Study Area are endemic, their distribution is not limited to any specific site or habitat type, and their distribution is widespread.

Small Mammals

None of the small mammals observed or reported from the Ecological Study Area are included in the IUCN Red List 2013. No threatened small mammals or endemics were determined to be resident on the Ecological Study Area. There are some species of limited conservation concern, but their distribution is widespread.

Herpetofauna

One of the reptile species recorded from Ecological Study Area is included in the IUCN Red List 2013. This is the Indian Rock Python Python molurus that is listed as Near Threatened. Of the herpeto–fauna species observed in the Ecological Study Area, four are endemic to Pakistan. These include Rohtas Fort Gecko Cyrtopodion rohtasfortai, and Kashmir Torrent Frog Allopaa barmoachensis. The two species included in CITES Appendix II are Central Asian Cobra Naja oxiana and Indian Rat Snake Ptyas mucosus, while Varanus bengalensis Bengal Monitor is included in CITES Appendix I.

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54 IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 26 October 2013.

55 Status and Red List of Pakistan Mammals. 2006. Biodiversity Programme IUCN Pakistan

56 UNEP–WCMC. 14 November 2013. UNEP–WCMC Species Database: CITES–Listed Species

57 The Equator Principle. June 2006. Adopted by The Equator Principles Financial Institutions, www.equator–principles.com, Accessed 11 October, 2011.

58 Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

Birds

Two bird species found in the Ecological Study Area are included in the IUCN Red List 2013. These include the Oriental White–backed Vulture Gyps bengalensis and Egyptian Vulture Neophron percnopterus listed as Critically Endangered and Endangered respectively. Both these species are placed in Appendix II of the CITES Species List. Two bird species, Black Kite Milvus migrans and White eyed Buzzard Butastur teesa are included in CITES Appendix II. The vultures observed in the Ecological Study Area were concentrated near Kotli city's waste dumping site and the waste outlet of Kotli slaughter house, both of which are located near Sampling Point S18 (**Exhibit 3.30**). However, these vulture feeding and resting areas are located at least 2 km from the area where the Project facilities will be constructed. According to preliminary investigations, most of the vultures breed in the Pir Lasura National Park located about 12 km from the Ecological Study Area. Therefore, it was determined that the Ecological Study Area is not critical to the survival of these vulture species.

Fish

Six fish species observed in the Ecological Study Area are listed in IUCN Red List. Kashmir Catfish Glyptothorax kashmirensis is listed as Critically Endangered in IUCN Red List. Mahaseer Tor putitora is listed as Endangered while Pabdah Catfish Ompok pabda and Butter Catfish Ompok bimaculatus are listed as Near Threatened. Moreover, Common Carp Cyprinus carpio, Snow Carp Schizothorax plagiostomus and Twin–banded Loach Botia rostrata are listed as Vulnerable.

The endemic fish species in the Ecological Study Area include Pakistani Baril Barilius pakistanicus, Punjab Loach Schistura punjabensis, Kashmir Catfish Glyptothorax kashmirensis and Nazir's Catfish Glyptothorax naziri.

It was determined that the aquatic habitat in the Ecological Study Area is important for survival of Kashmir Catfish Glyptothorax kashmirensis listed as Critically Endangered and Mahaseer Tor putitora listed as Endangered in IUCN Red List.

3.9 Conclusions

- The most important biological resources of the Poonch River National Park that constitutes a Critical Habitat are the aquatic floral and faunal species of the river i.e. the bank-side vegetation which stabilizes the riverbanks and is part of Otter habitat, the Threatened Otter, macro-invertebrates which are an important food source for fish, and fish, which include the Endangered Mahaseer and Critically Endangered Kashmir Catfish. Therefore the focus of the BAP is on conserving these resources to achieve a net gain as required under IFC Performance Standards and betterment of the national park under AJK wildlife legislation.
- Even though terrestrial habitats are not included in the national park, the improved and enhanced watch and ward will also help to prevent illegal hunting of large mammals and removal of terrestrial vegetation.
- Vulture feeding and resting areas are located at least 2 km from the Project dam site and not likely to be impacted by Project construction and operations. However, monitoring of the vultures at these sites has been included in the BAP.

4. Stakeholder Consultations

Successful implementation of the proposed Biodiversity Action Plan (BAP) requires a management strategy centered on effective understanding of the stakeholders and their concerns. This section provides an overview of the biodiversity related concerns and suggestions of the institutional and community stakeholders as well as the relevant NGOs working in the area that have been instrumental in defining the scope and contents of the BAP.

The draft plan was shared with the relevant stakeholders particularly the AJK Fisheries and Wildlife Department (AJKFWD), the NGOs working in the area and relevant communities for their comments and suggestions, and was finalized after addressing the concerns and comments of the stakeholders. It has now been accepted and agreed upon by all the stakeholders.

Through consultations, Mira Power Ltd. has ensured development of a strategy for biodiversity protection that:

- Identifies potential for collaborative measures on biodiversity management with the government organizations and relevant NGOs working in the area
- Incorporates suggestions and comments of the local communities and hence benefited from their ‘collective wisdom’, and
- Has built consensus on the expectations of the institutional and community stakeholders.

4.1 Objective of Consultations

Stakeholder consultation is a means of involving those affected due to an activity in the decision-making process, in order to ensure that their concerns are addressed at the design stage. These consultations, if conducted in a participatory and objective manner, are a means of enhancing sustainability and ensuring environmental compliance.

The objective of the consultations were as follows:

- Provide information to the stakeholders regarding the Gulpur Hydropower Project (Project) and the anticipated impacts of the Project on the biological resources of the Poonch River basin
- Document the concerns of the stakeholders regarding the impact of Project construction and operation on the biological resources of the Poonch River
- Gather data and information regarding the dependence of the local communities on these biological resources
- Ensure involvement of the stakeholders in Project planning, EIA processes and development of the Biodiversity Action Plan

- Seek input from the stakeholders and biodiversity experts on the contents of the Biodiversity Action Plan, its implementation mechanism, implementing partners and monitoring framework.

4.2 Consultation mechanism

Stakeholders are groups or individuals that can affect or take affect from a project's outcome. SPS 2009[59] and IFC Performance Standards[60] specifically identifies affected people, concerned nongovernment organizations (NGOs) and government as prospective stakeholders to a project. Public consultation is also mandated under Pakistan's environmental law (Pakistan Environmental Protection Act 1997) as part of the ESIA requirements. The consultations for this project have been undertaken in compliance with relevant national legislation set by Pakistan Environmental Protection Agency, IFC Performance Standards on social and environmental sustainability, and the environmental and social safeguards laid out under ADB's safeguard policy (SPS 2009). The details of these standards are provided in **Section 9.2** of the ESIA of Gulpur Hydropower Project,

This section provides a summary of the concerns relevant to biodiversity and ecology raised during

- community consultations carried out for the ESIA of the Project
- institutional consultations carried out for the ESIA of the Project
- ESIA public hearing
- consultations carried out specifically for developing the implementation strategy and monitoring framework of BAP

Exhibit 4.1 lists the Project stakeholders consulted. Consultation were conducted in representative number of communities while ensuring that people from various segments of the society participate in the consultation, to ensure proper coverage of possible stakeholder concerns. **Exhibit 4.2** shows location of stakeholders consulted near Project site. Consultations with institutional stakeholders were also conducted in Muzaffarabad and Islamabad but these are not shown on the map.

The consultations were carried out to meet the regulatory requirements of the ESIA and therefore included consultations regarding the bio-physical environment, ecological environment and socio-economic conditions. Complete details are provided in the ESIA of the Project [61]. This document, however, outlines only on the concerns related to ecology and biodiversity raised by the institutional and community stakeholders i.e. those concerns that are relevant to formulation of the Biodiversity Action Plan.

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59 Safeguard Policy Statement, Asian Development Bank, June 2009

60 IFC Performance Standards, International Finance Corporation, January 2012

61 Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd.

Exhibit 4.1: Stakeholders Consulted

Group	Stakeholders	Consulted / Invited	Date Consulted (DD/MM/YY)	No. of Participants (Men)	No. of Participants (Women)
Community: Villages	Aghar	C	08/02/14	16	8
	Phagwari	C	15/02/14	15	13
	Gulpur	C	12/02/14	30	32
	Kohali	C	09/02/14	12	25
	Rajdhani	C	12/02/14	15	16
	Rehmani Muhallah	C	10/02/14	17	10
	Hill Killan	C	11/02/14	15	26
	Kameli	C	11/02/14	10	7
	Barali	C	15/02/14	9	14
	Naroch Colony	C	10/02/14	17	20
	Bialian	C	09/02/14	11	10
Government and related	Deputy Commissioner, Kotli	C	12/02/14		
	Superintendent Police, Kotli	C	12/02/14		
	Private Power Infrastructure Board (PPIB)	C	19/02/14		
	Environmental Protection Agency (EPA) AJK	C	20/03/14		
	Forest Department AJK	C	20/03/14		
	Hydroelectric Board (HEB)	C	20/03/114		
Academics and NGOs	Kotli Traders Association	C	11/02/14		
	World Wildlife Fund (WWF)	C	19/02/14		
	International Union for Conservation of Nature (IUCN)	I			
	Himalayan Wildlife Foundation (HWF)	C	19/02/14		
	Snow Leopard Foundation (SPF)	C	19/02/14		
	ZB Mirza (ZBM) (Ecologist)	C	19/02/14		

C – Consulted; I – Invited but did not participate

Exhibit 4.2: Consultation Locations

4.2.1 Community Consultation

The Potentially Affected Communities (local communities living in Project site and vicinity) were visited and consultations were conducted with the community members within their settlements to encourage and facilitate their participation. Representatives, notables and other interested groups from the Potentially Affected Communities were invited. A total of 11 settlements were consulted. Separate consultations were conducted with community women of all 11 settlements. An ESIA specialist led the team, which comprised of stakeholder consultation experts and male/female social assistants that were familiar with the area and the local languages.

The main document for distribution to the community stakeholders during the consultations was the Background Information Document (BID) that informed the stakeholders about the ESIA process and provided a background about the Project (**Appendix B**). The feedback from the communities was recorded and the detailed log of consultations was maintained.

Exhibit 4.3 summarizes the key concerns emerging from community consultations regarding wildlife and ecology. The detailed log of consultations is provided in the ESIA of the Gulpur Hydropower Project[62]. The photographs of the consultations are given in **Exhibit 4.4**.

4.2.2 Institutional Stakeholder Consultation

For institutional consultation, HBP organized one meeting in Muzaffarabad for the government departments and agencies and one in Islamabad for the remaining institutions. Letters to inform experts/institutional stakeholders about the objective of the consultation process and to arrange meetings with the stakeholders were dispatched in advance. BID and detailed Institutional Stakeholder Consultation documents[63] were enclosed with the letters for the information of the stakeholders. A power point presentation on Impact Assessment of the Project on the aquatic ecological resources of a designated section of the Poonch River was presented during these consultations followed by a question-answer session. Individual meetings with stakeholders based in Kotli were also undertaken.

The consultations were carried out to meet the regulatory requirements of the ESIA and document their concerns regarding the environmental impacts of the Project particularly on the biological resources of the Poonch River basin.

Exhibit 4.5 summarizes the key concerns emerging from institutional stakeholder consultations and explains how each concern was addressed in the ESIA. The detailed log of consultations is provided in ESIA of the Gulpur Hydropower Project. The photographs of the consultations are given in **Exhibit 4.6**.

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62 Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd.

63 Hagler Bailly Pakistan (HBP), February 2014, Impacts on Biodiversity, Information Document for Institutional Stakeholder Consultations, Gulpur Hydropower Project,

4.2.3 ESIA Public Hearing

Consultations to be undertaken as part of the Project ESIA process include the public hearing conducted by the AJK Environmental Protection Agency (EPA). The AJK EPA requires that one or more public hearings are held to assess public opinion on the environmental impacts of the Project. The legal requirement is advertisement in at least one English or Urdu national newspaper, but in practice, advertisements are usually placed in two national newspapers and also in local newspapers.

For the Gulpur Hydropower Project, the AJK EPA advertised the public hearings in a newspaper on April 11th 2014 and the public hearing was conducted in Kotli on May 12th 2014. The public hearing was chaired by Director AJK EPA Dr Aurangzeb Khan. Copies of the ESIA report and a non-technical summary were made accessible to the public during the notification period. The issues and concerns regarding the protection of biological resources raised during the public hearing are listed in **Exhibit 4.7**.

4.2.4 Consultations for BAP Development

The development and effective implementation of the BAP requires co-ordination, support and joint collaboration among all the stakeholders and implementing partners (**Section 6**).

The basic responsibility for managing and conserving the wildlife and fisheries of AJK lies with AJK Wildlife and Fisheries Department (AJKFWD or Department). This includes protecting and managing the river and river-dependent flora and fauna. The Wildlife and Fisheries Department works in conjunction with the Forest Department to manage the protected areas such as national parks, the terrestrial forests and river-dependent forests (**Section 1.7**). In addition to these government departments, the most prominent NGO in the Poonch River basin is the Himalayan Wildlife Foundation that has worked for protection of the ecological resources of the Poonch River since the last 4 years and was instrumental in the declaration of the Poonch River as a national park.

Representatives of the key stakeholders for the BAP of the Poonch River basin were invited for consultations in the second week of May. Their advice was noted and incorporated into formulating the BAP. A meeting was held in Islamabad in the last week of May with the Honorary Game Warden in AJK Wildlife and Fisheries Department in which details of BAP implementation strategy and watch and ward were worked out. Consultations were also carried out with the Director AJK Wildlife and Fisheries Department, Director Himalayan Wildlife Foundation and members of the local communities. In addition, input was sought from Mira Power Ltd (the owners of the Gulpur Hydropower Project), independent ecologists, zoologists and fish experts. A summary of these consultations is given in **Exhibit 4.8**.

The Draft BAP was shared with Mira Power Ltd on 10 June. Subsequently, a meeting was held on 24 July between representatives of Mira Power Ltd; Director, AJK Fisheries and Wildlife Department; and Director, Himalayan Wildlife Department to finalize the BAP. A summary of these consultations is given in **Exhibit 4.9**.

4.3 Summary of Consultations

A summary of the consultations and some photographs are given in **Exhibit 4.3** to **Exhibit 4.9** below.

Exhibit 4.3: Summary of Community Consultations and Comments

Issues raised by Community Stakeholders	*Response*
Reduced flow downstream of the dam may result in lesser habitat available for the fish	MPL has specified a minimum Environmental flow in the low flow section (**ESIA Section 6**)
Reduced flow downstream may increase the concentration of contaminants in river water	The concentration of the toxic metals in the effluent from the Project were all found to be within the NEQS limits for liquid effluents as well as those for the drinking water. (**ESIA Section 5.2**). Mitigation and good practice measures have been identified and will be applied (**ESIA Section 7**)

Exhibit 4.4: Photographs of Community Consultations

Consultation with Men at Aghar

Consultation with Women at Aghar

Consultation with Men at Barali

Consultation with Women at Barali


Consultation with Men at Bialian


Consultation with Women at Bialian


Consultation with Men at Gulpur


Consultation with Women at Gulpur


Consultation with Men at Hill Killan


Consultation with Women at Hill Killan


Consultation with Men at Kameli


Consultation with Women at Kameli

Consultation with Men at Kohali

Consultation with Women at Kohali

Consultation with Men at Naroch Colony

Consultation with Women at Naroch Colony

Consultation with Men at Pagwari

Consultation with Women at Pagwari

Consultation with Men at Rajdhani

Consultation with Women at Rajdhani


Consultation with Men at Rehmani Mohallah


Consultation with Women at Rehmani Mohallah

Exhibit 4.5: Summary of Institutional Stakeholder Consultations and Comments

Issues raised	*Stakeholder*	*Comments*
PPIB awarded the contract for the development of Gulpur Hydropower Ltd in 2005 and the Poonch River was declared a national park in 2010 without consulting the PPIB or their counterpart in AJK (Azad Jammu and Kashmir). In view of the ongoing electricity shortages and load shedding, power generation is very important for the economy.	PPIB	The Poonch River provides habitat for two fish species, Mahaseer (*Tor putitora*) and Kashmir Catfish (*Glyptothorax kashmirensis*) listed as Endangered and Critically Endangered respectively in the IUCN Red List 2013. Therefore, the Poonch River is a Critical Habitat according to IFC Guidelines whether or not it is declared a national park. Communication gaps between PPIB and AJK Government is not a Project concern. If EIAs were done on time then PPIB and developers would have known the environmental concerns.
How far back will the reservoir extend upstream of the Project location?	HWF	The Project is a run of river (RoR) type hydropower project so no reservoir like the Mangla reservoir will be created. The water level in the River will rise but will not go beyond the flood line. No houses will be submerged and no agricultural land will be lost
The Poonch River is an ecologically sensitive river, and provides habitat for fish of conservation and socio-economic importance. So PPIB should not authorize any more projects on this river.	HWF	The Cumulative Impact Assessment of the planned hydropower projects on the Poonch river is being investigated. Only when this is done, we can determine if there is room for any more projects. Keeping in view the ecological sensitivity of the Poonch River, it seems unlikely that more hydropower projects can be built and can achieve the net gain for conservation as proposed in the IFC guidelines. If any more Projects are to be sanctioned on the Poonch River at all, it is recommended that they be considered first downstream of the Gulpur Hydropower Project. This will avoid blocking the important fish breeding areas located in the Ban Nallah and Rangar Nallah
The information document provides information only about baseline biodiversity assessment surveys done in October. How will seasonality be captured?	WWF-P	In addition to literature reviews, field surveys have been conducted in June (for the ESIA), October and December (fish survey). Spring surveys are scheduled for May 2014. So seasonal variations in biodiversity will be captured. Full details are available in the Baseline Biodiversity Assessment Report that can be shared with the stakeholders upon request.

Issues raised	*Stakeholder*	*Comments*
Local communities in the Poonch River basin will be affected by decline in fish resources. They are also dependent on sand and gravel extraction from the river bed for construction. How will this be dealt with?	HWF	A draft Biodiversity Management Plan has been developed and work is in progress for the Biodiversity Action Plan. Measures to conserve the fish resources include reactivation and rehabilitation of the Mangla hatchery and stocking the fish like Mahaseer upstream of the Project location. If the protection measures outlined in the Pro 2 scenario are implemented and the Biodiversity Action Plan is implemented, a net gain for conservation can be achieved. However, the 0.7 km stretch of the River that will experience low flows due to Project operations is likely to suffer negative ecological impacts. But this is only 0.7% of the total length of the Poonch River in Pakistan. As for sand and gravel extraction, a sand and gravel mining plan will be developed and locals will be allowed to extract the sand and gravel trapped upstream of the dam (of the Project).
Have fish ladders been incorporated in to the Project design	Independent Ecologist	According to the feedback provided by local and international fish experts, fish ladders are seldom successful, and are not going to be useful for protecting the fish species of the Poonch River especially considering the gradient of the landscape.
We are depending on the AJK Fisheries and Wildlife department to implement the environmental conservation and protection measures while we know that they are inefficient. The Poonch River is already a national park yet conservation measures are presently inadequate.	HWF	Subject to agreement with government of AJK on the Biodiversity Action Plan (BAP) for the project, The AJK Fisheries and Wildlife Department will have to sign an agreement for effective implementation of the conservation and protection measures outlined in the BAP. In addition, there will be external third party monitoring to ensure that goals are being met. Training and capacity building measures for the AJK Wildlife and Fisheries Department will be included in the BAP.
What about the impacts of Project construction and operation on the terrestrial biodiversity of conservation importance such as the Common Leopard, vultures as well as the aquatic mammals particularly the Otter?	WWF-P	Terrestrial Impact Assessment of the Project has been completed, and no significant impact of the Project on the terrestrial ecological resources is expected, considering the small size of terrestrial habitats that will be inundated due to Project construction. The area of habitat loss is approximately 0.33 km^2 and an area of approximately 3 km^2 will become submerged in water due to formation of a reservoir upstream of the dam. No leopard was observed during the ecological fied surveys Signs of otters were absent from the Project location and vicinity. Otters are present upstream and downstream of the dam but they are not likely to be impacted. Otters depend on impact on fish population as fish is the main source of food for the otter. If fish abundance increases assuming Pro2 Scenario, then the otters will benefit. The Project design will include adequate facilities for solid waste disposal and waste water treatment to minimize impacts on the terrestrial and aquatic resources.

Issues raised	*Stakeholder*	*Comments*
As long as the BAP assures improvement in ecosystem integrity as defined in the Enhanced Protection or Pro2 scenario, 4 cumecs eflow is acceptable.	HWF	Noted.
There could be some potential positive ecological impacts in the river stretch that will experience low flows due to Project operations. These may include an increase in the number of waders and birds that prefer to sit on slow moving water with a consequent increase in their predator bird species. The droppings of these birds will increase the organic contect in the dewatered river stretch.	Independent Ecologist	Noted. Comments will be incorporated in to the Final Impact Assessment Report.
Data on the forest area that will be damaged by the project has not been provided. Plantation will be required to compensate for the vegetation lost.	Forest Department	The section on terrestrial ecology in the ESIA will provide this detail. There is only scrub cover in the area that will be used by the Project, and only a limited area in the ownership of Forest Department will be required for the project. A budget for plantation and re-vegetation will be allocated in the Environmnetal Management and Monitoring Plan. .
General opinion of all the participants was that commitments made in ESIA for environmental improvements and CSR are not kept by the project owners. The participants provided examples of other hydropower projects in AJK where this had occurred. Concern was expressed that the BAP and CSR commitments will not be implemented		
EPA will not comment on the EFlow at this point. The EPA will review the EIA to be submitted by the Project Owner and will give its opinion after examining the analysis and justification provided for the suggested flow in the EIA	EPA-AJK	Peaking flow which causes substantial damage to downstream section of the river will be avoided. After switching to Option 3 in design the low flow section of the river downstream of the dam and upstream of the power house where major impacts will occur is only 700 meters. A net gain will be achieved through implementation of the BAP in the remaining stretches of the river.

Exhibit 4.6: Photographs of the Institutional Stakeholder Consultations

Consultation with Deputy Commissioner, Kotli

Consultation with Traders Association, Kotli

Consultation with Superintendent Police, Kotli

Consultation with HWF, WWF, SLF, PPIB and Scientists

Consultation with HWF, WWF, SLF, PPIB and Scientists

Consultation with EPA-AJK, HEB-AJK and Forest Department-AJK

Exhibit 4.7: Concerns Related to Biodiversity Raised in ESIA Public Hearing

Issues/Comments	*Raised by*	*Response*
A project for eco-tourism should be launched and the project should work for the revival of Mahaseer Park.	Dr Mahmood ul Hassan, Secretary Kashmir Liberation Cell	Noted. Will be included in BAP
The presentation and reports are very impressive and comprehensive but will there be an improved protection of Mahaseer fish and not just a paper exercise.	Mr Muhammad Riaz, Resident of Kurti	The improved watch and ward as well as the Mahseer hatchery will be ensure that this is not just a paper execrice. Details will be presented in the Biodiversity Action Plan
The proposed biodiversity action plan is the key tool which has been identified for the future of the park. In this regard we seek a firm commitment from the proponent, the government departments particularly wildlife department and private players involved in the protection of river, to implement this plan throughout the life of the project and after. The suggestion in the ESIA of oversight and monitoring of the Biodiversity Action Plan by the Wildlife Management Board of AJK was not realistic as the Board is a high level body with state wide responsibilities and seldom ever meets. The Board will therefore not be able to give attention to implementation issues. A Management Committee with representation from key stakeholders should be constituted to perform this function.	Dr Anis ur Rehman, Director Himalayan Wildlife Foundation	Noted. Will be included in BAP
The Mahaseer hatchery/nursery should be located on the Poonch River instead of Mirpur/Mangla. The community does not like the idea of their river being serviced out of a hatchery located at a distance.	Ghulam Murtaza, Honorary Game Warden	Noted. Will be included in BAP.

Exhibit 4.8: Input from Stakeholders for BAP Development

Issues/Comments	*Raised by*	*Response (Section of BAP)*
The principles outlined in the ESIA seem logical and acceptable. However, the responsibility for oversight and monitoring of the Biodiversity Action Plan by the Wildlife Management Board of AJK is not a good idea. An independent third party should be appointed by Mira Power for monitoring.	Javaid Ayub, Director AJK Fisheries and Wildlife Department	Independent Third Party monitoring included - Section 8
Implementation of the BAP should be the joint responsibilities of AJK Wildlife and Fisheries Department and an implementing partner with independent monitoring by a third party. Education and awareness raising among the local communities regarding the importance of a national park, protection of biological resources is imperative to conservation Capacity Building of the staff of the AJK Wildlife and Fisheries Department for effective implementation of the BAP must be included in the BAP contents. Once the results of the enhanced protection scenario become evident and the biological resources show recovery, the Poonch River basin can be developed for recreational activities such as angling, jet-skiing, para-sailing etc. While the BAP will focus on protecting the aquatic ecological resources, the enhanced protection as outlined in the BAP will also benefit the terrestrial ecological resources.	Dr Anis ur Rehman Director Himalayan Wildlife Foundation	Section 6 Section 7 Section 6 Section 6 Section 6
Mangla hatchery should be left undisturbed as it is a large establishment and most of it is a fish farm design for production rather than breeding. The breeding part of the hatchery was designed to stock Mangla Reservoir and not Poonch River. Mangla hatchery is in poor condition and considerable rehabilitation is required. Additionally, the water available at Mangla may not be that suitable for operating the hatchery. We should look at the option of constructing a small hatchery for Mahaseer, and maybe one more important fish, in the downstream section of the Poonch River. The hatchery could also serve as an office/guard room for the park staff working on the downstream section of the river.	Dr Rafique. Fish fauna expert.	Section 6
For effective and efficient watch and ward responsibilities, the entire Poonch River and tributaries should be divided in to sections based on their importance and pressure of illegal fishing Two field offices should be constructed and additional watchers should be hired Field equipment, vehicles, motorbikes and communication facilities are needed for effective watch and ward	Ghulam Murtaza, Honorary Game Warden	Section 6

Exhibit 4.9: Input from Stakeholders for BAP Finalization

Issues/Comments	*Raised by*	*Response (Section of BAP)*
The AJKFWD is constructing a Mahaseer hatchery on the Poonch River near Moli Nullah and plans for this have been approved by the Government. Instead of constructing a new hatchery, it would be more economically feasible that Mira Power Ltd. makes a contribution towards equipment and supplies for this hatchery. Cost of land and hatchery operation costs will be borne by the AJKFWD. As its contribution towards watch and ward, AJKFWD is willing to provide land for construction of the two field offices. In addition, we will hire six watchers who will be stationed for watch and ward duty at the Poonch River. We will also arrange the uniforms and field gear for all the watchers.	Javaid Ayub, Director AJK Fisheries and Wildlife Department	Section 6
Plantation should be carried out using only native plant species With a total of 18 watchers, an excellent watch and ward system can be established.	Dr Anis ur Rehman Director Himalayan Wildlife Foundation	Section 6

5. Threats to Biological Resources and Proposed Conservation Measures

Section 3 outlines the biological resources of the Study Area located in the Poonch River. The anticipated impacts of the proposed Project on these resources as well as the recommended mitigation and management measures are described in detail in the ESIA of the Gulpur Hydropower Project[64]. This section identifies and summarizes some of the threats to these biological resources and outlines the necessary measures for protection and conservation of these resources. The information in this section is a summary of the detailed discussion in Section 6,'Environmental Flow Assessment', and Section 7, 'Assessment of Impacts on Environment' of the ESIA of Gulpur Hydropower Project.

5.1 Fish fauna

There has been considerable decline in the abundance and diversity of the fish fauna in the last fifty years largely due to anthropogenic forces[65]. These threats are discussed below.

5.1.1 Threats

Illegal Fishing

The entire stretch of the Poonch River along with its tributaries has been declared as River Poonch Mahaseer National Park in a notification issued by the President of AJK in December 2010. According to the AJK Wildlife (Protection, Preservation and Management) Ordinance 2013, hunting, shooting, trapping, killing or capturing of any wild animal is prohibited. Similarly fishing is not allowed, and polluting or poisoning the flowing waters is forbidden in a National Park. However, despite these regulations, illegal fishing is rampant in several sections of the River (**Section 2.3**).

The preferred fishing areas comprise mainly of segments where there are pools and the relatively deeper provides refuge to the larger fish that are the preferred catch. Fishing is also limited by accessibility of locations. The locations where fishing takes place are shown in **Exhibit 2.4**. The impact of fishing pressure on the river ecosystem is dependent on the methods used, number of fishermen, and the location and timing of the fishing activities. In general, fishing in the tributaries, in particular during breeding migrations, is more harmful to fish populations than fishing at other locations and other times of the year. Fishing methods can be categorized into two broad headings.

- Selective fishing pressure: fishing using selective gear such as cast nets and fishing rods. This type of fishing tends to target specific species and the adult

[64] Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd.

[65] Ecological Baseline Study of Poonch River AJ&K with Special Emphasis on Mahseer Fish, January 2012, Rafique, M., Pakistan Museum of Natural History, prepared for WWF Pakistan by Himalayan Wildlife Foundation

populations including Pakistani Labeo Labeo dyocheilus, Mahaseer Tor putitora, Alwan Snow Trout Schizothorax plagiostomus (richardsonii), Common Corp Cyprinus carpio, Garua bachwaa Clupisoma garua **(Exhibit 3.7**)

- Non–Selective fishing pressure: fishing using non–selective methods such as explosives and poisons. This type of fishing tends to result in large collateral losses of non–target fish and other aquatic species, as well as indiscriminate loss of early fish life stages (fry, fingerlings, eggs and larvae) especially if done during the breeding season of fish. This includes loss of fish of conservation and commercial importance such as Twin–banded Loach Botia rostrata and Kashmir Catfish Glyptothorax kashmirensis (**Exhibit 3.7)**.It may also cause localized habitat destruction. The use of finer nets called gill nets is included in non–selective fishing.

Impact of Gulpur Hydropower Project

The Project is a run-of-the-river (RoR) type and will require construction of a dam on a bend of the Poonch River. A surface powerhouse will be located about 1 km downstream of the dam in the Poonch River. Two or three tunnels (depending on the number of units chosen) each about 180 m long, will connect the water inlet to the powerhouse. The water after passing through the powerhouse will be discharged back into the Poonch River. A reservoir will be created upstream of the weir and approximately 0.7 km of the river stretch between the weir and power tunnel will experience low flows. The impact of these changes is assessed and analyzed in detail in the ESIA of the Gulpur Hydropower Project.[66] A brief summary of the predicted impacts on the fish fauna is outlined below.

Loss of Riverine Ecosystem due to Inundation by Gulpur Reservoir

A segment of 10 km or 12% of the length of the river between the LoC and Mangla reservoir will be inundated by the Gulpur reservoir, where the river will cease to exist. The ecosystem will change from riverine to lake and a new ecosystem will be created which will support life forms that are adapted to it. The fish that can survive in a lake environment such as the Endangered Mahaseer Tor putitora, Labeo dyocheilus and Schizothorax plagiostomus (richardsonii) will benefit from extension in habitat and enhanced protection (**Section 6,** ESIA of Gulpur Hydropower Project) while the fish that require riffle habitat such as the Critically Endangered Kashmir Catfish Glyptothorax kashmirensis and Botia rostrata will not survive in the reservoir.

Degradation of the River Ecosystem in the Low Flow Segment

The ecosystem integrity in the low flow section of the river between the dam and the power house tailrace outlet which is 700m in length will experience severe degradation with fish populations, particularly the large fish dropping to critical levels and extensive loss of ecosystem functions.

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66 Section 6, 'Environmental Flow Assessment, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd. Hagler Bailly Pakistan (HBP), April 2014,

Decrease in Population of Mahaseer Downstream of the Gulpur Tailrace

Following construction of the Project, the population of the Endangered Mahaseer is expected drop by about 8% compared to present day in the 34 km section of the river downstream of the Gulpur tailrace outlet despite increased protection[67]. The main reason for this is the location of the principal breeding areas of Mahaseer upstream of the Gulpur dam. The fish will continue to breed in the river, but even with enhanced protection under the BAP it will not be possible to maintain the present day population levels of Mahaseer. The AJK Fish and Wildlife Department has plans and the budget to build a Mahaseer hatchery at Moli Nullah. The fish successfully bred in this hatchery will be released downstream of the dam to compensate for decline in Mahaseer abundance due to Project operations. There is evidence of successful captive breeding of this fish in hatcheries in Pakistan and Nepal[68]. Captive breeding and stocking of Mahaseer in Poonch River downstream of the tailrace is expected to compensate for the predicted 8% loss of population of this fish due to the Project, and possibly improve the population above present day levels.

Barrier to Fish Movement

The dam will present a barrier for the fish migrating upstream and downstream. It is expected that upstream migration will be halted by the dam, but that there will be some downstream movement through the spills and EFlow releases. The bulk of the tributaries of the Poonch River that are used for breeding by Pakistani Labeo, Mahaseer are located upstream of Gulpur HPP. However, fish restricted to the lower part of the Poonch River by Gulpur HPP will breed in the main river to some extent and will also migrate to breeding grounds in the tributaries downstream of Gulpur HPP. The population of the Endangered Mahaseer is expected drop in the 34 km section of the river downstream of the Gulpur tailrace outlet. The main reason for this is the location of the principal breeding areas of Mahaseer upstream of the Gulpur dam. Following the construction of the Project, the fish will continue to breed in the river, but even with enhanced protection recommended in the BAP it will not be possible to maintain the present day population levels of Mahaseer downstream of the dam.

Non-Flow Related Pressures on the Fish Fauna

Sand and gravel mining, pollution and nutrient enrichment are the major non-flow related pressures on the fish fauna of the Poonch River. Since the impact of sediment mining is on all floral and faunal species, not just fish, it is discussed in a separate heading below (**Section 5.13**).

5.1.2 Conservation Measures

The following measures will be implemented by the AJK Fisheries and Wildlife Department with support from MPL for conserving the fish populations of the Poonch River. The legislative basis for implementation of these measures is discussed in **Section**

[67] See Section 6.9.3 of the ESIA for the results of DRIFT model used to predict the impacts of the Project on fish species.

[68] Breeding of pond reared Golden Mahseer (*Tor putitora*) in Pokhara, Nepal. Gurung, T.B., A.K. Rai, P.L. Joshi, A. Nepal, A. Baidya and J. Bista. Cold water fisheries in trans Himalayan countries, FAO Technical Paper 431, 2002.

1.5.2, 'National regulatory Requirements'. Details of support to be provided by MPL are included in **Section 6** 'Action and Implementation Plan', and **Section 7**, 'Awareness and Education'.

- Non-selective fishing using gill nets, poisons and dynamites will be completely banned in the entire stretch of the Poonch River
- Fishing in the tributaries that are the breeding grounds of fish will be banned
- Fishing during the breeding season of the fish (May – August) will be banned
- Sediment mining will only be allowed in designated areas and banned from ecologically sensitive areas such as tributaries and fish breeding locations (discussed in **Section 6.2**)
- The above rules and regulations will be strictly implemented with an efficient and effective watch and ward system.
- The AJKFWD is planning to construct a hatchery on the Poonch River near Moli Nullah. The Project will provide some financial support for construction of this hatchery.
- To compensate for loss in fishing incomes, subsistence fishing will be allowed in the reservoir created upstream of the Gulpur Hydropower Project
- Angling will be allowed in the reservoir to attract visitors and develop the educational and recreational value of the national park

5.2 Sand and Gravel Mining

Sand and gravel mining activities are extensively undertaken along the Poonch River and are widely practiced in the areas of Kotli, Hil Kalan up to confluence of Poonch River and Ban Nullah, in some parts of the river stretch near Kohali and Gulpur, as well near Rajdhani and upstream of Rajdhani (**Exhibit 2.4**). The demand for river sediments is driven by the construction of roads (boulders and cobbles), and new homes (building sand). The expansion of the road network and increased stability and accessibility has led to increased mining activities in the last 10–20 years. The improved road network is also opening up additional areas for access for sand and cobble mining.[69]

5.2.1 Threats

In-stream sand mining results in the destruction of aquatic and riparian habitat through large changes in the river bed and channel morphology. Impacts include bed degradation, bed coarsening, lowered water tables near the streambed, and channel instability. These physical impacts cause degradation of riparian and aquatic biota.

Sand and gravel mining not only destroys aquatic habitats at the point of mining activities but also changes the size and amount of sediment that is distributed downstream, which can affect aquatic habitats in the downstream reaches. Changes to aquatic habitats as a result of mining have knock–on effects on the fish and other biota.

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[69] Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd

Mining results in physical destruction of fishing grounds and results in loss of important spawning or nursing ground areas for fish. Fish communities are potentially impacted by changes in turbidity and sediment erosion, transport and deposition. Increased turbidity can impact fish by reducing their feeding efficiency and increasing their overall physiological stress. Increased sediment loads can disrupt fish reproductive success by interfering with the viability of their eggs and fry.[70]

In addition to the fish, the benthic invertebrates that provide food for most of the carnivorous fish of the river are also impacted negatively by sediment mining. A change in the river turbidity, caused by sediment mining, causes a decline in species diversity, abundance, and productivity of the macro-invertebrates.

5.2.2 Proposed Conservation Measures

Sediment mining will only be allowed in designated areas and banned from ecologically sensitive areas such as tributaries and fish breeding locations as well as Otter hotspots (**Exhibit 3.20**). A Sediment Mining Management Plan will be developed. An outline of this plan is presented in **Appendix C**, Outline of Sediment Mining Management Plan.

5.3 Otter

Otters are the only water mammals associated with the Poonch River. The Otter Lutra lutra lives in a wide variety of aquatic habitats, including highland and lowland lakes, rivers, streams, marshes, and swamps. This species is considered to be Near Threatened (IUCN Red List 2013) due to an ongoing population decline over the years.

5.3.1 Threats

The aquatic habitats of otters are extremely vulnerable to man–made changes. Canalization of rivers, removal of bank side vegetation, dam construction, draining of wetlands, aquaculture activities and associated man–made impacts on aquatic systems are all unfavorable to otter populations.[71]

In the Poonch River, anthropogenic factors such as vegetation removal for grazing and fuel wood (**Section 5.1. 4**), sand and gravel extraction from the river bed, as well as pollution and habitat disturbance have all played a role in contributing towards a decline in the population of this species.

No Otter signs or sightings were observed in the River at the location of the Gulpur Hydropower Project and no significant impacts on the population of this species are expected from the construction or operation of the Project.

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70 (M.J Robertson et al 2006. Effects of Sediment on freshwater fish and Fish Habitats, Canadian Technical Report Of Fisheries and Aquatic Sciences 2644)

71 Ruiz–Olmo, J., Loy, A., Cianfrani, C., Yoxon, P., Yoxon, G., de Silva, P.K., Roos, A., Bisther, M., Hajkova, P. & Zemanova, B. 2008. *Lutra lutra*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on **02 January 2014**.

5.3.2 Conservation Measures

- The areas along the Poonch River where Otter signs have been seen or where the animal has been sighted by survey teams or locals will be labeled as Otter hotspots (**Exhibit 3.20**).
- Habitat disturbance and degradation due to grazing, removal of vegetation, sediment mining or other anthropogenic influences in these Otter hotspots will be monitored and controlled through an efficient watch and ward system.
- If considered appropriate and useful[72], sign boards will be put up in the Otter hotspots to warn both the locals and visitors to avoid disturbance to Otter hotspots

5.4 Bankside Vegetation

Bankside vegetation refers to the trees, bushes, shrubs and herbs that grow on the banks or flood plain of the river. The bankside vegetation stabilizes the riverbanks, is part of the Otter habitat, and can provide breeding area for the fish.

5.4.1 Threats

The communities residing in the Poonch River basin cut the vegetation on the river banks and on the flood plains to meet their requirements for fuel wood and fodder. Grazing by livestock also degrades the riparian vegetation. Alien invasive species such as Lantana camara have occupied areas that have suffered a high level of disturbance. If the past trends of usage continue, which is highly likely given non–availability of natural gas as household fuel and rising prices of commercial fuels such as kerosene and LPG (bottled gas), the vegetation cover along the riverbanks would be expected to reduce to half of the present levels over the next 52 years.[73]

5.4.2 Conservation Measures

- Livestock grazing and fuel wood collection by the local communities from Otter hotspots and ecologically sensitive locations will be monitored and controlled.
- An efficient watch and ward system will ensure that these conservation measures are implemented.
- Plantation of indigenous trees and shrubs and removal of alien invasive vegetation will be included in the watershed management plan (see **Section 6.3.3**)

5.5 Awareness among local communities

5.5.1 Threats

Despite the declaration of the Poonch River as a national park, extensive sediment mining, indiscriminate grazing, removal of bankside vegetation, illegal fishing and pollution continue in many parts of the river. One of the reasons for this is that local

[72] Signboards identifying otter hotspots can attract attention of poachers and increase the risk to the already threatened otter population

[73] Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd

communities that reside in the Poonch River basin are largely unaware of the detrimental impacts of their activities on the river ecology. They do not fully appreciate the fact that the area contains resources of conservation and socio-economic importance.

5.5.2 Conservation measure

Education and awareness, particularly at the local level, is a critical factor in generating support among local communities for conservation and management initiatives. An awareness raising program will be initiated to inform and educate the local communities about the importance of the biological resources of the area and actions required for their protection. In addition, some educational material for distribution among visitors to the National Park will be developed.

5.6 Inadequate Resources

The basic responsibility for managing and conserving the wildlife and fisheries of AJK lies with AJK Wildlife and Fisheries Department (AJKFWD) and AJK Forest Department (**Section 1.2**). This includes the management of protected areas such as national parks, terrestrial forests and river-dependent forests.

5.6.1 Threats

Due to inadequate financial and human resources, the Wildlife and Fisheries Department is unable to provide the required protection to the Poonch River Basin to control illegal fishing or prevent sediment mining and removal of riparian trees and bushes.

5.6.2 Conservation Measure

- As part of the Biodiversity Action Plan, Mira Power Ltd. will provide funds to support an improved watch and ward system of the entire Poonch River basin. This will include construction of two field offices, hiring of additional staff members (watchers), and necessary equipment and facilities.
- Mining inspectors will be hired to prevent sand and gravel extraction from ecologically sensitive locations. (**Section 5.2.2**).
- Social mobilizers will be hired for education and awareness-raising of the local communities.

6. Action and Implementation Plan

An overview of the biological resources of the designated Study Area in the Poonch River basin is presented in **Section 3**. The threats to these resources from various anthropogenic forces and the major conservation issues in the Poonch River Mahaseer National Park (national park) are outlined in **Section 5**. This section presents the necessary measures to protect these resources and achieve the net gain for biodiversity according to the requirements of IFC's Performance Standard 6 for a development project located in a Critical Habitat (**Section 1.2**) which in case of this Project constitutes the national park, inclusive of the Poonch River and its tributaries located in AJK. The primary purpose of the BAP is to achieve net gain for the aquatic biodiversity particularly the fish species of conservation importance including Endangered Mahaseer and Critically Endangered Kashmir Catfish which will directly be impacted by the Project. Improvement and strengthening of protection systems will also benefit terrestrial biodiversity in the Poonch River basin in AJK which, though not expected to be directly impacted by the Project, is presently facing a number of threats.

6.1 Background and Objectives

The ESIA of the Gulpur Hydropower Project evaluated various scenarios to address both flow and non-flow related pressures on the biological resources of the Poonch River. The flow requirements of selected ecosystem indicators and the impact of the Gulpur Hydropower project on the indicators is described in **Section 7 Impact Assessment,** of the ESIA[74]. The design of the Project was modified and flow regime in Poonch River was adjusted through the following flow related measures to minimize the impact of the changes in flow regime due to the Project on the aquatic ecosystem:

- Setting an environmental flow which will be maintained downstream of the dam at all times to support the ecosystem in the 0.7 km section between the dam and the tailrace tunnel, and
- Avoidance of a peaking operation to restore the flow in the length of the river downstream of the tail-race tunnel to Mangla reservoir.

In addition to the impact of changes in flow regime due to the Project, five non-flow related pressures (**Section 5**) studied were:

- Selective fishing pressure: fishing using selective gear such as cast nets and fishing rods. This type of fishing tends to target specific species and the adult populations.
- Non-selective fishing pressure: fishing using non–selective methods such as explosives and poisons. This type of fishing tends to result in large collateral losses of non–target fish and other aquatic species, as well as indiscriminate loss of early fish life stages (fry, fingerlings, eggs and larvae) especially if done during

74 Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd

the breeding season of fish. It may also cause localized habitat destruction. The use of finer nets called gill nets is included in non–selective fishing.

- Sediment mining: Unregulated extraction of sand, gravel and boulders from stream beds damages the aquatic habitat and impacts the population of macro-invertebrates that are an important source of food for fish
- Nutrient enrichment: Phosphates and nitrates in waste water from population centers can accelerate the production of algae which can give advantage to the herbivore fish species and ultimately lead to reduction of dissolved oxygen in the river water
- Harvesting of riparian vegetation: Bank side grasses, bushes and trees stabilize the river banks and form breeding areas for fish during wet season

The three protection levels evaluated for non-flow related pressures were:

- Protection Level 1 (Pro 1) = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over time
- Protection Level 2 (Pro 2) = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over time. The pressures will be halved over the next 5 years and then remain stable at that level for the next 48 years.
- Business as usual (BAU) = - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years.

According to the results of the ESIA, if Business as Usual prevails (BAU Scenario), the non-flow related pressures on the aquatic ecosystem in the Poonch River and its tributaries will double in intensity over the next fifty years which will result in significant decline in abundance and diversity of the aquatic and semi-aquatic flora and fauna. Similarly, maintaining 2013 levels of non-flow-related pressures on the river (as envisaged for the Pro-1 scenario) will not achieve 'net gain' for the biological resources when coupled with the operation of the Gulpur Hydropower Project. Only by reducing 2013 levels of non-flow-related pressures by 50% under the Pro 2 Scenario will the biological resources of the river show recovery over present day levels and achieve the net gain for biodiversity as required by the IFC Performance Standard 6[75]. The necessary protective measures to achieve this net gain in aquatic biodiversity include an effective watch and ward system supported by institutional arrangements to reduce illegal and indiscriminate hunting, killing, capture, and trapping of wildlife, both aquatic and terrestrial, and removal of vegetation that is important for supporting biodiversity

Following the implementation of a Biodiversity Action Plan, the ecological integrity of the segment of the river upstream of the dam and downstream of the power house would improve from Mid Category C or Moderately Modified to Borderline Category B and C, Slightly Modified/Moderately Modified (**Section 2.6**). This is a positive impact on the ecosystem of the river that will occur on about 87% percent of the length of the river between the Line of Control (LoC) and the Mangla reservoir. While achievement of net

[75] Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd

gain for terrestrial habitats[76] is not required under IFC Performance Standards and AJK legislation, the watch and ward system will not be limited to the river and tributaries alone and will extend to the adjacent terrestrial areas in the Poonch River valley as well. This will help in enhancing terrestrial biodiversity at a marginal cost.

The ESIA of the Gulpur Hydropower Project describes the impact of Project operations on various ecological indicators under various scenarios of flow and protection at three designated sites. Given below is the predicted mean percentage change (relative to 2013) for the two fish species of conservation importance for two scenarios (**Exhibit 6.1**). The impact on the other fish indicators is described in **Section 6** of the ESIA of the Gulpur Hydropower Project.

Exhibit 6.1: Mean percentage Changes Relative to 2013 for Mahaseer and Kashmir Catfish

Fish Species	*Scenarios*	
	G4ORBAU	*G4ORPro 2*
EF 1 (upstream of Project dam)		
Mahaseer	-80	+79.86
Kashmir Catfish	-79.92	+21.46
EF 2 (between dam and tailrace of Project)		
Mahaseer	-100.0	-92.9
Kashmir Catfish	-100.0	-91.0
EF 3 (downstream of Project tailrace)		
Mahaseer	-100.0	-7.7
Kashmir Catfish	-46	+57.4

G4OR[77]BAU: A 4 cumec minimum release from the Gulpur dam. Protection level BAU.
G4ORPro2: A 4 cumec minimum release from the Gulpur dam. Protection Level 2
+ denotes an increase from baseline (2013) values
_ denotes a decrease from baseline (2013) values

The protection measures associated with enhanced protection under the Pro 2 scenario are expected to increase fish populations at EFlow Site 1 relative to the BAU Scenarios (where fishing pressures are expected to double). The population of the Mahaseer is expected to increase by 80 % and that of the Kashmir Catfish by 21% of its present value due to implementation of enhanced protection under Pro 2 scenario (**Exhibit 6.1**).

In the section of the River between the dam and tailrace outlet of the Project, the populations of Mahaseer and Kashmir catfish will be wiped out without implementation of protective measures. With enhanced protection under the Pro 2 scenario, this can be reduced to a decline of 92 % and 91 % respectively in the population of the Mahaseer and Kashmir catfish populations respectively.

[76] There is no Critical Habitat identified in the terrestrial area that could be impacted by the Project.

[77] OR = Operating Rule assumed for the design configuration of two Kaplan turbines.

Downstream of the dam, the Mahaseer will be wiped out due to Project operations if Business as Usual prevails. However, with increased protection and stocking from the planned Mahaseer hatchery near Moli Nullah, this decline can be reduced to 7.7 %. Similarly, the Kashmir catfish will decline by 46 % of its present day population (2013) due to Project operations. But due to enhanced protection under the Pro 2 scenario, the population can increase by 57%.

The impact of the Gulpur Hydropower Project on the terrestrial ecological resources is described in **Section 7, Impact Assessment, of the ESIA**[78]. A brief summary is given below. Site clearance, construction of Project infrastructure and creation of the reservoir will result in immediate and direct modification of land and a loss of terrestrial habitat (Area of Habitat Loss) leading to loss of plants and animals in this area. The Area of Habitat Loss is estimated at 313 hectares consisting largely of riparian habitat and scrub forest. No threatened flora or fauna species were found or reported from this Area of Habitat Loss and signs of the Otter Lutra lutra (Near Threatened in IUCN Red List) have not been observed in this area. Therefore, the magnitude of impact of habitat loss and associated loss of flora and fauna is considered minor.

6.2 Institutional Arrangements for Implementation of BAP

As summarized in **Section 4.24** of this document, based on discussions with the stakeholders, mainly the AJK Fisheries and Wildlife Department (AJKFWD) and independent organizations active in conservation of the Poonch River, the strategy to be adopted for implementation of the BAP will include:

- Putting in place a protection system for the national park and adjacent areas with financing from the Project to fill the gaps in the existing system
- Implementation by an independent Implementation Organization
- Active support from the AJKFWD by making available existing staff for protection, assistance in coordination with other government line departments such as police and district administration
- Commitment by AJKFWD to provide legal authority to the staff of the Independent Organization for exercising powers under wildlife legislation
- Regular oversight and monitoring by a Management Committee set up for implementation of the BAP
- Establishment of two wildlife management offices along the Poonch River to provide a base for the watch and ward staff to operate
- Monitoring on a long term basis by an independent Monitoring and Evaluation Consultant

Exhibit 6.2 illustrates the institutional and contractual arrangements for implementation of the BAP. These are summarized below.

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[78] Hagler Bailly Pakistan (HBP), April 2014, Environmental and Social Impact Assessment of Gulpur Hydropower Project, Mira Power Ltd

6.2.1 Implementation Agreement

Mira Power will enter into an Implementation Agreement with the Government of AJK for implementation of the BAP. A draft agreement that provides the essential features of the obligations of the parties to the agreement, namely the Government of AJK and Project owner, Mira Power Ltd, and assigns responsibilities to the AJKFWD for implementation of the BAP actions is included in **Appendix D**. The draft will be finalized through consultation by the parties and will incorporate the inputs from the AJK Law Department and the legal counsel of the Project owner. It is not within the scope of the BAP to prepare the final legal instrument.

6.2.2 Management Committee

A BAP Management Committee will be established by the AJKFWD through a notification. The Committee will have the following constitution:

Director Wildlife and Fisheries – Chair

Project Manager of Implementation Organization – Secretary

Representative of Mira Power Ltd. – Member

District Coordination Officer – Member

Representative of Civil Society – Member

Recognized Expert on Freshwater Ecology – Member

The membership of the Management Committee could be amended by the mutual consent of AJKFWD and Mira Power Ltd.. Depending on the issues and threats being faced, additional representatives from organizations such as the Police Department and the Mines and Minerals Department may be included in the Management Committee.

The Management Committee will be responsible for:

- Reviewing the reports submitted by the Implementation Organization
- Reviewing the reports submitted by the M&E Consultant
- Organizing and conducting field inspections as and when warranted
- Reporting to on an annual basis and coordination with a high level oversight body such as a Wildlife Management Board if and when constituted by the AJK government
- Providing directions to the staff of the AJKFWD, Implementation Organization, and the M&E Consultant for improving the effectiveness of the implementation of the BAP

6.2.3 Implementation Organization

Mira Power Ltd. will contract with an Implementation Organization with demonstrated interest and experience in biodiversity protection in the national park for delivery of services and materials required for implementation and within its scope of responsibility. The Implementation Organization will be responsible for supporting the AJKFWD in maintaining and effective watch and ward system for protection of the national park and adjacent areas. Specifically, the Implementation Organization will provide the following support:

- Hire and manage the staff indicated in **Section 6.3** for protection activities
- Procure and maintain equipment and materials required for supporting the watch and ward as listed in **Section 6.3.**
- Collect data and prepare reports on watch and ward and management of sediment mining, and submit the reports to the Management Committee and the M&E Consultant.
- Provide training to the staff of the Department in protection and management of national park and wildlife.
- Oversee the operation of Mahaseer hatchery at Moli Nullah and release of fish into the river, and provide technical advice and support where needed
- Maintain contact with local communities and stakeholders and promote awareness on biodiversity protection among them.
- Advise the Management Committee and the M&E Consultant on ways and means for improving the effectiveness of BAP.

6.2.4 M&E Consultant

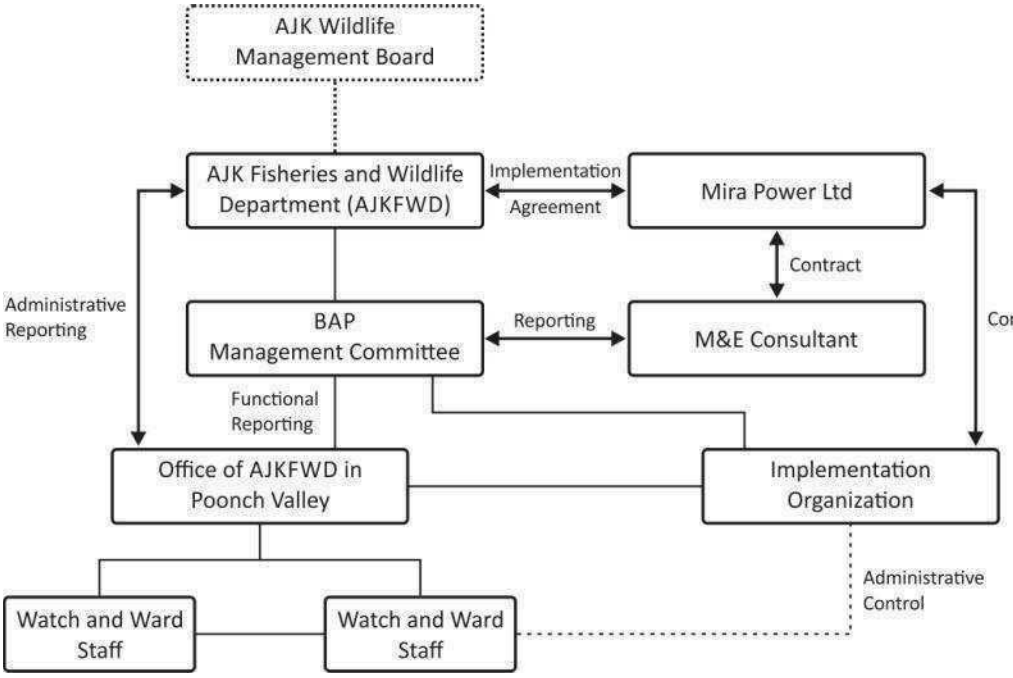
Mira Power Ltd. will contract with an M&E Consultant with experience in biodiversity assessment in the national park who will be responsible for performing tasks described in **Section 8,** Monitoring and Evaluation. The scope of services to be provided by the M&E Consultant is summarized below:

- Conducting field surveys and investigations to assess the effectiveness of implementation of the BAP, and
- Preparation of the Annual M&E Report and Biodiversity Assessment Report for submission to the Management Committee

The M&E Consultant will engage local biodiversity specialists and park management specialists for supervision of data collection, analysis, and report writing, and for advising the Implementation Consultant and the Management Committee on improvement of protection strategies and adopting measures for adaptive management.

The M&E Consultant will engage independent international biodiversity and monitoring specialists with expertise in environmental flow modeling and long term monitoring of ecological impacts of dams to advise on setting up the M&E data collection and reporting systems, and to review quality control and quality assurance carried out by the M&E Consultant.

Exhibit 6.2: Institutional Arrangements for Implementation of BAP



6.3 Measures for Protection and Management

The required measures to achieve the Enhanced Protection under the Pro 2 Scenario are described in the following sections.

6.3.1 Watch and Ward

The identification of key threats and their appropriate management is central to keeping the integrity of protected areas intact. People do not hesitate to farm, hunt, or consume any resource available in protected areas because they feel that state land is owned by everyone, and that anyone can therefore take whatever one wants.[79] Given this situation, specified goals cannot be achieved without active management. [80] In a study of 86 tropical national parks, successful species management was attributed to the greatest number of guards per unit area as well as clearly marked and maintained park boundaries.[81] Most examples from around the world show that sufficient trained staff, equipment, and communication infrastructure is essential to a park's success.[82]

An increase in surveillance and improved watch and ward in the Poonch River basin will

- curtail illegal fishing including non-selective fishing, fishing in breeding season of fish, fishing in river tributaries etc. (**Section 5.1**)

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79 Halvorson, W. L. and G. E. Davis. 1996. Lessons Learned from a Century of Applying Research Results to Management of National Parks. Pp. 334-344 in Halvorson, W. L. and G. E. Davis (eds). Science and Ecosystem Management in the National Parks. The University of Arizona Press, Tucson. 362 p

Richard B. Primack, Finding the Pot of Gold, Conservation Biology, Volume 10, Issue 2, pages 690–691, April 1996

81 Bruner A.G., Gullison, R.E., Rice, R.E., da Fonseca, G.A.B., 2001. Effectiveness of parks in protecting tropical biodiversity. Science 291, 125–127

Richard B. Primack, Finding the Pot of Gold, Conservation Biology, Volume 10, Issue 2, pages 690–691, April 1996

- prevent sediment mining from ecologically sensitive locations (**Section 5.2.2**)
- control harvesting of riparian bushes and trees particularly from the Otter hotspots (**Exhibit 3.20)**.

The focus of the watch and ward will be on protecting the aquatic and semi-aquatic ecological resources. However, the improved watch and ward will benefit the terrestrial ecological resources by

- preventing illegal hunting and killing of large mammals particularly Common Leopard Panthera pardus and Rhesus Monkey Macaca mulatta
- protecting the habitats of the vultures of economic importance (**Section 3**) by preventing disturbances to their feeding and resting areas (**Exhibit 3.30**). These include the the White-rumped vulture Gyps bengalensis listed as Critically Endangered and Egyptian vulture Neophron percnopterus listed as Endangered in the IUCN Red List 2013 respectively. .

In the context of Poonch River, some aspects of the watch-and-ward system that require development are:

- Additional staff
- Surveillance coverage
- Reporting and information management
- Field offices
- Additional equipment and material
- Communication and coordination
- Staff training

Existing watch and ward setup

The basic responsibility for managing and conserving the terrestrial and aquatic biological resources of the province of Azad Jammu and Kashmir (AJK) lies with the AJK Wildlife and Fisheries Department (AJKFWD) as described in **Section 1.6**.

An organogram of the AJK Wildlife and Fisheries Department is given in **Exhibit 6.3**. The AJKFWD is headed by the Director and divided into two management divisions: Mirpur and Muzaffarabad, each headed by one Deputy Director. The Poonch River National Park, located in District Kotli, falls in the jurisdiction of the Mirpur Division. The organogram in **Exhibit 6.3** thus, presents the positions in the Mirpur Division of the Department, the seniority level (Government grade) of each position and the number of persons holding that position.

There are a total of 14 Watchers (10 Game Watchers and 4 Fisheries Watchers) in addition to 2 Head Watcher Fisheries, 1 Game Jamadar and 1 Head Game Watcher, for existing watch and ward responsibilities for the entire districts of Mirpur, Bhimber and Kotli. The seniority levels of these staff members under the administrative system are given in **Exhibit 6.3**. These watchers are responsible for patrolling, surveying and preventing illegal hunting and fishing in these three districts. The focus is on areas of conservation importance including Pir Lasura National Park, Deva Vatala National Park, Chukar Sanctuary, Poonch River Mahaseer National Park, and Mangla Reservoir. The protected areas in vicinity of the Poonch River Mahaseer National Park are shown in **Exhibit 6.4**). If there is an emergency, these watchers may also be called for assistance to Muzaffarabad District. Clearly, the number of watchers is insufficient to provide adequate protection to all these areas.

Additional staff requirements

A total of at least 18 watchers are required that can regularly patrol and survey all sections of the Poonch River from LOC (Line of Control) to Mangla Reservoir. (The justification for this number is provided in the following section). During discussions with the Director, AJKFWD for finalization of the BAP (**Exhibit 4.9**), it was agreed that the AJKFWD will hire six watchers exclusively for watch and ward of the Poonch River. In addition, Mira Power Ltd. will provide financial assistance for hiring 12 more watchers.

Therefore, under the agreement for implementation of the BAP (**Section 6.2.1**), Mira Power Ltd. will support hiring of 12 Watchers, 1 Supervisor and 1 Project Manager. In addition, 2 mining inspectors will be hired to prevent sand and gravel extraction from ecologically sensitive locations (**Section 5.2.2**). Of these inspectors, one will be stationed at the site of the Gulpur Hydropower Project, one downstream and one upstream of Kotli. Also required will be one vehicle driver and one administration assistant. This is summarized below:

Project Manager - 1

Supervisor - 1

Watchers - 12

Sediment Mining Inspectors – 2

Vehicle Drivers – 1

Administration /Accounts Assistant – 1

Exhibit 6.3: Organogram of AJK Wildlife and Fisheries Department and Proposed Support under BAP

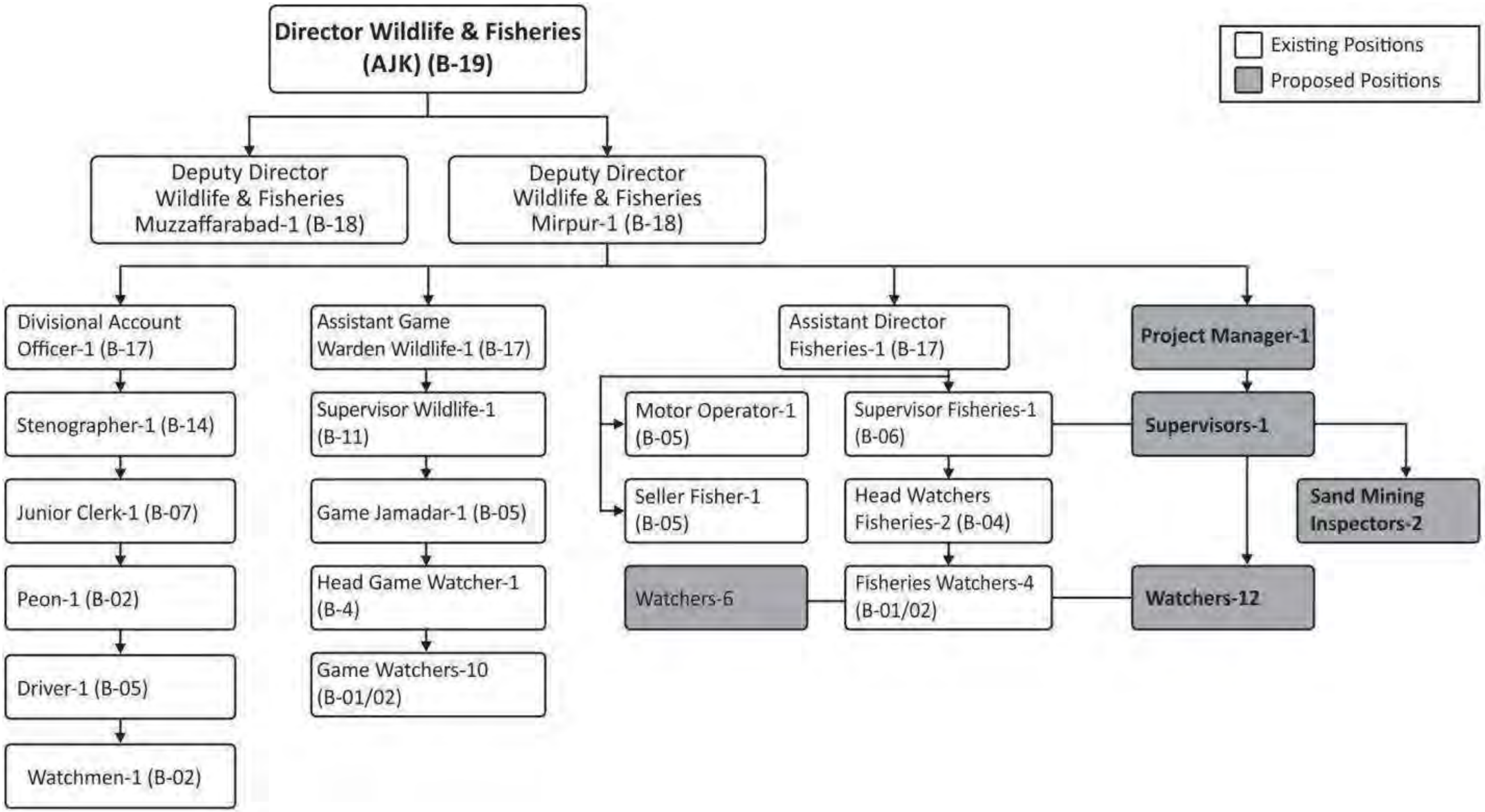
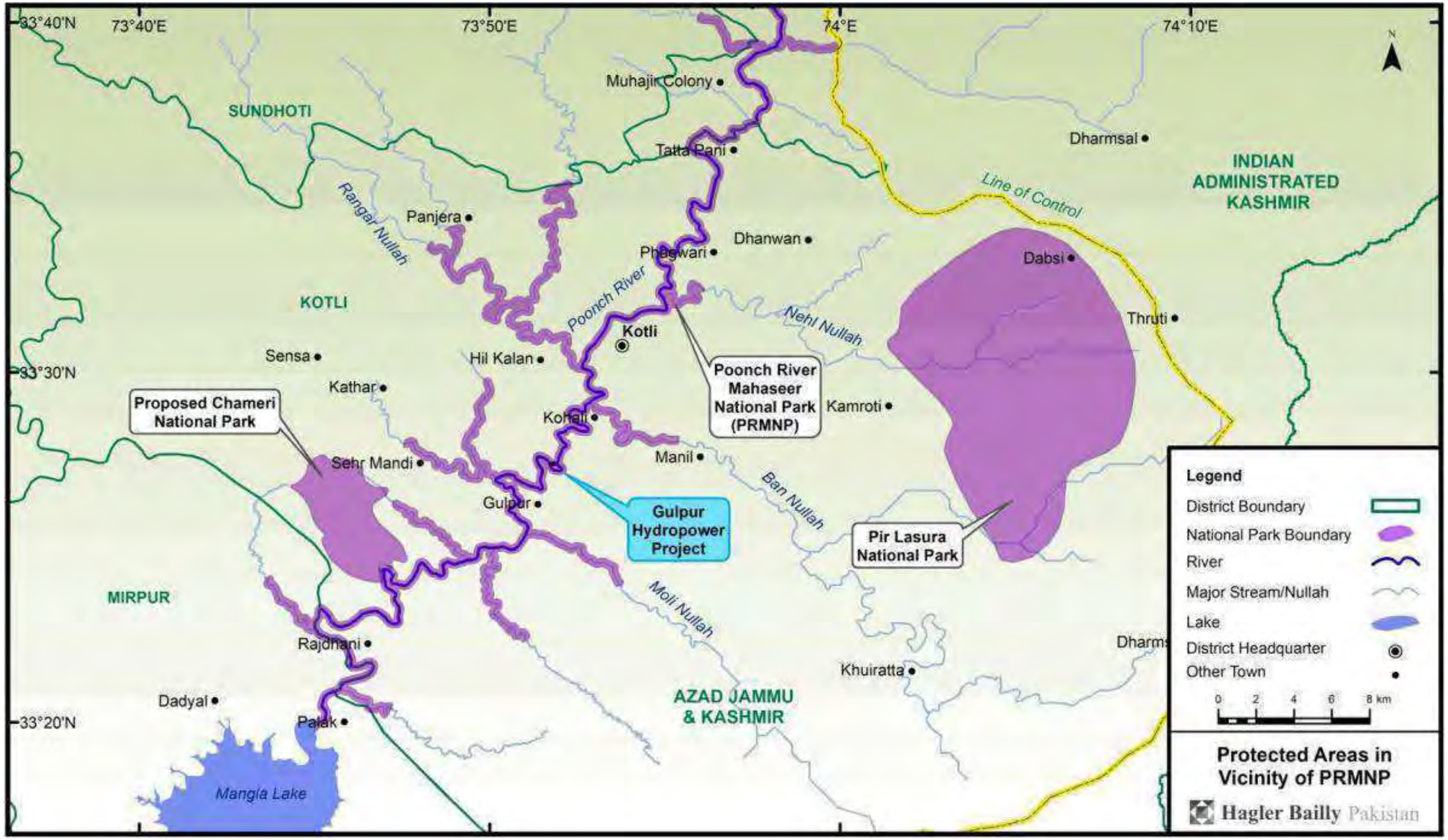


Exhibit 6.4: Protected Areas in Vicinity of Poonch River Mahaseer National Park



Patrolling and reporting

River sections

For effective and efficient watch and ward, the River and tributaries can be divided into different sections based on their conservation importance and the intensity of fishing pressure. These are listed in **Exhibit 6.5** and shown on a map in **Exhibit 6.6**.

Patrolling responsibilities

The 18 watchers (6 hired by AJKFWD and 12 supported by Mira Power Ltd.) will carry out regular patrols of the entire Poonch River, its tributaries and adjacent terrestrial habitats during both day and night.[83] Their activities will be supervised by the Supervisor. The number of watchers assigned to each river section, in view of the conservation importance of the section and the intensity of illegal fishing pressure are given in **Exhibit 6.5**.

Reporting

The watchers assigned to each section will be responsible for enforcing the national park and wildlife regulations and reporting violations. All violations will be noted, logged and reported to the Supervisor every day. In case of an emergency or major violation, the Project Manager will be informed immediately and will visit the site to constitute a team to inquire into and rectify the matter. The Implementation Organization in consultation with the Department will develop a management information system for collection, analysis, and reporting of watch and ward data.

Exhibit 6.5: River Sections based on Conservation Significance and Hunting Pressure

No	*Section Name*	*River Length (km)*	*Conservation Significance*	*Illegal Fishing Pressure*	*No of Watchers*
1.	Hajeera	8	This section includes the Abbaspur Nullah which drains into Poonch River about 88 km upstream of LoC, and the Hajeera Nullah. The river in this section is open and broad and divided into many channels. This River section as well as the two nullahs provides good breeding grounds for Mahaseer, Pakistani Labeo and Snow Trout in addition to other species. Sand and boulder mining is also highly pronounced in this section of the river.	4	3
2.	Mendhar	17	This section includes the Mendhar Nullah which is a hot spot area for Mahaseer and other fish species. It is one of the best breeding grounds for Mahaseer fish.	3	2
3.	Nehl	13	This includes the River section from Tatta Paani bridge to Talhair Bridge. The Nehl nullah is included in this section and provides breeding ground for Mahaseer.	2	2

83 Most of the illegal fishing takes place in the dark when detection is difficult

No	*Section Name*	*River Length (km)*	*Conservation Significance*	*Illegal Fishing Pressure*	*No of Watchers*
4.	Rangar Section	8	This section includes the River from Thalair Bridge to Rehman Bridge as well as the Rangar NUllah. The Rangar Nullah divides into branches in its backwaters and these branches are open, gently sloped and form typical hillstream channels suitable for Mahaseer breeding. This nullah has severe illegal fishing pressure throughout the year particularly gill netting. There is extensive sand and gravel mining in this section.	4	3
5.	Ban	13	This River section extends from Rehman Bridge to Gulpur Bridge and includes the Bann Nullah, an important breeding ground for Mahaseer. This is one of the most disturbed sections, particularly in its upper reaches, due to high sand and gravel extraction pressure. Gill netting is also common in this section.	3	3
6.	Nar/Para i	16	The River in this section extends from Gulpur Bridge to Billiporian bridge and includes the Moli Nullah. This section has deep, long and widespread pools which are wintering grounds for most of the fish found in Poonch River including the Mahaseer and Pakistani Labeo.	2	2
7.	Palak	13	This section extends from Billiporian Bridge to Palak Bridge and includes the Palak Nullah. It provides an important channel for the upstream migration of the fish of the Mangla reservoir. The deep pools in this section provide wintering grounds for the fish fauna of Poonch River and so vulnerable to blasting and gill netting.	4	3

Note: Illegal Pressure on a scale of 1 – 4.

Low (1), Moderate (2), High (3), Severe (4).

Exhibit 6.6: River Sections

Park management offices

Two Park Management Offices will be set up. There is an existing office of the AJKFWD near Moli Nullah. The AJKFWD plans to set up a hatchery and associated office at this location. Additional facilities in the form of a field office will be established at this location with the funds provided by Mira Power to support the watch and ward activities for the national park and adjacent areas. In addition, a new office will be constructed near Tatta Pani to better manage watch and ward in the upper reaches of the River. Land for these two offices will be provided by the AJKFWD. Construction costs as well as required furniture and equipment will be supported by Mira Power under the BAP agreement.

There will be 4 rooms in each field office that will include 2 rooms for watch and ward staff, 1 room for office and 1 a guest room for visitors. There will also be a bathroom, kitchen and store.

Required equipment and materials

For effective implementation of protection measures and efficient watch and ward, the staff will require the following additional equipment and facilities.

- 4WD Vehicles – 1
- Inflatable boats with rafts, gear and life jackets - 2
- Motorbikes – 4
- Uniforms and suitable gear for watchers including shoes and a jacket – 22 (18 watchers, 1 supervisor, 1 project manager and 2 mining inspectors).
- Field gear for each watcher that includes hat, torch, binoculars, life jacket - 22
- Night Vision Binoculars – 2
- Global Positioning System (GPS) - 1
- Video Camera - 1
- Digital Cameras – 2
- First Aid Box - 2

The following office equipment will be required:

- Computers – 2
- Laptop - 1
- Printers – 2

The AJKFWD has agreed to provide the uniforms and field gears for the watch and ward staff**.** The other equipment and materials listed above will be purchased using funds provided by Mira Power Ltd.

Communication and coordination

A communication network is vital for the proper functioning of the watch-and-ward system. Each of the two field offices will have a telephone and a computer.

Email/internet facilities will be added depending on the availability of communication networks.

For field communication, the watchers will use their cellular phones and a monthly allowance will be given to the watchers for their phone bills.

Operating costs

Besides one-time costs for purchase of equipment and material described above, the Field Offices will require funds on an annual basis to pay for the utilities, vehicle fuel, travelling charges, and miscellaneous office expenses. These have been included in the budget required for implementation of the BAP (**Section 6.5**).

Staff training

Training of new and existing staff is central to the success of implementing the Enhanced Protection Scenario proposed in the ESIA. A 10 day course will be designed for the watch and ward team that will include information regarding:

- Important biological resources of the area, the conservation importance of these species and need for their protection.
- Legal framework in which the national park operates as well as the applicable rules and regulations
- Guidelines and procedures patrolling, coordination, and efficient watch-and-ward.

The course will be organized by the Implementation Organization and delivered by a leading conservation biologist and fish expert; a legal expert; and a senior official of the Department or an NGO with experience in management of national parks in AJK.

Implementation plan for watch and ward

This section contains an extract from previous sections dealing with the measures and actions prescribed, the roles and responsibilities assigned, and the timeframe within which each action should be carried out. The implementation plan is given in **Exhibit 6.7**.

Exhibit 6.7: Implementation Plan for Watch and Ward Plan

No	*Task/Action*	*Responsibility*	*Timing*
1.	Hiring of Additional Staff a) Project Manager - 1 b) Supervisor - 1 c) Watchers – 18 (12 supported by Mira power Ltd. and 6 by AJKFWD) d) Mining Inspectors - 2 e) Drivers – 1 f) Admin/Accounts Assistant - 1	Implementing Organization and AJKFWD	On initiation of BAP

No	Task/Action	Responsibility	Timing
2.	Construction of Field Offices: a) River near Tatta Pani b) River near Moli Nullah	Implementation Organization and AJKFWD	On initiation of BAP
3.	Purchase of required equipment and facilities: 4WD Vehicle – 1 Inflatable boats with rafts, gear and life jackets-2 Motorbikes – 4 Uniforms and suitable gear for staff including shoes and a jacket (two sets) – 2 x 22 = 44 Field gear for staff that includes hat, torch, binoculars, life jacket - 22 Night Vision Binoculars – 2 GPS - 1 Video Camera - 1 Digital Cameras – 2 First Aid Box - 2 Computer – 2 Laptop - 1 Printer – 2	Implementing Organization	Every 10 years
4.	Staff training	Implementing Organization and Department	On initiation of BAP within six months

Short Term – 1 – 2 years, Medium Term = 3 -5 years Long Term = 6 - 8 years.

6.3.2 Requirements for fish hatchery

The AJK Fisheries and Wildlife Department plans to construct a fish hatchery near the confluence of Moli Nullah and Poonch River located about 15 km downstream of the dam (**Exhibit 6.6**). MPL will provide supplemental equipment and technical support to the Department to breed Mahaseer for release in the downstream section of the river. Technical advice and co-ordination with experts may be facilitated by the Implementation Organization of the BAP (**Section 6.2.3**) who will oversee the working of the hatchery.

There is evidence of successful captive breeding of this fish in hatcheries in Pakistan, India and Nepal[84]. Breeding of Mahaseer has successfully been demonstrated in Pakistan

[84] Breeding of pond reared golden mahseer (Tor putitora) in Pokhara, Nepal. Gurung, T.B., A.K. Rai, P.L. Joshi, A. Nepal, A. Baidya and J. Bista. Cold water fisheries in trans Himalayan countries, FAO Technical Paper 431, 2002.

at the hatchery of the Punjab Forestry, Fisheries, and Wildlife Department at Garyala in District Attock.[85] A list of some successful hatcheries in the region is given below:

- Pakistan
  - Fish Nursery Kotly Araian District Sialkot, Punjab, Pakistan
  - Mahseer Fish Seed Hatchery, Garyala, District Attock
- India:
  - Anji Mahseer Hatchery (Reasi) of Jammu & Kashmir state (at Salal Hydropower Project)
  - Tata Power Company's fish farm at Lonavla, District Pune (Maharashtra).
  - Mahaseer fish hatchery at Dehradun
  - Mahaseer fish hatchery at Bhimtal
  - Haranji Fish Farm in Kodagu District, of Karnataka
  - Wayanad Mahaseer fish hatcher, Kerala
  - salaiyar Dam Mahaseer fish Hatchery, district Coimbatore, Tamil Nadu
- Nepal:
  - Mahasher Hatcherty at Kali Gandaki Hydro Power Project, Nepal
  - Pokhara Fisheries Research Centre, Nepal
  - Fisheries Research Centre, Trishuli, Nepal

The basic responsibility for construction of the hatchery and purchase of equipment will lie with the AJK Fisheries and Wildlife Department. A list of this equipment is provided for reference.

- Water supply system
- Ponds
  - Ponds for broodstock (1),
  - Nursery ponds (1),
  - Rearing tanks for juveniles (2),
  - Reservoir Pond to store inlet water from the water source before use in the hatchery and nursery,
- Hatchery building
- Breeding and hatching circular tanks (3)
- PVC pipes and fittings

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85 Evaluation Report on Project ‘Establishment of Mahseer Fish Hatchery and Seed Rearing Farm for Stock Replenishment in Semi Cold Natural Water Bodies of the Province’, Directorate General of Fisheries, Forestry, Wildlife & Fisheries Department, December 2010.

- Electricity supply
- Pumps
- Aeration system
- Fish transportation bags with Oxygen Supply
- Fish Food
- Hormones (Ovaprin)
- Nets

6.3.3 Plantation and revegetation

Plantations will be carried out in association with the AJK Forest Department and AJK Fisheries and Wildlife Department (AJKFWD) preferably in the vicinity of the Project site, Otter hotspots, and other sensitive areas. Alien invasive species such as lantana will be removed and native fast growing plant species will be planted that will increase the vegetative cover, improve the ecological integrity of the basin, and prevent soil erosion. In addition, the increased vegetation will provide the local communities with an alternative source of wood for fuel and grazing. This is important keeping in view that grazing and fuel wood collection from Otter hotspots, vulture resting areas, fish breeding areas and other ecologically sensitive areas will be monitored and controlled. An amount for this activity has been included in the budget for implementation of the BAP provided in **Section 6.5**.

6.4 Review of implementation Plan

The Implementation Plan will be evaluated every three years by the M&E Consultant. Recommendations for improvement of the BAP will be presented as a part of the Biodiversity Assessment report prepared by the Consultant. The Management Committee will review the recommendations of the M&E Consultant and may amend the Implementation Plan to improve its effectiveness through changes in actions and activities and allocation of resources.

6.5 Management Plan for the National Park

Under ‘Functions of the Department’, Section 4 of the AJK Wildlife (Protection, Preservation and Management) Ordinance 2013 stipulates that the Department will ‘prepare and implement annual and periodic development plans for wildlife and biodiversity’. There is no further detail provided in the legislation on what the plans should include, and when they should be prepared. It is, however, a common practice in the country to prepare management plans for the protected areas, and these plans generally form a basis for allocation of funds and resources by the government for development and operation budgets. By the ESIA process, the profile of the National Park, its conservation importance, and threats to its ecological resources have been highlighted and brought to public notice. This Biodiversity Action Plan and the ecological baseline included in the ESIA provide much of the information and detail required for the preparation of a management plan for the Poonch River Mahaseer National Park. MPL will support the AJK Fisheries and Wildlife Department in preparation of the management plan for the national park either directly or through the Implementation Organization[86]. The likely timing of this effort will be during the construction phase of the Project, and prior to operation of the Project, when some level of information and insight is available on the management strategies and practices that are best suited for the national park. Resource requirements if any will be discussed with the Department at that time.

6.6 Budget for Implementation

Exhibit 6.8 and **Exhibit 6.9** present budgets for capital and onetime costs and for annual operating or recurring costs respectively for implementation of the BAP. Implementation will be initiated following the financial close of the project. The discussion on budget for awareness and education activities is included in **Section 7**, Awareness and Education. The budgets for monitoring and evaluation are presented separately in **Section 8**, Monitoring and Evaluation.

[86] An NGO such as the Himalayan Wildlife Organization which has been assisting the AJK Department of Fisheries and Wildlife for the past five years in management and protection of the national park is a possible option for the preparation of the park management plan.

Exhibit 6.8: Budget for Capital and One Time Expenses

Activity	*Units*	*Qty*	*Unit Cost PKR*	*Contribution by Mira Power*		*Contribiuton by the AJKFWD*		*Budget Notes*
				Total Cost PKR	*Total in USD**	*Total Cost PKR*	*Total in USD**	
Plantation and Re–vegetation in watershed	Ls	1	2,000,000	2,000,000	19,608	–	–	Vegetaion using native species in vicinity of Project site
Staff training	Days	18	10,000	180,000	1,765	–	–	Three sessions of 6 days each for newly hired and exisitng staff of Implementiong Organization (IO) and AJKFWD
Training Material and Boarding/Lodging	Days	18	10,000	180,000	1,765	–	–	Development of training material and training by 3 experts in ecology, law and watch and ward.
Land for field office in Tatta Pani	Ls	1	6,000,000	–	–	6,000,000	58,824	Land provided to construct the office
Land for Field office and hatchery at Moli Nullah	Ls	1	24,000,000	–	–	24,000,000	235,294	Land provided to construct field office and hatchery
Civil Works for hatchery **	Ls	1	41,000,000	–	–	41,000,000	401,961	Civil Works for hatchery
Equipment & material for hatchery	Ls	1	9,970,000	–	–	9,970,000	97,745	Equipment & material for hatchery
Supplemental equipment & accessories for hatchery	Ls	1	8,000,000	8,000,000	78,431			Supplemental equipment & material for hatchery
Construction of field offices (02)	No	2	1,500,000	3,000,000	29,412	–	–	4 rooms in each of 2 offices. 1 kitchen, bathrom and store included
Funiture & fixture	No	2	100,000	200,000	1,961	–	–	For the 2 field offices
Equipment and Materials								
First Aid box	No	2	5,000	10,000	98	–	–	Standard first aid box – 1 for each office
4 WD vehicle	No	1	3,500,000	3,500,000	34,314	–	–	Toyota Hilux Double Cabin standatd 4 x 4
Motor bikes	No	4	130,000	520,000	5,098	–	–	Honda CG 125 cc
Boat, Rafts, Gear, Life Jackets	No	2	125,000	250,000	2,451	–	–	Imported inflatable boats and equipment
Night vision binoculars	No	2	20,000	40,000	392	–	–	Gen. 1 image–intensifier tube Powerful infrared spotlight 750–feet viewing range
Binoculors	No	24	4,000	96,000	941	–	–	Bushnill Bi Nocular 20 X 16
GPS (Garmin eTrex 30)	No	1	30,000	30,000	294	–	–	2.2" 65K color, sunlight–readable display 3–axis compass and barometric altimeter Wireless capability to share waypoints.
Video camera (Sony HDR–CX280)	No	1	40,000	40,000	392	–	–	(Sony HDR–CX280) Full HD, wide–angle Carl Zeiss lens, Exmor R™ CMOS sensor, 50x extended zoom & Optical SteadyShot
Cameras	No	2	55,000	110,000	1,078	–	–	Nikon D5100– NIKKOR lens with 7x optical zoom.DSLR
Computer	No	2	50,000	100,000	980		–	Core I 3 computers , with 4GB Ram 80 GB HDD, Suprer Drive 6 MB Cache
Laptop	No	1	70,000	70,000	686	–	–	HP Core I 7 Laptop , with 6GB Ram 640 GB HDD, Suprer Drive 6 MB Cache
Printer	No	2	30,000	60,000	588	–	–	HP Laser jet Printer with coper scanner and Fax
Posters	No	2000	50	100,000	980	–	–	1500 copies of 22 " X 33" of four color poster
Brochures	No	2000	15	30,000	294	–	–	2000 copies of four color A4 brochure with 3 foldings
Signboards (Small)	No	36	8,000	288,000	2,824	–	–	36 number of road direction sign boards (1.0m X 0.7m) with 10ft Iron poll
Signboards (Large)	No	12	22,000	264,000	2,588	–	–	12 number of steel sign boards (104m X 2m) with 10ft Iron poll
Sediment Mining Plan	No	1	8,519,040	8,519,040	83,520			See Appendix C, Sediment Mining Management Plan for details
Total Capital and One Time Costs				**27,587,040**	**270,461**	**80,970,000**	**793,824**	

*1 USD = 102 PKR

** The AJK Fisheries and Wildlife Department is making a large hatchery for breeding Mahaseer and some other fish primarily for commercial purposes. Construction of a Mahaseer hatchery to meet the requirements of the Project would cost substantially less (an estimated 20,000,000 PKR for civil works and 8,000,000 for equipment and materials = 28,000,000 PKR (USD 274,510).

Exhibit 6.9: Budget for Annual Operating Expenses

	Units	*Qty*	*Unit Cost PKR*	*Contribution by Mira Power*		*Contribiuton by the AJKFWD*		*Budget Notes*
				Total Cost PKR	*Total in USD**	*Total Cost PKR*	*Total in USD**	
1. Staffing								
a. Watch and Ward								
Part time Project Manager	Months	12	80,000	960,000	9,412	–	–	Manager of Implementing Organization (IO)
Supervisor	Months	12	40,000	480,000	4,706	–	–	Supervisor of Watch and Ward
Mining Inspectors (02)	Months	12	20,000	480,000	4,706	–	–	1 upstream Kotli and 1 downstream Kotli
Watchers (12)	Months	12	12,000	1,728,000	16,941	–	–	For watch and ward of entire Poonch River
AJKFWD watchers (06)	Months	12	10,000	–		720,000	7,059	For watch and ward of entire Poonch River
Admin/Accounts assistant	Months	12	30,000	360,000	3,529	–	–	For support in field office / office of IO
Female social mobilizers (2)	Months	12	18,000	432,000	4,235	–	–	2 female for community outreach program
Vehicle driver (01)	Months	12	15,000	180,000	1,765	–	–	Vehicle driver for watch and ward and other activities such as staff training and community outreach
b. Hatchery								
Assistant Director Fisheries	Months	12	40,000	–	–	480,000	4,706	Manager of hatchery
Computer operator	Months	12	20,000	–	–	240,000	2,353	For hatchery office
Accounts clerk	Months	12	17,000	–	–	204,000	2,000	For hatchery office
Fisheries supervisor	Months	12	15,000	–	–	180,000	1,765	Supervize hatchery activities
Driver	Months	12	12,000	–	–	144,000	1,412	For hatchery office
Head watcher (02)	Months	12	13,000	–	–	312,000	3,059	For hatchery operation
Watcher (08)	Months	12	12,000	–	–	1,152,000	11,294	For hatchery operation
Plumber	Months	12	15,000	–	–	180,000	1,765	For maintenance of hatchery equipment
Electrician	Months	12	15,000	–	–	180,000	1,765	For maintenance of hatchery equipment
Chowkidar	Months	12	12,000	–	–	144,000	1,412	Guard for hatchery
Office Attendant	Months	12	12,000	–	–	144,000	1,412	For hatchery office
Sub Total for Staffing				**4,620,000**	**45,294**	**4,080,000**	**40,000**	
2. Operating Costs								
Fuel for vehicle (01)	Months	12	35,000	420,000	4,118	–	–	Fuel for1 4WD Toyota Hilux
Fuel for m/bikes (04)	Months	12	6,000	288,000	2,824	–	–	Fuel for 4 motorbikes
Running and maintenance vehicle (01)	Months	12	10,000	120,000	1,176	–	–	Oil change, repairs, service, tuning etc
Running and maintenance m/bikes (04)	Months	12	2,500	120,000	1,176	–	–	Oil change, repairs, service, tuning etc
Travelling boarding and lodging charges	Months	12	10,000	120,000	1,176	–	–	Visits by staff of Implementing Organization (IO) to Project site
Printing and stationary	Months	12	10,000	120,000	1,176	–	–	Field office requirements
Communication charges (24)	Months	12	500	144,000	1,412	–	–	Mobile phone charges for 24 staff of watch and ward including mining inspectors and supervisor and social mobilizers
Uniform (02 for each watcher)	No	44	6,000	–	–	264,000	2,588	2 Uniforms each for 22 staff of watch and ward

	Units	*Qty*	*Unit Cost PKR*	*Contribution by Mira Power*		*Contribiuton by the AJKFWD*		*Budget Notes*
				Total Cost PKR	*Total in USD**	*Total Cost PKR*	*Total in USD**	
Field gear	No	22	15,000	–	–	330,000	3,235	Hat, torch, binoculars, life jacket, day bag, shoes, jacket, name badges etc.
Teacher training program	No	4	25,000	100,000	980	–	–	4 programs in a year for elementary school teachers of community
School activities and community outreach programs	No	8	10,000	80,000	784	–	–	Awareness programs. One every month in selected school (except 4 months of school holidays)
Office utilities	Months	12	10000	120,000	1,176	–	–	gas, electricity, water for field offices
Depreciation on vehicle and equipment	No	1	–	455,600	4,467	–	–	Depreciation on vehicles and motorbikes @10% of cost less salvage value @40%, and @20% for equipment
Sub Total for Operating Costs				**2,087,600**	**20,467**	**594,000**	**5,824**	
3. Management and Overheads	**15%**			**937,800**	**9,194**		**–**	
Total Annual Recurring Cost (Sum of Staffing Cost + Operating Cost + Management and Overheads)				**7,645,400**	**74,955**	**4,674,000**	**45,824**	

* 1 USD = 102 PKR

7. Awareness and Education

The awareness and education plan for the Poonch River Mahaseer National Park and adjacent areas presented in this section, is designed to contribute to biodiversity conservation through information sharing, education and capacity building of the concerned population groups i.e. the local communities and visitors.

The activities proposed for awareness and education will focus on the aquatic and semi-aquatic biological resources of the Poonch River that is a Critical Habitat according to IFC Guidelines[87]. However, the proposed activities will also cover and benefit the wildlife in adjacent areas in the Poonch River valley where terrestrial wildlife species such as the leopard and monkey are highly vulnerable and need protection.

7.1 Introduction

Environmental education (EE) is a concept often adopted by people concerned with the protection of the environment and is seen as an important instrument for achieving PA (Protected Areas such as national park) conservation. The IUCN described EE as: "... the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among men, his culture and his biophysical surroundings. Environmental Education also entails practice in decision-making and self-formulation of a code of behavior about issues concerning environmental quality".[88]

Thus, the ultimate goal of EE is to equip people with the knowledge and skills they need to be active and authoritative partners in managing the environment and to empower individuals to make effective changes in their lives to ensure that all species have a healthy environment. This can largely be achieved by:

- Providing individuals with opportunities to acquire knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment
- Encouraging individuals to examine and interpret the environment from a variety of perspectives by promoting interdisciplinary inquiries encompassing a broad spectrum of environmental, social, ethical, economic, and cultural dimensions in the decision-making process.

In a natural environment the quality of local communities is dependent upon the resource generating ability of natural systems. The long- and short-term consumption choices of local communities can either enhance or compromise the ability of the natural systems to meet their needs, the needs of their neighbors, and the needs of their future generations. Education and awareness efforts can assist local communities to safeguard existing

[87] Policy on Social and Environmental Sustainability, January 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, International Finance Corporation. The World Bank Group.

[88] Neal P. & Palmer J. editors, 1990:2 http://www.glocom.org/special_topics/colloquium/20030723_iguchi_environmental3/

resources, improve the ecology, and mitigate the hardships caused by lack of awareness and know how. Awareness regarding the PA and its significance may also mitigate potential conflict between PA staff and local communities required to live their lives by a specific set of ground rules. Thus, targeting local communities will ensure that conservation is not limited to protecting the PA in isolation, but extends to protecting the area as a place fit for human habitation as well.

During conservation efforts, it is essential to recognize, utilize, and build the human capital of the management organization of a PA in order to fulfill short- and long-term goals effectively. In combination with ecologically based land and resource management, targeting PA staff in education efforts can build the required foundation for managing PAs. Therefore, capacity building of PA staff is an important component of the overall awareness and education strategy.

Potential and existing PA visitors also require information. This varies from simple information on park location, times of operation, and fees, to much more complex and targeted information regarding cultural history and local ecology. Effectively educating and raising the awareness of PA visitors as well as the general public goes beyond simply informing, towards developing an understanding and appreciation of the PA and the objectives of the conservation effort. The promotion of a PA plays an important role in its conservation: it helps gain public support by educating people about the area and its significance in addition to building a greater appreciation of PAs in general and the conservation of natural and cultural heritage.

Launching education and awareness initiatives that cater to the local communities, staff of the PA, visitors, as well as the general public can bridge the knowledge gap and be vital to achieving synergy in conservation efforts.

Our primary concern is with the PRNMP as it is the critical habitat and therefore of importance in terms of achieving net gain. The purpose is to empower people to participate in conservation measures in an informed, committed, and skilled manner.

7.2 Activities for Facilitating Awareness and Education

Training for staff of the AJK Wildlife and Fisheries Department has been outlined in **Section 6**. This section provides a plan for raising awareness of the local communities of the Poonch River basin as well as the equipment and facilities required to educate the visitors to the national park.

7.2.1 Local Communities

The following steps are proposed to increase the environmental awareness of the local communities.

Staff requirements

The following staff members will be hired to work with the local communities:

Social Mobilizers - 2 female

These social mobilizers will be an integral part of the watch and ward team and will work on a regular basis to organize teacher training workshops, school activities, and community outreach programs. In a conservative segregated society like AJK, the female

Social Mobilizers will be in a better position to reach, communicate with and educate the community women.

Teacher Training Workshops

Training teachers will ensure that conservation education becomes part of the classroom teaching process and is integrated into the local school system. Gaining the support of schoolteachers and their students will not only help change the outlook of future community members but also provide a focus for the more immediate spread of information. The Social Mobilizers will conduct teacher training workshop in the local schools and provide information to the teachers regarding:

- The aquatic and semi-aquatic ecological resources of the Poonch River particularly fish and Otter
- The significance of the area as a Protected Area (national park) and the species of conservation importance for which the Park was designated
- Threats to these biological resources including over-fishing, use of destructive fishing means, deforestation and illegal hunting
- Rules and regulations of a national park
- Steps that community members can take to minimize the negative impact on the environment and biological resources

The workshops will be delivered using the following tools:

- Slide shows
- Posters and postcards
- Field visits

School Activities

School teachers will organize debates, drawing competitions, quiz competitions on various aspects of conservation in the Poonch River Mahaseer National Park. Social Mobilizers will facilitate these events and present certificates to the winners. The aim will be to raise environmental awareness among school children in a fun and interactive way.

Community Outreach

The Social Mobilizers with support from the Watchers (**Section 6.2.1**) will conduct non-formal awareness and education programs for the communities of the Poonch River basin. Separate events will be organized for men and women. During these sessions, the conservation significance of the Poonch River will be highlighted with recommendations on how the detrimental impact of anthropogenic activities on the biological resources of the area can be minimized. In addition, information will be provided about the rules and regulations of living in a national park.

7.2.2 Visitors and General Public

Awareness and education tools for visitors to the Poonch River Mahaseer National Park and the general public will include the items described below.

Posters and brochures

Posters and brochures will be prepared on the following themes:

- Importance of the Poonch River including pictures of aquatic fauna of conservation importance particularly fish and Otter
- Wildlife of conservation importance including pictures of mammals and birds found in the area such as Leopard, Monkey, Langur, and Vultures.
- Threats to the biological resources of the Poonch River basin
- The rules and regulations and do’s and don’ts of a National Park

Sign Boards

At least 12 large and 36 small sign boards will be prepared on some of the following themes

- Location, history and importance of Poonch River Mahaseer National Park
- Warning sign not to remove vegetation from, or cause disturbance to, the Otter hotspots
- Warning sign not to engage in illegal fishing particularly using gill nets, dynamite and poisons.
- Warning signs not to disturb the resting and feeding sites of vultures
- Warning signs not to engage in hunting of large mammals such as leopards
- Warning signs not to remove sand and gravel from the ecologically sensitive areas such as river tributaries.

7.3 Implementation Plan

This section contains an extract from previous sections dealing with the actions prescribed, the roles and responsibilities assigned, and the timeframe within which each action should be carried out. The basic responsibility for the awareness raising program will lie with the AJK Wildlife and Fisheries Department and the Implementing Organization (**Section 6.4**). The implementation plan for education and awareness activities is given in tabular form in **Exhibit 7.1.** Budget for the activities is provided in **Exhibit 6.8** and **Exhibit 6.9**. The plan:

- Describes various actions that must be taken
- Assigns responsibilities for each action
- Gives the timeframe (short term, long term) and frequency (annual, bi-annual) for the actions to be completed

Exhibit 7.1: Implementation Plan for Education and Awareness Program

No	*Action*		*Responsibility*	*Frequency*
1.	**Local Communities:**			
	1.1	Teacher training workshops	Implementing Organization	One workshop a month
	1.2	School activities	Implementing Organization	Two events a month
	1.3	Community outreach programs	Implementing Organization	Two events a month
2.	**General Public**			
	2.1	Posters and brochures	Implementing Organization	After every 10 years
	2.2	Sign boards	Implementing Organization	After every 10 years
	2.3	Website for the Poonch River Mahaseer National Park will be developed	Implementing Organization	One time (with updates every year)

8. Monitoring and Evaluation Framework

As stated in **Section1,** Introduction, the BAP is a key document that has been prepared to provide a framework and an action plan for achieving net gain in the Critical Habitat consisting of River Poonch and its tributaries under IFC Performance Standards, and betterment of the national park under the AJK Wildlife Ordinance 2013. This section provides the scope and framework for monitoring and evaluation to determine if the objectives of the BAP are being achieved through the life of the Project. This section also outlines the related institutional arrangements, procedures for reporting and review, and budgetary requirements.

The monitoring and evaluation framework presented in this section should be considered as an evolving document. The Monitoring and Evaluation Consultant will be expected to review the framework before initiating the activities, and periodically review and improve it as experience is gained in implementation of the BAP. The Monitoring and Evaluation Consultant will also be responsible for finalizing data collection forms and protocols, and developing information management systems to support the compilation of data and preparation of reports.

8.1 Analytical Framework for Monitoring and Evaluation

The analytical frameworks selected for monitoring and evaluation will be the same as those adopted in the ESIA. To assess whether or not a net gain or betterment of the national park has been achieved, comparisons will be made with the pre-Project conditions (referred to as Present Day conditions in the baseline for aquatic ecology (**Section 6**, Environmental Flow Assessment of ESIA submitted to ADB) Pre-Project conditions for the purpose of assessment of effectiveness of the BAP will be defined as conditions prevailing in the ecosystems in the year preceding the start of construction activities that could directly impact the aquatic or terrestrial ecosystems. In case of aquatic ecosystems, this will mean creation of any obstruction in the river for construction of the dam. In case of terrestrial ecosystems this will mean major land clearing activities for establishment of temporary or permanent project facilities. Data and information from the first set of sampling that will form the reference point for the BAP will be used to define the pre-Project conditions. Baseline data from the ESIA will not be used for assessment of effectiveness of implementation of the BAP. The reasons for adopting this approach are:

- To screen out any deterioration or improvement in the ecosystems that may have taken place between the time the sampling was done for the ESIA, and when the project impacts actually begin to occur.
- To further refine the sampling approach in view of the stakeholder comments received during the preparation of the BAP.

A Pressure-State-Response framework will be used for monitoring purposes[89]. The PSR framework lays out the basic relationships amongst:

- the pressures human society puts on the environment
- the resulting state or condition of the environment, and
- the response of society to these conditions to ease or prevent negative impacts resulting from the pressures

8.2 Scope of the Monitoring Programme

Following the Pressure-State-Response framework, data and information will be collected and reported as described in this section.

8.2.1 Monitoring Indicators - Pressure

Exhibit 8.1 summarizes the monitoring requirements for indicators of pressure on biodiversity. The Pressure indicators will include the following:

Exhibit 8.1: Framework for Monitoring of Pressure Indicators

Indicator	*Location*	*What to monitor*	*Method*	*Frequency*	*Responsibility*
Pressure on aquatic ecology due to harvesting, hunting, and habitat damage	Watch and ward sections along Poonch River and in tributaries	Legal and illegal harvesting and kills. Hunting, trapping, and disturbance of otters. Quantity and distribution of sand and gravel mining from river bed.	Data collection, analysis, and reporting using a watch and ward management information system.	Quarterly	Implementation Consultant
Pressure on terrestrial ecology due to hunting and habitat damage	Watch and ward sections along Poonch River and in tributaries	Hunting, trapping, and disturbance of key species such leopard, monkey and vultures.	Data collection, analysis, and reporting using a watch and ward management information system.	Quarterly	Implementation Consultant
Pressure on biodiversity due to construction of additional hydropower	Poonch River and tributaries both upstream and downstream	Status of projects and potential impact	Review of newspaper reports and reports prepared by Private	Annually	M&E Consultant

89 Pressure-State-Response Framework and Environmental Indicators, http://www.fao.org/ag/againfo/programmes/en/lead/toolbox/refer/envindi.htm

Indicator	Location	What to monitor	Method	Frequency	Responsibility
projects	of LoC		Power and Infrastructure Development Board and Ministry of Water and Power		
Population	Kotli city and villages along Poonch River included in ESIA baseline	Population of Kotli city and individual villages	Proxy indicators or census if available for Kotli city, survey of villages.	Once in three years	M&E Consultant
Land use pattern	Watch and ward sections along Poonch River	Land use by type within 500 m of the river bank, and from 500 m to 2.5 km from the river bank.	Analysis of selected representative segments using Google Earth imagery.	Once in three years	M&E Consultant

Pressure on Aquatic Ecology

1. The total amount of fish being harvested in a year separately reported or estimated for harvesting through legal means and catch or killing through illegal means. Qualitative indication of the type of fish being harvested, seasonal variations, means and methods being used, and events that may have impacted the harvesting or capture such as floods will also be provided. The number and type of fishing licenses or permits issued will be reported.
2. The following will be reported for individual instances of hunting or trapping of otters: Date and location (GPS coordinates) of incident, description of animal, photograph, names of accused or suspects, names of contacts or key informants, name of the reporting staff, and any other information related to the incident.
3. Total amount of sand and gravel extracted from the river and tributaries, separately reported or estimated for extraction through legal means (with permits at designated mining sites) and through illegal means (without permits).

Wherever possible, the above information will be reported on a quarterly basis for watch and ward management sections as defined in **Section 6.3.1**. The Implementation Organization will prepare systems for collection and reporting of information related to violations as described in **Section 6**.

Pressure on Terrestrial Ecology

All instances of hunting, trapping, or disturbance for the indicator species including leopard and monkey and any other species of wildlife that the Management Committee may specify, will be collected and reported. Information will be reported on a quarterly basis. Wherever possible, the information should be reported for the river sections as defined in **Section 6.3.1**. The Implementation Organization will prepare systems for collection and reporting of information related to violations as described in **Section 6**.

Additional Hydropower Projects

As discussed in the **Section 7, Impact Assessment** of the ESIA, Cumulative Impact Assessment, construction of additional hydropower projects on Poonch River and its tributaries is likely to have a detrimental impact on the aquatic ecology of the river, with a high probability of reversing the net gain in biodiversity achieved through the implementation of the BAP. The status of planning and implementation of other hydropower projects both upstream and downstream of LoC will be reported by the M&E Consultant, for various stages of the project cycle such as expression of interest, feasibility study, letter of interest, letter of support, tariff approvals, financial close, construction, and operation.

Population

Population of communities living adjacent to the river is a proxy indicator for water quality of the river, as the quantity of pollutants discharged into the river will be proportional to the population. Estimates for Kotli city or information available from the census, and data for the villages included in the socioeconomic baseline in the ESIA will be collected and reported by the M&E Consultant after an interval of three years.

Land Use

Land use is direct indicator of habitat conversion and proxy indicator for water and air pollution associated with anthropogenic activities. Through analysis of Google Earth imagery, the percent of land under different use categories that are relevant to biodiversity such as forest, scrubland, agriculture, and built up property and infrastructure will be reported once every five years. Analysis will be done by the M&E Consultant for each management section, and for segments extending to 500m from the river flood line and form 500 to 2.5km from the flood line.

8.2.2 Monitoring Indicators – State

Exhibit 8.2 summarizes the monitoring requirements for indicators of state of biodiversity. The M&E Consultant will be responsible for collection and reporting of information. Information on the following indicators will be collected and reported.

- Hydrology
- Water quality
- Geomorphology
- Fish
- Macro-invertebrates
- Periphyton
- Otter

- Riparian vegetation
- Terrestrial vegetation
- Terrestrial fauna

The draft monitoring programs for indicators of state and the survey methodologies are included in **Appendix E.** The methodologies will be adjusted and adapted over time where required to facilitate assessment as described further in **Section 8.4** below.

Exhibit 8.2: Framework for Monitoring of Indicators of State

No.	Outcome	Data required	Method	Sampling frequency, timings and locations	Data format	Field equipment	Data analysis
Hydrology							
1.	Discharge time series	Average daily discharge	Obtain from existing gauging stations and dam operation	Continuous monitoring at EF Site 2 (environmental and operational releases from Dam) and 3 (release from power house and flow from EF site 2)	Excel spreadsheet	None	Assessment of changes in hydrology using principal indicators listed in Section C.1.
Water Quality							
2.	In situ measurements of temperature	Time series measurements of temperature	Use of temperature data logger	Continuous at EF Site 2	Temperature time series data	Temperature data logger	Difference in seasonal and diurnal patterns relative to baseline
3.	Laboratory Analysis	Concentration of major anions, cations and some heavy metals in collected water samples	Methodology for Surface Water Collection in USEPA, Environmental Investigations – SOPs and Quality Assurance Manual	Once a year at EF Site 2 during December/January	Concentrations of selected variables at selected site downstream of dam.	Bottles, note book, , long-arm water sampler, cool box / freezer; preservatives from accredited laboratory	Compare values with thresholds of concern (e.g. toxicity effects on biota; trophic state changes, drinking water standards); Identify anomalous or unusual patterns e.g. change in data trends which require explanation / raise concern (e.g. heavy metal concentrations)

No.	Outcome	Data required	Method	Sampling frequency, timings and locations	Data format	Field equipment	Data analysis
Geomorphology							
4.	Channel planform	Fixed point photographs of sensitive reaches	Fixed point photographs.	Once a year during the low flow season (December/January) at EF Site 1, 2 and 3.	Geo-tagged photographs of selected reaches	GPS; camera	Annual assessment of the changes in low flow planform of flow-sensitive multiple channel reaches
5.	Channel shape	Surveyed cross-sectional profiles.	As described in Appendix G, Eco-hydraulics of ESIA of Gulpur Hydropower Project	Once every 3 years at EF Site 2 during the low flow season (December/January)	MS Excel spreadsheet	Total station, tripod, prism and poles	Assess changes in the width and/or depth of the active channel relative to the baseline (2014) condition.
6.	Bed sediment size	Bed-surface sediment size distribution of sensitive (secondary channel) habitat.	Bed-surface sediment size distribution of sensitive (secondary channel) habitat using the step-point survey	Annually during the low flow season at EF Site 1, 2 and 3 during the low flow season (December/January)	Sediment size distribution curve	Tape measure; GPS	Assess changes in the bed sediment distribution relative to the baseline (2014) condition.
Fish							
7	Fish community composition, and size distribution	Catch per unit effort and relative abundance of indicator fish species, species diversity, population size structure, fish size distribution	Cast netting in August/September Gill netting in December/January Measure weight, total length of fish collected	Twice a year at specified locations in the Poonch River during August/September and December/January	Species lists and catch per unit effort in Excel Mean weight and fork length in excel	Cast nets Gill nets Bucket Fish measuring board Scale Plastic bags	Relative abundance, Catch per unit effort of indicator fish species, index of fish community health and condition. Species diversity

No.	Outcome	Data required	Method	Sampling frequency, timings and locations	Data format	Field equipment	Data analysis
							using Shannon Weiner index Size frequency distribution and fish weight
8	Gonad Development	Stage of gonad development	Dissect fish and identify stage of gonad development	Once a year in May/June in tributaries	Excel	Dissection box	Comparison of stages of gonad development and breeding success with baseline conditions
9	Assessment of available fish habitat	Description of habitat according to flow and substratum size	Describe habitat at each study site qualitatively according to the estimated abundance of flow and substratum size. Take photographs	Twice a year in August/September and December/January at specified locations in Poonch River where fish sampling is conducted	Semi-quantitative description of fish habitat	100-m measuring tape Notebook and pencil Camera Ruler	Relative proportions of each habitat type
Macro-invertebrates							
10	Species richness and diversity	Species lists (higher taxonomic levels where unavoidable)	Field: Semi-quantitative (10 min) kick-net samples of invertebrates from two hydraulically different areas (deep fast rapid; shallow rapids with riffle and run)	Once a year in August/September at specified locations in Poonch River	Species list, annotations on distribution	Sampling jars, 96% ethanol, labels, alcohol-proof marker, kitchen pot scrubbing brush, 250 µm box sampler or net sampler, 250 µm sieve, forceps, data sheets.	Calculate and compare inter-annual change in species richness, diversity, contribution to diversity of higher taxonomic structures e.g. order

No.	Outcome	Data required	Method	Sampling frequency, timings and locations	Data format	Field equipment	Data analysis
			Laboratory: sort invertebrates from debris, identification of species or higher taxonomic level where spp. identification not possible.				
11	Macro-invertebrate community structure	Genus / species lists and abundance; information on Functional Feeding Group (FFG)			Species-by-site/date/habitat arrays for multivariate analysis		Summaries of the proportion of FFG per site / sampling; Multivariate analysis using PRIMER / PERMANOVA
Periphyton							
12	Periphyton biomass	Five replicate samples of the algae and periphyton covering submerged stones in run biotope: Chlorophyll a and algal ash-free dry weight density per unit area	Field: Surface material scrubbed from five medium cobbles per site; samples stored on ice in the field, frozen within 24 hours. Measure stone diameter along three perpendicular axes, x,y,z. Laboratory: Prior to freezing, 30 ml sub-sample	Once a year in December/January at specified locations in Poonch River	Chl a and AFDW density (mg m^{-2} stone surface)	Jars, labels, toothbrushes, depth measuring stick, measuring tape, portable ice-box, syringe, forceps, plastic jug, Lugols solution	Calculate differences in periphyton biomass between sites and years using a Kruskall-Wallas ANOVA / Dunn's post-hoc comparisons.

No.	Outcome	Data required	Method	Sampling frequency, timings and locations	Data format	Field equipment	Data analysis
			removed for A2. Subdivide rem. sample; extract chlorophyll according to specified protocols; filter and obtain dry weights of second half of sample.				
Otter							
13	Otter population size estimate	Location and number of Otter latrine sites	Noninvasive Latrine Survey methodology as described in Mowry et al. (2011)	Once a year in dry season (December/January) at specified locations along River and tributaries	Excel datasheet	GPS Camera Measuring tape	Population size estimated using scats per latrine and latrines per kilometre. Linear regression used to estimate changes in population
Riparian vegetation							
14	Riparian vegetation community structure	Vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the plant species	Transect method	Once annually in August/September at specified locations along River and tributaries	Excel	Tape measures / ropes; data sheets; plant press, specimen bags and sample labels	Multivariate analysis package such as PRIMER

No.	*Outcome*	*Data required*	*Method*	*Sampling frequency, timings and locations*	*Data format*	*Field equipment*	*Data analysis*
Terrestrial vegetation							
15	Terrestrial vegetation community structure	Vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the plant species	Transect method	Once every three years in April/May	Excel	Tape measures / ropes; data sheets; plant press, specimen bags and sample labels	Multivariate analysis package such as PRIMER
Terrestrial Fauna							
16	Terrestrial fauna community structure	Species richness (number of species observed) and abundance (number of individuals of each species observed) with a focus on the vulture species	Transect method	Once every three years in April/May	Excel	Tape measures / ropes; data sheets; identification keys, Sherman troops	Multivariate analysis package such as PRIMER

8.2.3 Monitoring Indicators – Response

Exhibit 8.3 summarizes the monitoring requirements for indicators of response to the implementation of BAP. The M&E Consultant will be responsible for collection and reporting of information. Information on the following indicators will be collected and reported.

- Policies, laws, and regulations
- Institutional capacity
- Awareness among stakeholders and their concerns
- Financing for conservation of biodiversity
- Hatchery performance

A combination of qualitative and quantitative techniques will be employed. Reports will be prepared and discussed with the key stakeholders once every three years. The first report will be more comprehensive and will provide an overview of the existing policy and institutional framework relevant to protection of biodiversity in the area of concern for the BAP. Subsequent reports will show improvements or deterioration with respect to the baseline conditions over a period of time.

Exhibit 8.3: Framework for Monitoring of Response Indicators

Indicator	*Scope/Coverage*	*What to monitor*	*Method*	*Frequency*	*Responsibility*
Policies, laws, and regulations	Overview of relevant policies, laws, and regulations at state level. Aspects of special concern for implementation of BAP	Adequacy for supporting the implementation of the BAP with respect to protection, habitat improvement, and stakeholder inclusion.	Identification of changes in policies and legislation and assessment of expected impacts	Once in three years	M&E Consultant
Institutional capacity	Primary: Fisheries and Wildlife Department, Forest Department Support: Mines and Minerals Department, District Administration, police.	Adequacy of the structure, level of staffing, and capacity of staff. Facilities and equipment available.	Identification of changes in staffing, facilities, and equipment and assessment of expected impacts on performance	Once in three years	M&E Consultant
Financing of conservation in Poonch River Mahaseer	Government spending on wildlife protection and management in Poonch River	Adequacy of financing and trends, whether increasing or decreasing in real terms.	Review of expenditure reports of the Department	Once in three years	M&E Consultant

Indicator	Scope/Coverage	What to monitor	Method	Frequency	Responsibility
National Park	valley.				
Awareness	Awareness among primary stakeholders including communities and secondary stakeholders including concerned government officials and civil society in Poonch River valley on value and importance of biodiversity	Level of awareness and trends over time, as well as concerns and perceptions of stakeholders	Sample surveys in target communities	Once in three years	M&E Consultant
Hatchery performance	Required procedures for egg handling, development of fingerlings and transportation of fingerlings to river are being followed.	Number of fish fingerlings and fries released in river	Review of annual reports of hatchery	Once in every year	M&E Consultant

8.2.4 Setting up the Monitoring and Reporting System

A data collection, monitoring, and reporting system will be set up in the first year of project construction, and will define the framework for the production of Annual Data Report. This exercise will consist of:

Design:

- Finalize indicators from DRIFT database and elsewhere for inclusion in the monitoring program.
- Finalize monitoring techniques for indicators identified above.
- Where applicable and possible, in conjunction with MPL and/or other responsible authorities, review and amend standard monitoring procedures to meet need of EFlow monitoring program and to ensure that internationally accepted norms are adhered to.
- Finalize design of program: objectives and scope; finalize allocation of tasks, sites, sampling times, methods, and budget.

Organization:

- Appoint suitable management, analysis, field and reporting staff.

- Independent review, adjustment and ratification of EFlow monitoring work plan
- Source accredited laboratories for water quality and sediment analyses. Ensure field data/samples collected as agreed, and immediately analyzed and formally interpreted/integrated. Develop reporting templates.
- Set up quality control measures, such as duplicate/blank samples for water quality analysis, cross check biological species identifications, identify and appoint reviewers.

Site and Infrastructure Setup:

- Check data collection and logging systems
- Full discipline team visits each site to establish extent and access, to place markers, locations for sampling, including: fixed-point photographs; cross-sections; habitat mapping; Establish sampling routines to be followed by technical staff.
- Design and develop at appropriate EFlow Monitoring Database or suite of databases for receiving and basic analysis of monitoring data, and reporting.

8.3 Assessment of Impact of BAP Actions

The Annual M&E Report will cover the assessment of impacts of BAP actions described in **Section 6.3** and will primarily consist of review of trends in indicators, and analysis to evaluate to the extent to which the BAP has contributed to improvements in biodiversity if any. Targets for achievement of net gain over the life of the project will be defined against the predictions made for change in indicators under the Enhanced Protection or Pro 2 Scenario as described in Section 6.10 of the ESIA, 'Conclusions of EFlow Assessment'. Time series of predicted changes in ecosystem indiactors such as fish over a 50 year period for the three EFlow Sites included in the specialist report 'Environemtnal Flow Assessment' included in Appendix H of the ESIA will be used as guidelines to define the dynamic targets for achievement of net gain in biodiversity.

Conceptually, assessment of the extent to which net gain in biodiversity has been achioeved can be a challenging task as a number of variables not in control of the Department and Mira Power Ltd. will contribute to improvement in or worsening of biodiversity in the area of concern, mainly the Poonch River. Examples are hydrology including major flood and drought events, climate change, quantity, quality, and treatment of waste water that flows or seeps into the river and tributaries from the population centers in the Poonch River Valley, and construction of hydropower projects upstream of LoC. In addition, as Section 6.1.2 of the Environment Flow Assessment specialist report states that 'the influence of the management options takes c. 5-10 years to take effect, and so the early part of the record can be quite different from the middle and later parts'. In other words, deterioration in the indicators will continue in the initial period of implementation due to the inherent inertia and time for the ecosystem indicators to respond to the management measures implemented under the BAP. A robust approach to setting up the monitoring and reporting system is outlined in **Section 8.2.3**, and has been separately budgeted for in this BAP.

Following the Pressure-State-Response framework, the following approach is proposed for assessment of Impacts of the BAP:

- Review and assessment of trends in pressure indicators once every year
- Semi-quantitative assessment of ecosystem state indicators once every year initially, and decreasing the frequency to once in two to three years if the net gain targets for biodiversity are achieved
- Review and assessment of trends in response indicators once every year
- Comaprison of changes in ecosystem state indicators with predicted changes to establish the extent to which net gain in biodiversity has been achieved
- Review of the factors that may have contributed to changes ecosystem indicators and recommendations for adaptive management

Data and information on hunting, killing and trapping of wildlife (**Exhibit 8.1**) will be analyzed to determine the extent to which the watch and ward system strengthened under the BAP has been effective in reducing the pressures. Trends and developments in planning and construction of infrastructure in the Poonch Valley, and land use patterns, factors that are primarily not in direct control of the BAP, will be reviewed to identify areas in which policy level advocacy and interventions can be initiated by the Department and stakeholders. The objective will be to generate a response that can lead to reduction in pressures in the long term.

Indicators of the state of the ecosystem (**Exhibit 8.2**) will be monitored using defined sampling procedures and protocols included in **Appendix E**. A quantitative review of trends (e.g. fish captured at a sampling point, signs of otters recorded, vegetation cover, and water quality) will be combined with a qualitative explanation of the factors that could be contributing to the trends observed. The factors could include pressures on the system as reflected by the trends in pressure indicators such as hunting and trapping or hydrological and weather related events such as floods and droughts. An annual assessment of state of the ecology, both terrestrial and aquatic, will be carried out in this manner.

Trends and developments in policy, legal, and institutional frameworks, availability of financing for conservation, and level of awareness among the stakeholders (**Exhibit 8.3**) will be assessed to determine their adequacy for supporting conservation and achieving a reduction in pressures in the long term.

8.4 Reports and Reporting Frequency

The scope and frequency of the reports, as already discussed in this section, are summarized in **Exhibit 8.4**.

Exhibit 8.4: Monitoring and Evaluation Reports

Report No.	*Title of the Report*	*Prepared by*	*Scope*	*Review by*	*Frequency and Timing*
1	Quarterly Watch and	Implementati on	Summary of violations and incidences of special	Management Committee	Two weeks after the end

Report No.	Title of the Report	Prepared by	Scope	Review by	Frequency and Timing
	Ward Report	Organization	concern Quantity and distribution of sand and gravel mining, and related violations		of the quarter
2	Annual Data Report	M&E Consultant	Data report outlining data sets, graphs, quality control issues and measures implemented.	Management Committee	February every year. Frequency may be decreased to once in two or three years if the conditions stabilize and targets are achieved.
3	Biodiversity Assessment Report	M&E Consultant	Review of pressure, state, and response indicators, trends, and key developments Recommendations for adaptive management with focus on response indicators.	Management Committee Wildlife Management Board Key Stakeholders	March every year. Frequency may be decreased to once in two or three years if the conditions stabilize and targets are achieved.

8.5 Institutional Arrangements

The institutional arrangements for monitoring and evaluation are outlined in **Section 6.2**. Responsibilities for preparation and review of reports are given in **Exhibit 8.4**.

8.6 Budget for Monitoring and Evaluation

The Quarterly Watch and Ward Report will be prepared by the Implementation Organization, and the cost of this report will be included in the annual budget of this organization.

The M&E Consultant will prepare the Annual Data Report and the Annual Biodiversity Assessment Report. The budget for these reports is included in **Exhibit 8.5**. The ecology and water quality surveys will be conducted at least once before the operation of the dam to re-establish the baseline conditions following the monitoring and evaluation set up as described in **Section 8.2.4**. Subsequently, the surveys will be conducted for the first three years following the creation of obstruction in the river to get a better understanding of the impacts of the Project on ecology. The frequency of the surveys may be decreased to once in two or three years, depending on the achievement of net gain and confidence developed in the results.

Exhibit 8.5: Budget for Monitoring and Evaluation

No	*Activity*	*Amount, US $*
Setting up the Monitoring and Reporting System, One Time Cost		**$43,200**
Annual Data and M&E Report		
1	Hydrology	$4,200
2	Hydraulics and channel shape survey (once in three years at EF Site 2)	$8,680
3	Biota and water quality surveys	$30,840
4	Assessment of use of river resources	$7,200
5	Data report and annual report	$18,480
	Total	**$69,400**

Appendix A: Permission for Construction and Operation

See following pages.

FROM : FAX NO. :92012017 21 May. 2014 03:42AM P2

AZAD GOVERNMENT OF STATE OF JAMMU & KASHMIR
DIRECTORATE OF WILDLIFE & FISHERIES

No 1941-43 Dated 21-05-2014

Mira Power Limited
Islamabad

Subject: **Permission for Construction and Operation of 100 MW Gulpur Hydropower Project.**

Dear Sir,

This is in reference to your letter No. PD/Permission/FPA/10624/2014, dated 10-05-2014. The Department has reviewed your request in light of the applicable legislation and the information provided in the EIA submitted to the AJK EPA by your Company. Permission to construct the 100 MW Hydropower Project in the Poonch River Mahaseer National Park is hereby granted subject to the following conditions:

1. The Project will support achievement of betterment of the national park as required under the law. This will be done through the implementation of a Biodiversity Action Plan (BAP) as outlined in the EIA for which Mira Power will provide the necessary support.

2. The BAP will be prepared by Mira Power in consultation with the Department and will be implemented after the approval of the Biodiversity-Action-Plan by the Department.

3. Mira Power will enter into an Agreement with the Department which will specify the roles and responsibilities of each party in implementation of the BAP and implementation arrangements.

4. An NOC for construction of the Project will be obtained by Mira Power from the AJK EPA following the approval of the EIA by the Agency.

5. Mira Power will provide periodic monitoring reports to the Department as specified in the BAP.

Sincerely,

21/5/2014
(Javaid Ayub)
Director Wildlife & Fisheries.

Cc:
1. The Secretary Forests, Wildlife & Fisheries AJK
2. The Director General, AJK Environmental Protection Agency.

FROM : FAX NO. :92012017 21 May. 2014 03:41AM P1

AZAD GOVERNMENT OF STATE OF JAMMU & KASHMIR
DIRECTORATE OF WILDLIFE & FISHERIES

No. 1944-48 Dated 21-05-2014

The Director General
Environmental Protection Agency
Muzaffarabad

Subject: Permission for Construction and Operation of 100 MW Gulpur Hydropower Project.

Sir,
Kindly refer to the request for permission by Mira Power for Construction and operation of the 100 MW Gulpur Hydropower Project in the Poonch River Mahaseer National Park. The Department has granted conditional permission as per the attached communication to Mira Power copied to you. Kindly note that the Department is highly concerned about the location of such projects in the National Park which is home to 37 species of fish including the Endangered Mahaseer for protection of which the national park was established, and the Critically Endangered Kashmir Catfish found in the national park. The Department has granted permission for the Project as an exception, recognizing that the Project will achieve betterment of the national park and provide much needed power which is important for the economic growth of AJK and Pakistan. Kindly note that consistent with the law the Department will follow the same principles embedded in the law in reviewing any subsequent application for permission to establish a hydropower or any other project in the Poonch River Mahaseer National Park, or for that matter any other national park in the AJK. We therefore suggest that AJK EPA consider the following while reviewing EIAs for projects proposed in the national parks in the AJK in future:

1. The projects should demonstrate achievement of betterment of the national park over the life of the project compared to the prevailing baseline conditions.

2. Specifically for the Poonch River Mahaseer National Park, the baseline conditions for all future projects will be considered as those that will be achieved in the long term following the implementation of the Biodiversity Action Plan as specified in the EIA for the Gulpur Hydropower Project and as approved by the Department. Subsequent projects if any will therefore have to demonstrate improvement over and above that projected to be achieved by implementation of the Biodiversity Action Plan as a part of the Gulpur Hydropower Project.

Sincerely,

21/5/2014
(Javaid Ayub)
Director Wildlife & Fisheries.

Cc: 1. The Secretary, Forest Wildlife & FisheriesGo. AJK
2. The Director General Private Power Cell.AJK.
3. The Managing Director Hydro Electric Board AJK.
4. Mira Power Ltd. Islamabad

Appendix B: Background Information Document

January 2014

Background Information Document Environmental Impact Assessment of Gulpur Hydropower Project

Introduction

Mira Power Limited (MPL) is an Independent Power Producer (IPP) developing the Gulpur Hydropower Project in Azad Jammu and Kashmir (AJK). It is a run-of-the-river project being developed in private sector on Build, Own and Operate Basis under Policy for Power Generation Projects 2002 promulgated by the Government of Pakistan (GoP) and adopted by the government of AJK.

MPL has initiated an Environmental Impact Assessment (EIA) to assess the biodiversity impacts, inclusive of terrestrial ecology and ecology of the Poonch River and likely environmental and socioeconomic impacts that may result from Project activities and to mitigate any potential negative impacts. The EIA process and the report will meet national regulations and international environmental guidelines.

MPL has acquired the services of Hagler Bailly Pakistan (HBP) (Pvt.) Ltd. to undertake the EIA study. Southern Waters from South Africa and National Engineering Services Pakistan (NESPAK) are supporting HBP in this study.

As part of the EIA process, consultations are undertaken with communities and institutions that may have interest in the Project or may be affected by the Project (the "Stakeholders") to record their concerns and to address them in the course of project design and preparation of the EIA. For informed consultations with the Stakeholder, this Background Information Document (BID) has been prepared to provide information on the project design, its setting, EIA process, potential impacts that will be the subject of the study, and the process to be followed for environmental impact assessment.

The BID is subject to changes as further information on some aspects of the Project become available during the course of the EIA.

Project Setting

The Project site is located in the Kotli district of AJK, about 11 km south of Kotli town on the Poonch River, a tributary of Jhelum River. The site is about 167 km from Islamabad and 285 km from Lahore. The project setting is shown in **Exhibit 1**.

The Poonch River originates in the western foothills of Pir Panjal range, in the areas of Neel-Kanth Gali and Jamian Gali. The steep slopes of the Pir Panjal form the upper catchment of this river. It is a small gurgling water channel in this tract and descends along a very steep gradient until it reaches in the foothill areas. The river widens as more and more tributaries from both sides enter into the main river. The upper catchment is covered by dense forests while the vegetation of the middle and lower region is under intense biotic pressure. Poonch River from the line of control to Kotli town has steep slope (6.9-8.3 m/km) and the valley is narrow. Below Kotli, the river gradient is relatively mild (3.7 m/km). The river ultimately joins the Mangla reservoir near Chomukh in Mirpur district of Azad Jammu and Kashmir. The photographs of project area are shown in **Exhibit 2**.

The Poonch is a warm water river and the water temperature approaches 30^{o}C during the summer months At least twenty-nine species of fish are reported from the Poonch River. The River is also the refuge for the Golden Mahseer fish (*Tor putitora*) in Pakistan, which is listed “Endangered” in IUCN Red List of Threatened Species[90] and is an important food and recreational fish. To conserve the Mahseer fish and the other ecological resources of the Poonch River, the AJK Wildlife and Fisheries Department has declared the entire stretch of the Poonch River as National Park.

Project Outline

The Project is a 100 megawatt (MW) power generation facility with annual generation capability of 465 gigawatt-hour (GWh). **Exhibit 3** illustrates the layout of the Project.

The Project will require construction of a 58 meter high weir on the upstream bend of the Poonch River, about 6 km downstream of its confluence with Bann Nullah, a tributary of Poonch River. The intake of the tunnel will be located on the right side near the weir. A surface powerhouse will be located about 1 km downstream of the weir. Two or three tunnels (depending on the number of units chosen), each about 180 m long, will connect the intake to the powerhouse. The water after passing through the powerhouse will be discharged back into the Poonch River.

[90] IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 24 July 2013.

Exhibit 1: Project Setting

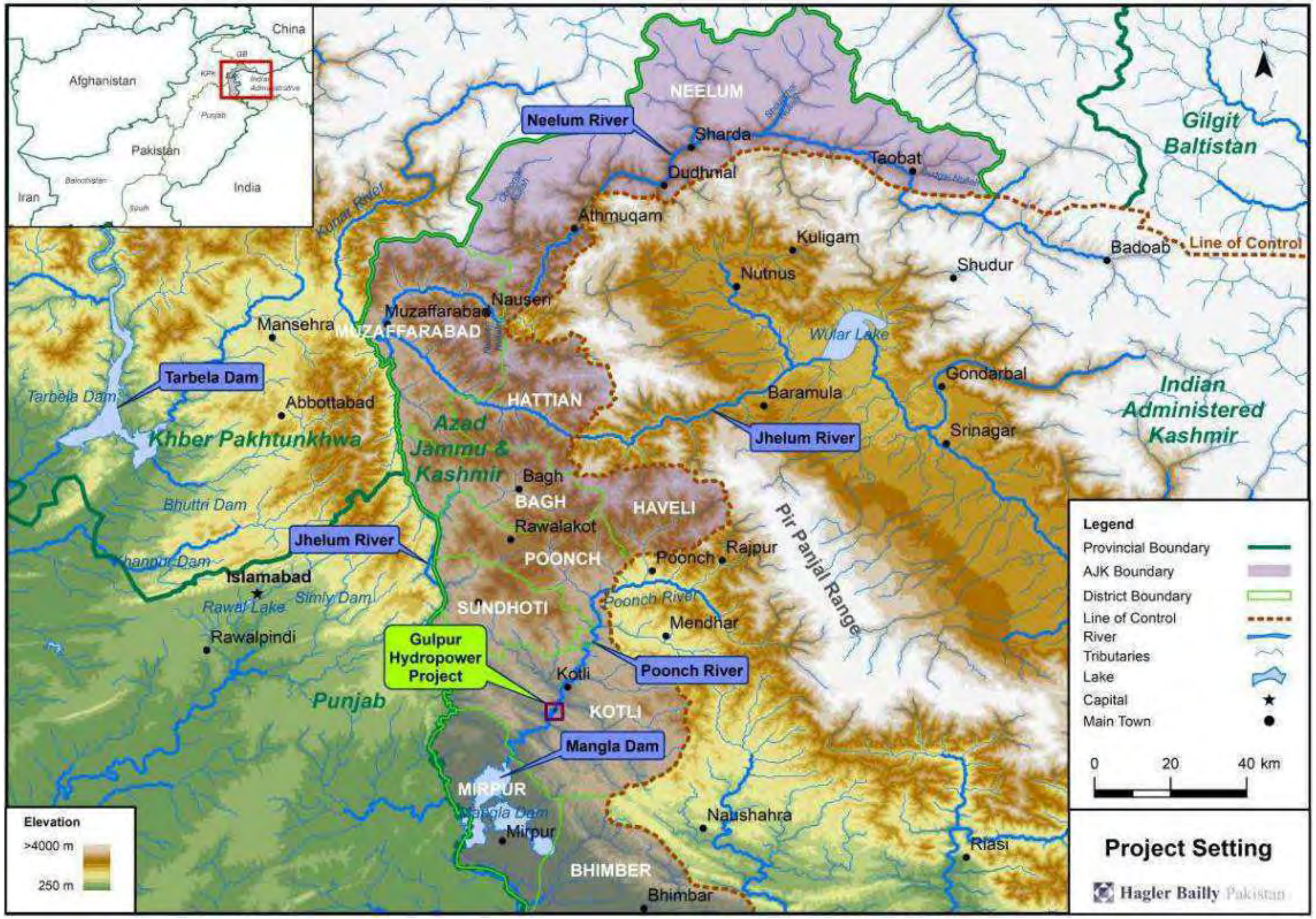
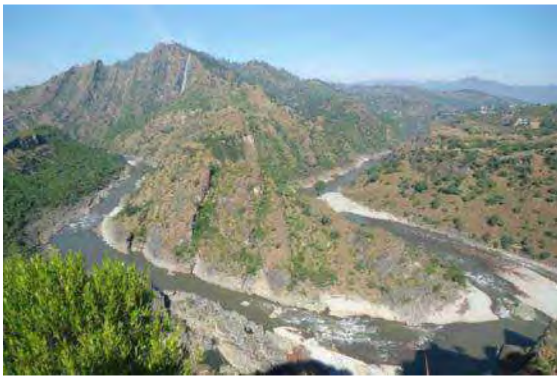


Exhibit 2: Photographs of the Project Area




View of the Project Site

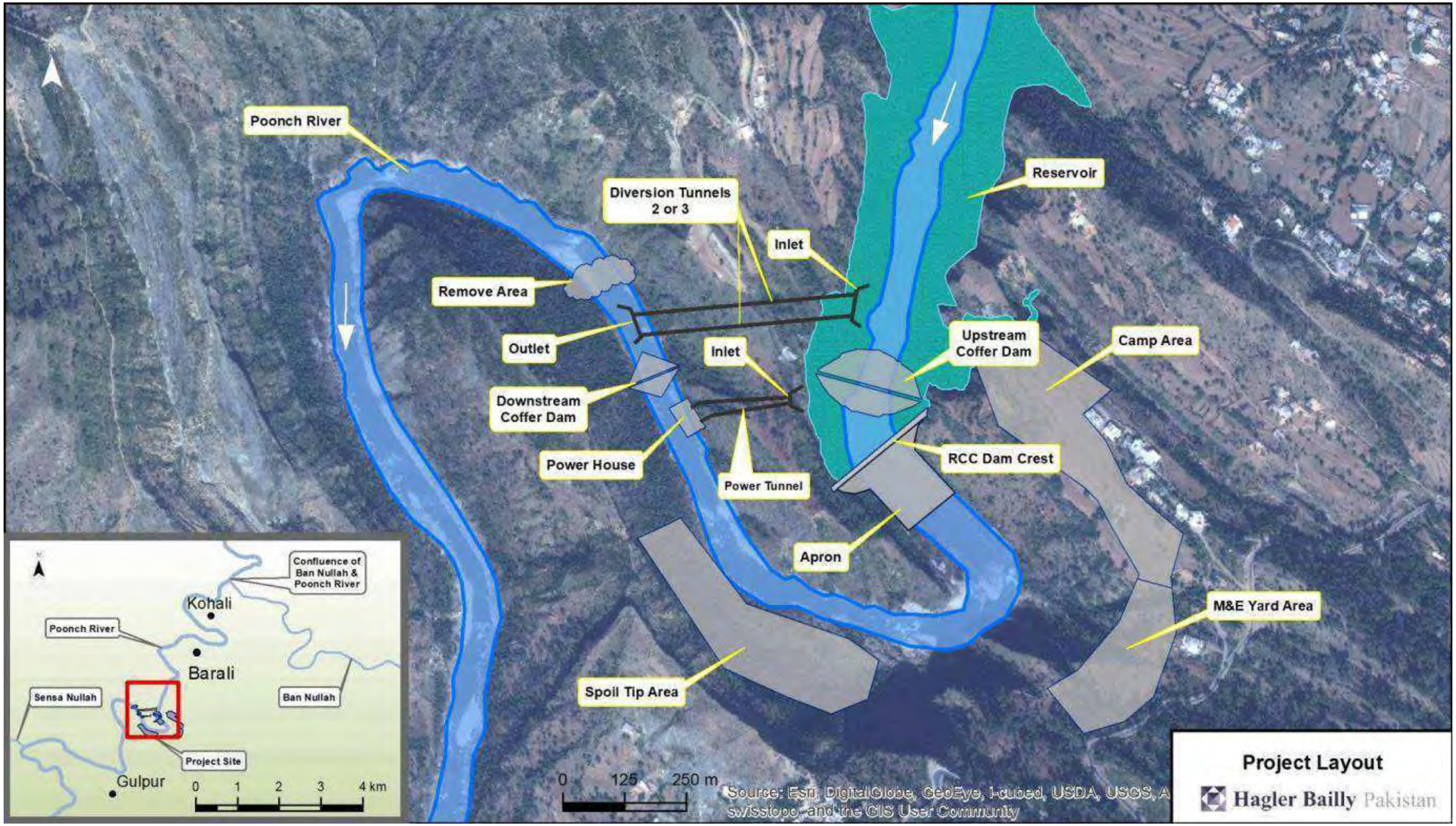
Bann Nullah at Manil

Confluence of Bann Nullah & Poonch River

Poonch River Upstream of Kotli

View of Poonch River at Kotli City

Exhibit 3: Project Layout



Approach to the EIA

The study will be undertaken in compliance with relevant national legislation and international guidelines. The major components of the study include:

- comprehensive baseline studies to characterize the existing ecological environment in the project area;
- a public consultation process to ensure that project stakeholders are informed of the project development plan and have an opportunity to influence it;
- input to the project planning process to ensure that ecological constraints are considered in project design;
- a comprehensive analysis of the ecological impacts of the project, both negative and positive; and,
- suggested mitigation measures to address the identified impacts.

A brief overview of the conceptual components of an EIA process that meets both Pakistan and international standards is given in **Exhibit 4,** whereas the detailed process to be followed for the study of ecological impacts of the Project is provided in **Exhibit 5**. A preliminary list of potential environmental and social impacts of the Project and a list of biodiversity issues that will be investigated during the EIA are provided below.

List of potential environmental and social impacts
• Provision of employment to people
• Creation of service-sector jobs, procurement of consumables and the outsourcing to local service providers.
• Construction related impacts such as noise and dust
• Reduction in power outages and revival of the affected economies
• Increase in traffic due to Project related transportation
• Disturbance due to blasting, dust, noise, vibration, road congestion, and safety hazard from heavy traffic
• Damage to infrastructure due to blasting and noise nuisance due to blasting, drilling and batching plant
• Changes to existing social and cultural norms
• Pressure on existing infrastructure as a result of influx of job seekers
• Impact on sand mining and gravel extraction
• Contamination of soil
• Transformation of landscape
• Physical displacement resulting in disruption of existing socioeconomic setup
List of biodiversity issues
• Reduction in water quality and quantity
• Changes in sediment load of river

List of potential environmental and social impacts
• Changes in the geomorphology of the river
• Fragmentation of fish habitat
• Damage to natural flora and fauna and river ecosystem
• Impact on endangered and migratory species

As impacts on the aquatic ecology due to the project are of critical importance, Hagler Bailly Pakistan (HBP) will employ the DRIFT (Downstream Implications of Flow Transformation) approach to assess the changes in flow regime of the river on fish and other river dependent wildlife. DRIFT is a holistic approach that employs a multidisciplinary team to analyse the likely effects on a range of flow scenarios, and has been tested in Himalayan rivers in the AJK. The DRIFT Process is shown in **Exhibit 6**. Its aim is to predict changes in the form of three streams of information—ecological, economic and social—that represent the three pillars of sustainable development. It incorporates a custom-built Decision Support System (DSS) that holds all the relevant data, understanding and local wisdom about the river provided by the team of river and social specialists.

The four main aims incorporated into the DRIFT process are to:

1) Synthesize present relevant knowledge on the river ecosystem;
2) Synthesize present relevant knowledge on use of the river;
3) Predict how the river ecosystem could change with water-resource development; and
4) Predict how these river changes could affect people and the economy.

Exhibit 4: Conceptual Components of an EIA Process

Component	*Main purpose*	*Activities related to Stakeholder Consultations*
Scoping	▶ Identify the issues on which the EIA should focus. ▶ Identify project alternatives that should be evaluated during the course of the EIA.	▶ Identify institutional and community stakeholders ▶ Engage stakeholders and record issues raised ▶ Provide feedback to the EIA team to incorporate stakeholders' concern in baseline investigations and impact assessment
Baseline investigations	▶ Collect background information on the environmental and social setting of the project.	▶ Incorporate additional issues raised during the baseline survey
Impact assessment, studies	▶ Define the potential impacts of the project ▶ Undertake specialist investigations to predict changes to environment due to the project	▶ Assess issues raised by stakeholders

Component	*Main purpose*	*Activities related to Stakeholder Consultations*
	▶ Determine the significance of the potential impacts ▶ Identify measures for the management of the impacts ▶ Determine the residual impacts of the project after incorporation of the management measures. ▶ Evaluate the overall acceptability of the project (from environmental and social perspectives).	
Mitigation Measures and management plan	▶ Environmental mitigation and monitoring plan will describe the measures proposed to ensure implementation of the mitigation measures identified during the impact assessment. It will include, for example, specific designs and plans, training requirements, resource requirements, monitoring details (sampling locations, methodology, and frequency), review and reporting requirements and budget.	▶ Assess the acceptability and practicability of the proposed mitigation measures
EIA Report Preparation	▶ After the studies, the EIA team will pull together the detailed assessment of impacts and mitigation measures. This may involve liaison with various specialists to ensure correct interpretation of information and compile EIA report.	▶ Provide stakeholders with a feedback on the EIA specifically communicate how the project proponent proposes to address the issues raised by the stakeholders.
EIA submittal to regulatory authorities and decision making	▶ Submittal and review of the EIA report by regulatory authorities and other interested stakeholders. The reviewers will inform about their decision on the acceptability of the Project from environmental and social perspectives and the conditions of approval for the development	▶ Attend the public hearings and respond to the issues raised during the public hearings.

Exhibit 5: Detailed Biodiversity Assessment and Management Process

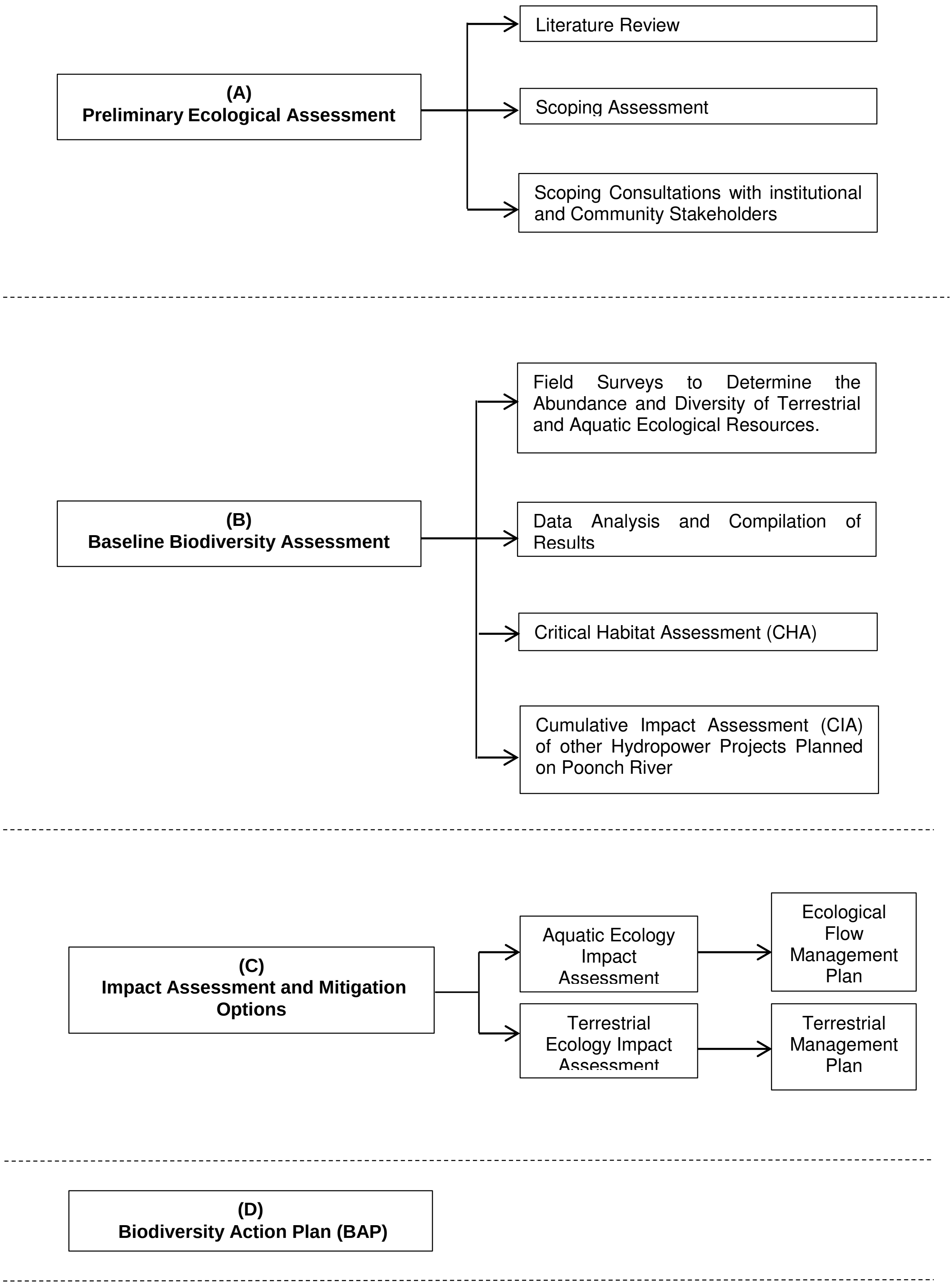
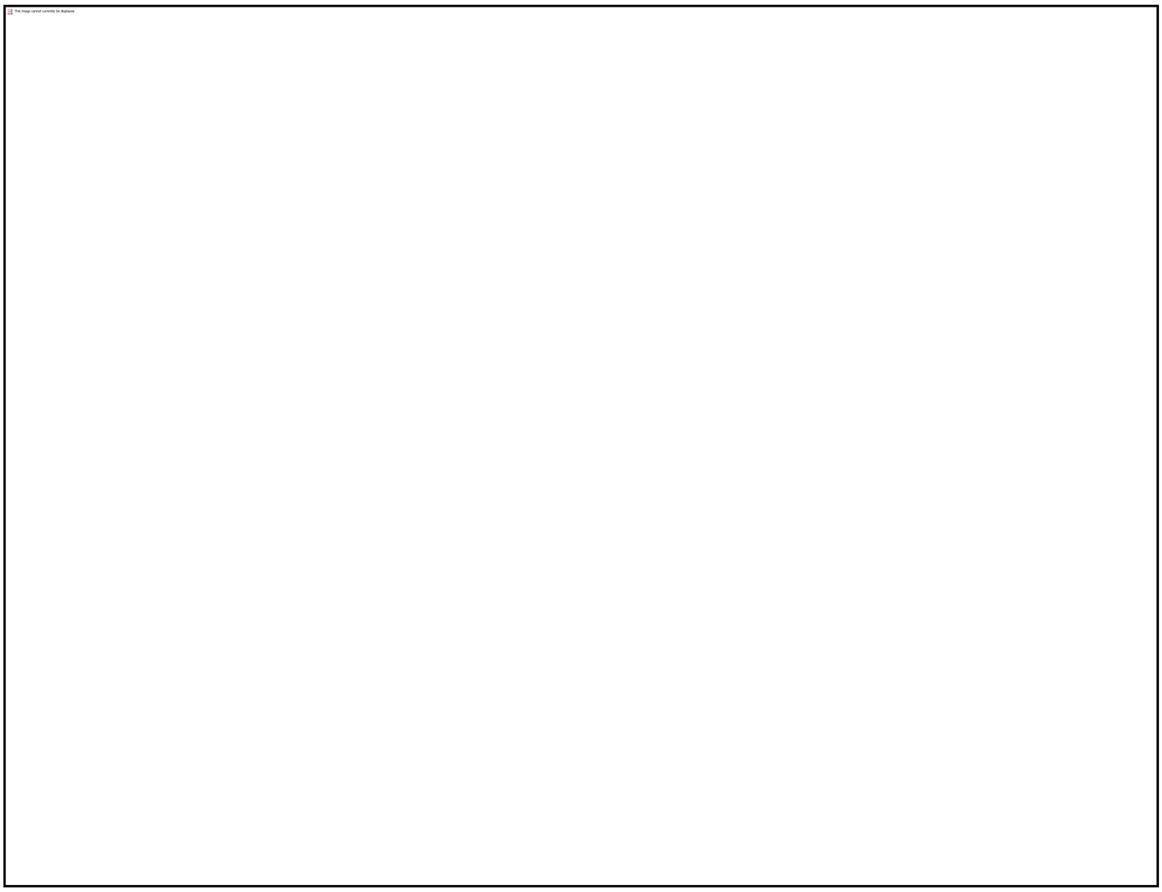


Exhibit 6: DRIFT Process



For further information on the study please contact:

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Appendix C: Outline of Sediment Mining Management Plan

C.1 Management of Impacts of Sediment Mining in the Poonch Basin

This section is based on the discussion, analysis and recommendations in the report included in **Appendix F of ESIA of Gulpur Hydropower Project.** , 'Possible Mitigation Strategies with respect to Sand and Gravel Mining in Poonch River Basin'[91].

The Environmental Flow scenarios for Gulpur HPP (**Section 6**) included evaluation of three protection levels affecting the non-flow related human induced impacts on the riverine ecosystem.

- Protection Level 1 (Pro 1) = maintain 2013 levels of non-flow-related pressures on the river; i.e., no increase in human-induced catchment pressures over the next 50 years.
- Protection Level 2 (Pro 2) = reduce 2013 levels of non-flow-related pressures by 50%, i.e., decline in pressures (relative to 2013) over the next 50 years.
- Protection Level BAU = Business as usual - increase non-flow-related pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next 50 years.

Thus, in terms of sediment mining in the Poonch Basin, the 50-year targets were:

- Protection Level 1 (Pro 1) = no increase in mining impacts;
- Protection Level 2 (Pro 2) = 50% reduction in mining impacts;
- Protection Level BAU = doubling of mining impacts.

Given that it is entirely plausible that the demand for sediment will continue to increase over the next fifty years, achieving the Protection Level 2 will necessitate management and control that will limit the impact of mining on the river in the face of increased demand/volumes being abstracted. This could be achieved using one or more of the following strategies:

1. Focus mining activities in non-sensitive areas
2. Ban mining in sensitive areas
3. Implement on-site control and management of mining activities
4. Rehabilitate/restore habitats already destroyed by mining
5. Use of alternatives sources of aggregate for the Project including the following:
    a. reuse spoil
    b. quarries for aggregate

[91] Prepared by Fluvius Consultants and Southern Waters, March 2014.

C.1.1 Focus mining activities in non-sensitive areas

Arguably the best way to achieve the proposed reductions in mining impacts is to focus mining activities in fewer areas where they can be better managed as this will reduce the area of sediment mining, reduce mining in sensitive areas and potential reduce the direct site-specific impacts. The construction of Gulpur dam would present an opportunity for doing just this. As discussed in **Section 7.5**, it is expected that large quantities of sediment will become trapped at or slightly upstream of the upper end of the reservoir in an area that is both close to Kotli and easy to access.

Although the feasibility of implementing a large-scale mining operation in the head waters of the Gulpur reservoir is subject to confirmation, initial indications suggest that:

1. the quantities likely to be deposited annually will exceed the (very) preliminary estimates of 2013 demand for sediment and probably exceed demand for quite some time to come[92] (**Section 5.3**)[93];
2. roads could be constructed/existing roads improved to allow for easy and safe access to the area;
3. since sediment loads are highest in the wet season, much of the sediment would probably be deposited above the normal operating level as reservoir levels and backup effects tend to extend upstream in the wet season;
4. if necessary, access to the sediments, particularly the smaller size fractions, could be enhanced by lowering the operating level of the dam in the dry winter months;
5. current mining operations within a 10-15 km radius of the backup zone could be relocated to the backup zone without subjecting the miners to undue additional travel or transport costs (E**xhibit C.1**);
6. it possible that some (or all) of the activities further afield than the 10-15 km radius, such as those of the upper Bann Nullah (**Ehibit C.1**), can also be relocated to the back-up of Gulpur dam, depending on the location of the target market for sediments mined in these areas;
7. similar initiatives have been successfully implemented elsewhere, for instance:
    i. at Inanda Dam on the Mgeni River (South Africa), sediment mining in the backup zone upstream of the dam is promoted to reduce sedimentation of the reservoir (**Exhibit C.2**).
    ii. in Yorkshire (UK) sediment from reservoirs is used for potting soil, which is sold commercially Halcrow[94].

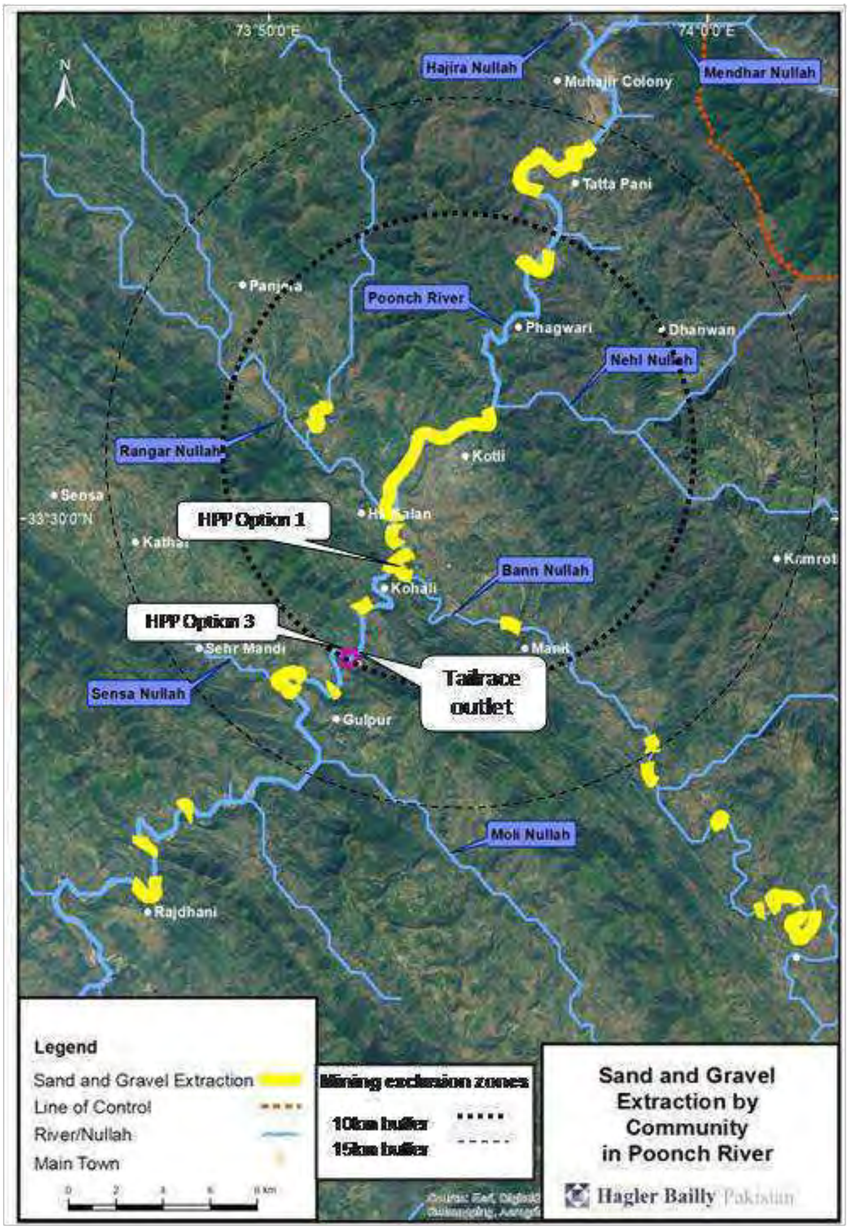
[92] The assumptions regarding sediment deposition locations and volume estimates require validation in the form of detailed backflooding and sedimentation studies of the proposed reservoir. These verification studies would be undertaken as part of a detailed feasibility study of the identified mitigation options.

[93] The quantity of sediment extracted in the stretch of the river downstream of the LoC to the Mangla reservoir is estimated at 224,500 m^3

[94] Halcrow Water. 2001. Sedimentation in storage reservoirs. Department of Environment, Transport and the Regions. 82 pp.

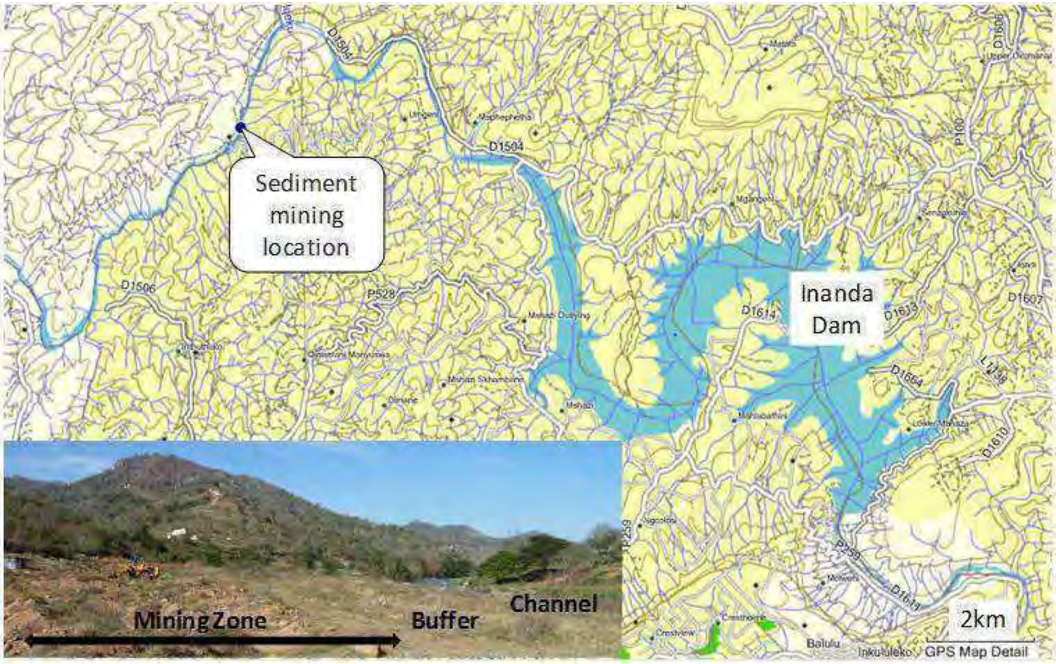
Outside of the 10-15 km radius, mining operations can also be focused on fewer, better controlled areas that avoid the sensitive habitats. The selection of appropriate sites for sediment mining should be based on local knowledge or information regarding aggradation (sediment deposition) rates; where the proposed operation can minimize disturbance and maximize stability of channel; and where in-stream sites are located where the channel loses gradient or increases in width, and deposition occurs unrelated to regular bar-pool spacing in channel (such as upstream of a bedrock constriction or backwater, or at deltas created near confluences.[95]

Exhibit C.1: The 10 and 15 km Radii around the Backwater Areas of the Gulpur Reservoir



[95] Garcia River Gravel Management Plan. Philip Williams & Associates, Ltd., San Francisco, 1996.

Exhibit C.2: Inanda Dam on the Mgeni River (South Africa), sediment mining in the backup zone upstream of the dam is promoted to reduce sedimentation of the reservoir



As mentioned above (Inanda Dam), mining sediments from the back-up zone may also reduce sedimentation in Gulpur reservoir, prolonging the life of the dam and/or reducing the need for sediment flushing (Basson and Rooseboom[96]).

C.1.2 Ban mining in sensitive areas

It is unlikely that provision of a focused mining area (or areas) alone will reduce sediment mining in the sensitive areas. This will need to be accompanied by a prohibition on mining in sensitive areas, particularly in the tributaries and at the confluences between tributaries and the main river. Such a ban could include:

- Limiting access (or implementing road closures using barriers or decommissioning roads) to sensitive zones of the river.
- Policing of the restricted, sensitive breeding areas of the rivers and tributaries.

This could be achieved through development of a sediment mining plan in conjunction with authorities and miners to scale down operations in sensitive areas and relocate those operations to less sensitive reaches (cf. **Exhibit C.2**). Collaboration with the Fisheries Development Board, Pakistan, and AJK Fisheries and Wildlife Department should be sought, as they have proposed similar measures (http://www.fdb.org.pk/documents/mnp.pdf, accessed February 2014). Note: A two year

96 Basson, G.R. and Rooseboom, A. 1999. Dealing with reservoir sedimentation. South African ICOLD Bulletin 115.

ban on sediment mining in the Poonch River, and total ban on extraction of sand and gravel at the confluence of the nullahs, with the offer of alternative sites to miners, was requested in 2012 by the Fisheries Development Board[97].

C.1.3 Implement on-site Control and Management of Mining Activities

Where sediment mining is allowed, the localized and downstream impacts of operations could be reduced through on-site control and management measures. These could include:

1. License mining activities according to volume based on measured annual replenishment, and with conditions regarding method of mining (following best practice guidelines), location, timing and volumes of extraction permissible[98];
2. Implementation of setbacks and buffer zones (which could include placement of berms) between the sediment extraction areas and the low flow channels in order to reduce low flow season impacts. These should ensure:
   a. that excavations are set back at least 5 m from the main low flow channel bank;
   b. that the maximum depth of mining is > 1 m above natural channel elevation, as determined by pre-mining surveys, to prevent channel shift.

1. Employing more environmentally-friendly extraction methods (**Box 1**);
2. Minimize activities that release fine sediment to the river;
3. Avoid the removal of any vegetation;
4. Retain a buffer (at least 5-10 m) between the low flow channel and the mining operations;
5. Limit in-stream operations to the dry season (DID)[99]; and
6. Implement a program of compliance monitoring and control.

[97] (http://www.fdb.org.pk/documents/mnp.pdf).

[98] Garcia River Gravel Management Plan. Philip Williams & Associates, Ltd., San Francisco, 1996.

[99] Department of Irrigation and Drainage (DID). 2009. River Sand Mining Management Guidelines. Department of Irrigation and Drainage, Ministry of Natural Resources and Environment Jalan Sultan Salahuddin, Kuala Lumpur, Malaysia.

Box 1: Less-Damaging Methods for Sediment Removal

Kondolf et al.[100] identified several methods of sand and gravel mining operations that are less damaging than the more commonly employed methods.

Bar scalping or skimming

Bar scalping or skimming is the extraction of sand and gravel from the surface of bars. Historical scalping commonly removed most of the bar above the low flow water levels, leaving an irregular topography. Present methods generally requires that surface irregularities be smoothed out and that the extracted material be limited to what could be taken above an imaginary line sloping upwards and away from the water from a specified level above the river's water surface at the time of extraction
(typically 0.3 - 0.6 m).

Bar scalping is commonly repeated year after year to maintain the upstream hydraulic control provided by the riffle head. The preferred method of bar scalping is generally to leave the top one-third (approximately) of the bar undisturbed, mining only from the downstream two-thirds.

Bar Excavation

In this sediment extraction method, a pit is excavated at the downstream end of the bar as a source of aggregate and as a site to trap sand and gravel. Upon completion, the pit may be connected to the channel at its downstream end to provide side channel habitat. This method reduces the area of disturbance.

A combination of these measures would assist to regularize the sediment mining activities in the Poonch Basin, and to reduce the localized and downstream impacts associated with such.

Cooperation could be enhanced through the development of guidelines or best practice principles for sediment mining operations to which an association of sediment miners could subscribe. This should take in to account buffer zones between the mining operation and active (low flow) channels; ecologically sensitive methods of sediment removal, as well as the overarching focus of only removing sediment at appropriate (less sensitive) extraction sites.

C.1.4 Rehabilitate habitats already destroyed by mining

Reactivate secondary channels near Kotli

The reach of the Poonch River adjacent to Kotli shows signs of changes in course. In particular, comparison between 1970 maps and 2011 Google images (**Figure C-3**) suggest that at least two secondary channels in this reach have been abandoned during the last few decades. Although it is not possible to identify the reasons for these abandonments without more extensive investigation, the river reach around Kotli has

[100] Kondolf, G.M., Smeltzer, M. and Kimball, L. 2001. Freshwater Gravel Mining and Dredging Issues. Washington Departments of Fish and Wildlife, Ecology, and Transportation, Olympia

been extensively mined and there are signs of bank stabilization that indicate an incising reach. It is thus possible that the secondary channels have been abandoned due to the incision (down-cutting) of the active channel in response to sediment extraction. Incision of the active channel and abandonment of secondary channels is a common response to the reduced sediment availability associated with sediment mining Kondolf[101].

The top map in **Exhibit C.3** (derived from a 1970's USSR Topographic map) indicates two secondary channels which have been abandoned. Their alignment is indicted in the lower 2011 Google image. Secondary channel abandonment is a common response to sediment mining, and there has been extensive sediment extraction from the river in the vicinity of Kotli.

Exhibit C.3: Two secondary channels opposite the town of Kotli appear to have been abandoned in recent decades

[101] Kondolf, G.M. 1997. Hungry Water: Effects of dams and gravel mining on river channels. Environmental Management, Volume 21 (4):533-551.

Experience in similar mountainous rivers and discussions with local experts indicate that these types of secondary channels represent areas of slower velocity in the flood season and are important fish refugia in fast, steep rivers. The reconnection and rehabilitation of these secondary channels, to allow for annual flooding and the creation of additional instream habitat area for fish species, could be assessed:

1. as a potential off-site mitigation option to reduce (offset) the effects of inundating kilometers of the dam,
2. to potentially reverse some of the impacts of sediment mining on river habitat, and
3. to improve the physical habitat upstream of the dam.

Similar restoration initiatives are showcased at http://wildfish.montana.edu/Cases.

Once mining operations have been moved from sensitive tributary areas, the river will gradually reset. However, this natural restoration could be accelerated through judicious site specific manipulations of the channel.

C.1.5 Alternatives sources of aggregate

A reduction in the sediment mining pressures in the river could be achieved if alternative sources of building aggregate could be found, such as:

1. Reusing surplus spoils: surplus spoils from the construction of the Gulpur HPP could be stockpiled for use.
2. Using open rock quarries on hillsides rather than using river sediment as source of gravels.

Neither of these has been considered in any detail at this stage, but can form part of the considerations in developing a Sediment Mining Management Plan for the basin.

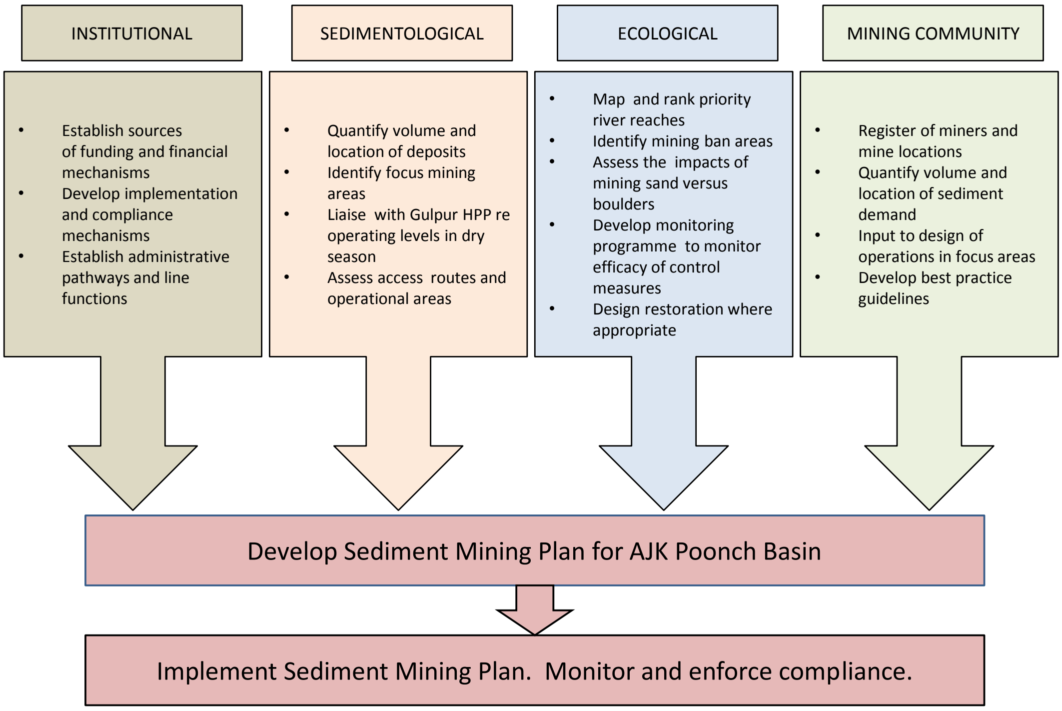
C.2 Outline of Key Components of Sediment Mining Management Plan to Achieve Protection Level 2

The main challenges in implementing protection measures for sediment mining in the Poonch Basin are:

1. the level of integration required between technical, legal, administrative and political processes, and the private and government sectors;
2. the need for extensive public participation, and broad governmental and societal support, both during the technical work and for legislating the outcomes; and
3. the need for interventions that depend on people changing their perceptions and behavior.

To achieve the mining targets for Protection Level 2 (50% reduction in impacts), these challenges will be focused in preparation and implementation of a Sediment Mining Management Plan that is supported by technical data, considers trade-off between ecological protection and the requirements of the miners and the community at large, and enjoys broad-based support from both the community and the authorities that will be responsible for its implementation. The key activities required to develop Sediment Mining Management Plan are summarized in **Exhibit C.4**.

Exhibit C.4: Key activities required for a Sediment Mining Management Plan to achieve Protection Level 2



These have been arranged according to four categories:

1. The institutional (legal and administrative) provisions that need to implement protection measures.
2. The modeling and other technical studies required to determine the location, quality and quantity of sediment deposits linked with Gulpur HPP, and to assist with identification of other focus areas.
3. The confirmation of the key ecological sites or reaches within the system needed to identify no-go or restricted use reaches to inform the trade-offs between ecosystem protection and mining locations.
4. The necessary engagement with the affected mining operators in order to ensure that their needs are considered in, and where possible integrated into, the process.

In reality, however, there will need to be considerable co-operation across these areas to produce the technical information, management mechanisms and buy-in required to ensure successful implementation of the protection measures.

Institutional

The key legal and administrative activities required include:

1. Establish/implement sources of funding and financial mechanisms: The Biodiversity Action Plan for Gulpur HPP will identify avenues for generating funds for the implementation of Protection Level 2 measures for fishing, sediment mining and use of riparian vegetation. However, appropriate mechanisms will still need to be designed and implemented to finance the acquisition of technical information; the formation of stakeholder associations; construction of access roads, and; the ongoing costs of management, administration, monitoring and reporting.
2. Develop implementation and compliance mechanisms.
3. Establish administrative pathways and line functions.

Sedimentological

The key technical activities required include:

1. Quantify volume and location of deposits: A two-dimensional hydraulic model will need to be developed based on existing hydrological and sediment records and used to predict the areas and volume of sediment deposition in the backup zone of the Gulpur reservoir. This critical aspect of work should determine the volumes and accessibility of the sediment deposits associated with the proposed reservoir. This information will contribute to an assessment of the feasibility of focusing mining activities in this area, and be used to inform the need for additional focus areas, whether the operation of Gulpur dam should consider mining and the design of access road and operational areas.
2. Identify other focus mining areas: It may not be possible to relocate mining activities downstream of Gulpur dam to the back-up zone of the dam, but this does not necessarily mean that the impact of these activities could not be reduced by focusing mining in less sensitive reaches. Any decisions with respect to this would need to include:
    a. economic in terms of transportation cost.
    b. ecological considerations as the fish in that section of the river will be cut off from their favored breeding areas in the upper catchment.

1. Liaise with Gulpur HPP operators: if necessary, the possibilities of manipulating the operating levels of Gulpur dam to increase dry-season access to smaller sediments should be explored.
2. Undertake an assessment of the access routes and the operational areas: Whether existing routes will do or upgrading or new access roads will be required. Also, are there sufficient spaces to organize operations where the different sediment sizes are deposited, e.g., for boulders, is there an area where stone crushers for producing aggregate can be placed.

Ecological

The key technical activities required include:

1. Map and rank priority river reaches: Sensitive and important river reaches in the tributaries and mainstem will need to be identified and ranked to provide input to decisions about where sediment mining should be restricted to protect instream habitat. This information will be needed to evaluate the potential of tradeoffs between mining activities and biodiversity protection.
2. Assess the relative ecological impacts associated with sand and gravel mining versus cobble and boulders mining.
3. Identify mining ban areas. In liaison with miners, authorities and based 1 and 2 above and on data provided by the sedimentological technical studies (**Appendix F, ESIA of Gulpur Hydropower Project.**).
4. Develop monitoring programme to monitor efficacy of control measures.
5. Design restoration where appropriate: The cost and benefits of undertaking restoration in areas previously destroyed by sediment mining will been to be evaluated based on the extent to which mining activities can be relocated, the importance of the areas (see 1 above), damage caused by previous activities and whether this damage will reset naturally once mining has stopped. Such an assessment may be particularly important downstream of Gulpur dam as the fish in that section of the river will be cut off from their favoured breeding areas in the upper catchment. Additionally, if deemed necessary to achieve 50% reduction in activities, the secondary channels around Kotli could be examined to determine the potential of reconnecting and rehabilitation of these as summer breeding and nursery habitats.

Mining community

The buy-in of the mining community is possibly the most important aspect of successful implementation of the protection measures directed at sediment mining. How this could be achieved is outside of the ToR for this report, but there is little doubt that this will require extensive consultation. It is suggested that buy-in could be enhanced through the formation of a Miners Association, if this does not already exist. Such an association could elect representatives to provide input to the sediment management plan, and negotiate with authorities on their behalf. It could also be instrumental in:

Developing a register of miners and mine locations.

1. Quantifying volume and location of sediment demand.
2. Providing input to design of operations in focus areas.
3. Developing best practice guidelines: Best Practice Guidelines for sediment mining in the Poonch Basin could be developed by the mining community in liaison with environmental authorities and conservation bodies. These guidelines could then be translated into on-site management and control measures.

The Terms of Reference of the development of a Sediment Mining and Management Plan are given in **Appendix F , ESIA of Gulpur Hydropower Project.** The level of effort anticipated for each of the key project team members is given in **Exhibit C.5**. . An amount for this activity has been included in the budget for implementation of the BAP. Cost of the mining inspectors who will be a part of the watch and ward team and will assist the Department in monitoring and enforcement of the plan is included in the watch and ward budget of the BAP given in **Section 6.6** .

Exhibit C.5: Estimated Level of Effort and Cost for Key Project Team Members to Prepare Sediment Mining Plan

Project team members	*Time in days*	*Cost USD*
Team leader, international	20	$18,000
Fluvial sedimentologist/fluvial geomorphologist, international	26	$26,000
Fish biologist, national	12	$3,600
River restoration expert, international	12	$12,000
Policy and Public Participation Specialist, national	40	$10,000
Travel and accommodation		$13,920
Total		$83,520

The Monitoring and Evaluation programme for sediment mining will be included in the Sediment Mining and Management Plan.

Appendix D: Draft Agreement

See following pages.

Draft Agreement

between

The Government of Azad Jammu and Kashmir

and

Mira Power Ltd.

The **Government of Azad Jammu and Kashmir (GoAJK)** is the legal custodian of Poonch River Mahaseer National Park (PRMNP – national park) and under the Azad Jammu and Kashmir (AJK) Wildlife Ordinance, 2013 is responsible for protection and management of the natural resources within and outside the park area. **Mira Power Ltd. (Company)** aims to support the GoAJK in protection and management of wildlife and ecosystems in the national park and in the vicinity of the Gulpur Hydropower Project (Project) facilities to meet the obligations of the Company as outlined in the Biodiversity Action Plan (BAP) for the Project to achieve net gain in the Critical Habitat of the national park as defined in the BAP. The Company intends to do this by providing material as well as management support to the GoAJK through contractual arrangements with third parties to implement the BAP and to monitor the effectiveness of implementa tion of the BAP. The GoAJK and the Company have agreed to collaborate for implementation of the BAP. This Agreement is signed on _______________ to formalize the working arrangements and to define the role and responsibilities of the Company and the GoAJK in implementation of the BAP.

This Agreement will remain valid in the period of validity of the Power Purchase Agreement entered into by the Company with the designated government agency under the law and can be extended with mutual consent of the parties.

Aware of the importance of wildlife conservation and management for ensuring the betterment of the national park;

Recognizing that collective efforts are required of the government, the Company, the local communities, and NGOs for conserving and managing natural resources;

Considering the desire of the GoAJK and the Company to develop a model for protected area management through collaborative efforts between government organizations sand the private sector;

Cognizant of the opportunity to initiate collaboration between GoAJK and the Company for supporting conservation efforts of the people of AJK;

The GoAJK and the Company, as parties to this Agreement, agree to the following:

The Company shall be responsible for:

1. Providing management support for removal of habitat threats to create environmental conditions for betterment of national park and of biodiversity in areas in the vicinity of Project facilities,

2. Development, testing, and implementation of a monitoring and evaluation framework to assess the achievement of the objectives of the BAP,
3. Providing material support including provision of essential equipment and infrastructure for improvement of national park operations, and
4. Providing recommendations to the Department from time to time for improvements in management of national park and biodiversity in the Poonch River Valley (valley) in which the Project is located.

The Company will fulfill the above obligations through:

1. Providing financial resources in terms of amounts specified in the BAP and at times indicated in the BAP to procure materials and services within the scope of responsibility of the Company, as well as for technical support for preparation of management plan for the Poonch River Mahaseer National Park prior to project operation.
2. Contracting with an Implementation Organization that will procure the materials and deliver the services to fulfill the obligations of the Company for implementation of the BAP. The Company will seek written approval of the AJK Fisheries and Wildlife Department (Department) prior to entering into a contract with the Implementation Organization. The Implementation Organization will preferably be a non-profit non-governmental organization, having capacity and demonstrated experience of at least ten years in implementation of biodiversity conservation programmes in sensitive areas similar to that in the PRMNP.
3. Contracting with a Monitoring and Evaluation service provider that will deliver the monitoring and evaluation services required for the BAP. The Company will seek written approval of the Department prior to entering into a contract with the Monitoring and Evaluation service provider. The Monitoring and Evaluation service provider will be a registered company having capacity and demonstrated experience of at least fifteen years in conducting aquatic and terrestrial biodiversity surveys and preparing assessment reports for sensitive areas similar to that in the PRMNP.

The GoAJK will assign the following responsibilities to the Department, and ensure that these responsibiolites are fulfilled on an on-going basis:

1. Enforce the provisions of the Azad Jammu and Kashmir (AJK) Wildlife Ordinance, 2013 and other applicable legislation in the PRNMP as authorized in the law.
2. Make available existing staff for protection, and coordinate with other government line departments such as police and district administration.
3. Establish a Management Committee for oversight and monitoring of implementation of the BAP.
4. Provide legal autrhority to the saff of the Implementation Organization for exercising powers as permissible under the legistlation and as approved by the Management Committee.

5. Assess the adequacy and effectiveness of the wildlife management systems in place for achievement of the objectives of the BAP,
6. Evaluate the pressures on wildlife resources in the achievement of the objectives of the BAP and emerging threats (hunting and trapping, fishing, grazing, visitors, traffic, violations of park rules, construction of infrastructure, and pollution) ,
7. Use available resources to collect and share data on wildlife relevant to the BAP,
8. Promote and support implementation of conservation projects, mobilization of local communities, and coverage in local media to compliment and strengthen the efforts of the Department and the Company in implementation of the BAP,
9. Construct a hatchery at Moli Nullah for captive brreding of Mahaseer fish utilizing supplemental equipment provided by the Company as indicted in the budget for the BAP.
5. Place a system for registration and review of complaints and follow up conducted to address the complaints related to implementation of the BAP, and
6. Create policy, institutional, and financial frameworks for sustainable management of the national park and biodiversity in the valley, including preparation of a management plan for the PRNMP prior to the operation of the Project with technical support, if required, from the Company..

The parties to this agreement may, by mutual consent, add, modify, amend or delete any word, phrase, sentence or article to this Agreement.

This Agreement shall become effective after it has been signed by the Chief Secretary, GoAJK and the Chief Executive Officer of the Company on the dates affixed hereto. The duration of the Agreement may be modified, shortened or extended, by mutual agreement of the parties concerned.

Within one month of the signing of this Agreement, the Chief Executive Officer of Mira Power Ltd. will designate an officer of the Company who will be authorized to communicate on all matters related to this Agreement with the GoAJK, and with the Department as required for fulfillment of responsibilities specified in this Agreement. The senior most officer of the Department who will either be the Director or Director General will communicate on all matters related to this Agreement on behalf of the GoAJK.

In case of a dispute that cannot be resolved with the mutual consent of the parties, the parties will seek advice from the Director General of the AJK Environmental Protection Agency (EPA) for resolution of the dispute. In case the dispute cannot be resolved under advice from the AJK EPA, then the parties will have the option to seek legal redressal in a court of law in Pakistan. The financial and material obligations of the Company under this Agreement, however, will remain un affected while the case is under consideration of the court of law.

Chief Secretary

Government fo Azad Jammu and Kashmir

Date: ______________________

Chief Executive Officer

Mira Power Ltd.

Date: _________________________

Witnesses:

1.
Name: _____________________________

Designation: _______________________

Dated: _____________________________

2
Name: _____________________________

Designation: _______________________

Dated: _____________________________

Appendix E: Draft Monitoring Program for Indicators of State

The objective of monitoring described in this document is to detect changes in the river ecosystems that are associated with the operation of the Gulpur Hydropower Project in order to determine whether or not these result in a gain or loss of biodiversity. Changes are expected to be driven primarily by changes in the flow regime of the river, and implementation of management measures to protect the biodiversity as described in the Biodiversity Action Plan (BAP).

The monitoring program describes:

- Data collection
- Monitoring locations
- Monitoring schedule
- Data analysis and reporting
- Method statements and sampling protocols

Some aspects of the program, mainly those related to data storage and analysis, are currently incomplete as these will depend on the baseline data being collected. These will be finalized and established by the M & E Consultant in the first year of monitoring and adjusted and adapted over time as described in **Section 8.2.4** and budgeted for in **Section 8.6** of the BAP.

The program includes collection of data for the following parameters:

- Hydrology: the timing and magnitude of flows in the river as these will be the key drivers of ecosystem change;
- Water quality: the quality of the water in the channel including temperature, as this is an important cue for biological lifecycles stages;
- Geomorphology: the availability and distribution of key habitats, such as riffles, backwaters or pools;
- Fish: the abundance, distribution, species composition and breeding success of fish as these contribute to biodiversity;
- Macro-invertebrates: the abundance, distribution and species composition of aquatic macro-invertebrates as these contribute to biodiversity and provide food for fish;
- Periphyton: dominated by benthic algae, periphyton are the primary producers in rivers, providing food for macro-invertebrates and fish;
- Otter: the only aquatic river mammal found in the Poonch River likely to be impacted by flow related changes;

- Riparian vegetation: the abundance, species composition, distribution of the vegetation that lines the banks of the river as these contribute to biodiversity, river stability, channel shape
- Terrestrial vegetation: the abundance, species composition, distribution of the terrestrial vegetation
- Terrestrial fauna: the abundance, species composition, distribution of the terrestrial vegetation

Considerable effort will be expended to ensure that sampling conditions are as similar as possible among years because results vary with differences in flow, time of day, time of year, temperature, weather, habitat type, water clarity, net placement, etc. Comparisons among data collected at periodic intervals will be more meaningful if consistency is maintained sampling procedures and proper quality control is exercised through all stages of data collection. It is also important to use the same sampling sites each year. All sampling sites will therefore be geo-referenced, photographed and marked in the field to allow the same location to be used repeatedly across years. GPS co-ordinates of the proposed sampling locations for monitoring each of the parameters are given in (**Exhibit E.1)** and (**Exhibit E.2**). Sampling protocols are described below.

Exhibit E.1: Proposed Aquatic Ecological Sampling Locations

Sampling ID (EF Site)	*Location*	*Co-ordinates*		*Monitoring Location*						
		Latitude	*Longitude*	*Hydrology*	*Water Quality*	*Geomorp hology*	*Fish*	*Macro-invertebrates*	*Otter*	*Riparian Vegetation*
A-1 (EF Site 1)	River at Kallar Bridge	33°34'44.20"N	73°56'5.40"E			√	√	√	√	√
A-2	River at Confluence with Rangar Nullah	33°30'7.20"N	73°52'43.70"E				√			√
A-3a	River at Barali Bridge	33°28'20.64"N	73°52'9.24"E				√		√	√
A-3b (EF Site 2)	Gulpur Project (Near Rehmani Muhllah	33°27'18.05"N	73°52'1.17"E	√	√	√	√	√	√	√
A-4 (EF Site 3)	River at Gulpur Bridge	33°26'58.10"N	73°50'14.10"E	√		√	√	√	√	√
A-5 (EF Site 4)	River at Billiporian Bridge near Rajdhani	33°22'59.70"N	73°47'24.90"E				√	√	√	√
A-6	Rangar Nullah (Tributary)	33°31'18.34"N	73°50'40.42"E				√	√	√	√
A-7	Bann Nullah near Manil Tributary	33°28'3.70"N	73°55'25.30"E				√	√		√
A-8	Bann Nullah near Khuiratta	33°22'4.70"N	74° 2'18.90"E				√			√
A-9	Kotli City	33°31'47.09"N	73°54'23.16"E				√			√
A-10	Downstream Tatta Pani	33°36'31.36"N	73°55'42.95"E				√			√
A-11	Mendhar Nullah	33°39'18.18"N	73°58'39.20"E				√		√	√
A-12	Downstream Kakuta	33°42'15.20"N	73°57'11.28"E				√	√		√
A-13	Hajeera Nullah	33° 44.351'N	73° 55.659'E				√			√
A-14		33° 26.767'N	73° 51.094'E						√	√
A-15		33° 24.291'N	73° 48.345'E						√	√

Exhibit E.2: Proposed Terrestrial Ecological Sampling Locations

Sampling Location	*Co-ordinates*		*Monitoring Locations*	
	Latitude	*Longitude*	*Birds, Large Mammals and Terrestrial Vegetation*	*Small Mammals*
S-1	33º 29' 32.40"N	73º 51' 19.18"E	√	
S-2	33º 29' 41.70"N	73º 52' 18.70"E	√	
S-3	33º 29' 57.90"N	73º 53' 32.50"E	√	
S-4	33º 29' 50.29"N	73º 54' 49.51"E	√	
S-5	33º 29' 14.52"N	73º 55' 18.63"E	√	
S-6	33º 28' 33.20"N	73º 53' 59.10"E	√	
S-7	33°28'40.70"N	73°51'59.10"E	√	
S-8	33°28'54.86"N	73°50'57.14"E	√	
S-9	33°27'6.40"N	73°51'10.20"E	√	
S-10	33°27'21.60"N	73°52'27.10"E	√	
S-11	33°27'45.80"N	73°53'45.60"E	√	
S-12	33°27'42.90"N	73°54'23.10"E	√	
S-13	33°26'55.20"N	73°53'41.90"E	√	
S-14	33°27'4.15"N	73°51'58.62"E	√	
S-15	33°26'36.80"N	73°51'3.60"E	√	
S-16	33°25'44.70"N	73°52'13.00"E	√	
S-17	33°28'56.90"N	73°53'11.90"E	√	
S-18	33°28'56.90"N	73°53'11.90"E	√	
D-1	33°27'23.10"N	73°51'56.60"E	√	
D-2	33°27'20.80"N	73°51'41.60"E	√	
D-3	33°27'18.90"N	73°51'51.60"E	√	
T3	33°28'22.35"N	73°53'39.58"E		√
T5	33°27'24.89"N	73°52'10.82"E		√
T7	33°28'18.41"N	73°52'14.25"E		√
T6	33°27'6.50"N	73°51'51.78"E		√
T4	33°27'14.90"N	73°52'29.30"E		√
T1	33°29'1.30"N	73°53'1.60"E		√
T2	33°28'33.47"N	73°53'52.00"E		√

E.1 Hydrology

The baseline flows in the Poonch River are currently close to natural but will be altered once the Gulpur Hydropower Project becomes operational. It is in response to these changes that geomorphological, biological and water quality changes may occur, and it is thus important to quantify the flow changes.

E.1.1 Objective

The objective of the hydrological data collection is to generate time series of hydrological data at the three EF sites (**Exhibit E.3**).

E.1.2 Key Indicators for Monitoring

The key indicator for monitoring hydrological flow is the average daily discharge water volumes at the EF Site 2 (downstream of tailrace) and EF Site 3 (downstream of power house), as these are the ones that will be impacted by the project.

E.1.3 Methods for Data Collection

The EF sites selected on the Poonch River are shown in (**Exhibit E.3)**. Details are provided in the ESIA of the Gulpur Hydropower Project. Average daily discharge data for EF Site 2 and EF Site 3 will be collected from gauging stations installed by Dam operations of the Gulpur Hydropower Project.

E.1.4 Sampling frequency, timings and locations

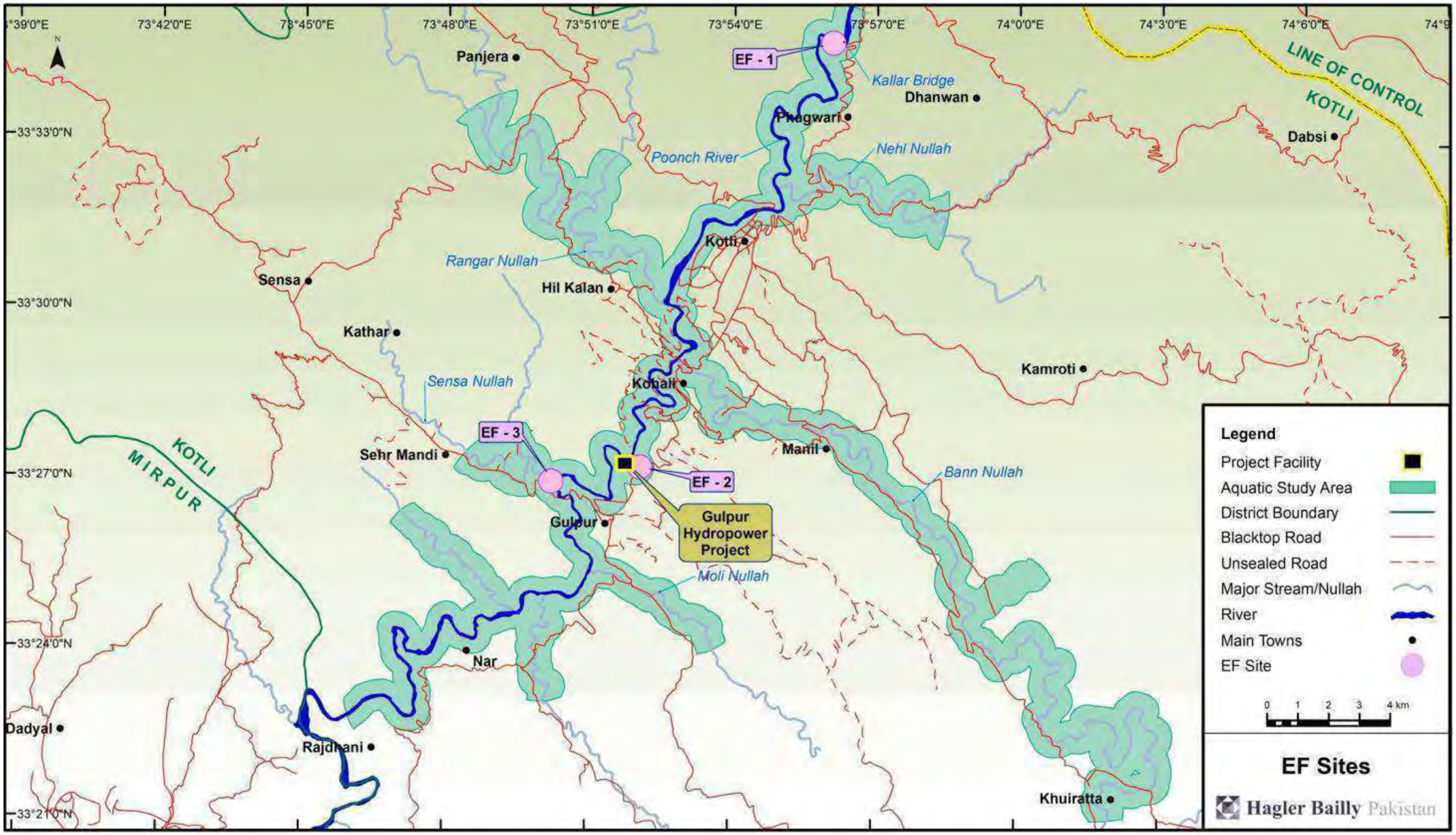
There will be continuous monitoring of average daily discharge water volumes at EF Site 2 and 3 .

E.1.5 Data Analysis

The analysis of operational hydrology involves calculation of the flow indicators used in the EF assessment (ESIA of Gulpur Hydropower Project). Changes in hydrology will be assessed using the following principal hydrology indicators:

- Mean annual runoff
- Median annual runoff
- Dry season onset
- Dry season minimum 5–day discharge
- Dry season duration
- Wet season onset
- Wet season peak 5–day discharge
- Wet season duration

Exhibit E.3: Proposed EF sites on the Poonch River



E.2 Water Quality

Water quality is a composite term describing the physical and chemical properties of water. The water quality of the Poonch river is generally fresh that can be used for irrigation and other non–consumptive purposes. However, the river water is contaminated from the disposal of wastewater effluent from towns, villages and settlements established along the river as well as located in the river drainage area. This particularly implies for the Kotli Town.[102]

E.2.1 Objective

The objective of the water quality monitoring is to

- monitor changes in physico-chemical characteristics of the river reaches to inform interpretation of biological data,
- demonstrate whether or not there are changes to the temperature regime,
- demonstrate whether or not there are changes to the concentrations of major anions, cations and some heavy metals associated with altered flow regimes.

E.2.2 Method for Data Collection

To measure the temperature of water downstream of the dam, a temperature data logger will be installed at the outlet of the power house that will take continuous temperature measurements. The average daily temperatures can be downloaded from the data logger and plotted on a graph. Only one location for measurement of water temperature is specified as change in temperature of water as it goes through the reservoir is not expected to be significant in view of limited storage capacity of the dam (3-4 days storage).

To analyze the water quality, grab samples will be collected from a sampling location downstream of the dam - EF site 2 (**Exhibit E.3**). The methodology described in USEPA, Environmental Investigations – SOPs and Quality Assurance Manual[103] for collection of surface water samples will be followed. The collected samples will be analyzed in a laboratory.

E.2.3 Sampling frequency, timings and locations

Temperature will be monitored continuously at EF site 2 using the temperature data logger.

The water sampling for laboratory analysis will be carried out at EF Site 2 once every year during low flow season (December/January) to ensure that dilution effects are minimum.

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[102] ESIA of Gulpur Hydropower Project

[103] Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, November 2001, U.S. Environmental Protection Agency

E.2.4 Indicators for Monitoring

Water samples collected will be tested for trace metals, BOD, COD, nitrates, phosphates, dissolved solids, and suspended solids. A complete list of all the parameters that will be tested and the reporting format is given in **Exhibit E.4.**

Exhibit E.4: Parameters for Water Quality Testing

Parameters	*Unit*	*LOR*	*NSDW*[104]	*WHO*[105]	*Upstream of Kotli Town*	*Downstream of Kotli Town*
Silver	µg/l		–	–		
Aluminum	µg/l		<200	200		
Arsenic	µg/l		≤50	10		
Boron	µg/l		300	300		
Barium	µg/l		700	700		
Cadmium	µg/l		10	3		
Chromium	µg/l		≤50	50		
Copper	µg/l		2,000	2,000		
Iron	mg/l		≤1.5	1.5		
Mercury	µg/l		≤1	1		
Manganese	µg/l		≤500	500		
Nickel	µg/l		≤20	20		
Lead	µg/l		≤50	1		
Antimony	µg/l		<20	20		
Selenium	µg/l		≤10	10		
Zinc	µg/l		5,000	3,000		
BOD	mg/l		–	–		
COD	mg/l		–	–		
Nitrate	mg/l		–	–		
Phosphate	mg/l		–	–		
TDS	mg/l		<1,000	<1,000		
TSS	mg/l		–	150		
pH			6.5–8.5	6.5–8.5		
Temp.	^{o}C					

104 S,R.O. 1062 (I)/2010, National Environmental Quality Standards for drinking water

105 WGO Drinking Water Standards, 2011, 4th Edition.

E.2.5 Data Analysis

The focus of the analysis of the water quality data is to identify the changes in concentration of these variables as a result of changes in flow or associated interactions. Data analysis will be carried out as follows:

- Identifying change:
  - Plot longitudinal and measured data for each variable.
  - Examine inter-annual change, longitudinal patterns and, if change occurs then identify the trajectory of change.
  - Where relevant, compare data for one variable with data for linked variables, such as those that may influence its toxicity
  - Identify anomalous or unusual patterns.
- Assessment of identified change:
  - Compare values with thresholds of concern (e.g. toxicity effects on biota, trophic state changes, drinking water standards)
  - Identify anomalous or unusual patterns e.g. change in data trends which require explanation / raise concern (e.g. heavy metal concentrations).

E.3 Geomorphology

E.3.1 Objectives and rationale

The objective of the geomorphological monitoring is to record changes to the physical habitat availability and composition that are likely to result from the altered flow and sediment conditions arising from the proposed Gulpur Hydropower Project.

Geomorphology provides a critical link between the hydrology, hydraulic and sedimentological processes at a site and the physical habitats where the biota live. Thus, the geomorphological condition of a system, and changes thereto as a result of a dam, can be used to predict and/or explain changes in biodiversity based in changes in flow-sensitive physical habitats.

In the Poonch River basin, the construction and operation of the Gulpur Hydropower Project will alter the hydrology and sedimentological processes. Sediment trapped in the dam will only be able to move downstream during flushing operations of the dams, during flood peaks and periods of maximum flow when there are high sediment loads. Even then however, much of the coarse sediment fraction is likely to remain trapped in the reservoir. The downstream reaches may therefore experience a deficit of sediment supply relative to natural conditions, and this may result in enhanced erosion of the river banks and bed.

E.3.2 Description of indicators for monitoring and sampling frequency

The geomorphological monitoring will assess how changes in sediment and flows alter the physical habitats of the river. The following indicators will be used

- Channel Planform: Annual fixed-point photographs will be taken over time at the three EF sites (**Exhibit E.3).** These will be used to record changes in channel patterns and gross morphology. Photographs looking upstream and downstream must be taken from the exact same spot at each data collection. This will provide a macro-level assessment of change in riverine habitat. These annotated fixed point photographs will be taken annually in the dry season. The date, GPS co-ordinates, time, flow conditions of river will be noted for each photograph.

- Active Channel Morphology: Cross sectional profile will be taken to provide a quantitative measures of change. The cross sectional profile will be taken at EF Site 2 once every 3 years during the low flow season (December/January).
- Bed Sediment Size: The measurement of the sediment size distribution in secondary channels provides an indication of changes, if any, in the diversity of these habitats. An increase in bed sediment sizes would indicate that the bed of the secondary channel is coarsening. The loss of slower, finer sediment in-channel habitat areas would lead to a reduction in physical habitat diversity. Changes in habitat diversity will have a knock-on effect on biotic diversity. This assessment of bed sediment size will be done annually during the low flow season (December/January) at the three EF sites (**Exhibit E.3**).

E.3.3 Methods for data analysis

- Fixed point photography

  The fixed point photographs should be compared to the baseline data and should demonstrate that secondary channels remain active at the same discharge range (discharge volume will be indicated at each photo period). Some allowance for in discharge at the time the photograph was recorded will be necessary, but in general the annual fixed point photographs should verify that patterns similar to the baseline persist in the identified river sections.

- Cross sectional surveys of the river channel

  The width and depth characteristics of the active channel at selected EF Monitoring site will be compared with the baseline condition. An increase in depth and/or width of the active channel may indicate that the channel capacity is increasing. An increasing active channel capacity will lead to the progressive loss of secondary channel habitats.

- Sediment size distribution in secondary channels

  The Step-point Survey Method (Evans and Love 1957)106 will be used for this assessment. In-field measurement (beta-axis) of at least 500 samples of the bed sediments will be carried out to derive a frequency distribution of sediment size representative of the site. Small sediment fractions will be collected from the slow flowing parts of the channel for laboratory analysis. In addition, a visual semi-quantitative assessment of relative proportion of large versus small sediment areas will be carried out. The bed sediment size data will be standardized to a percentage sediment size distribution curve. This bed sediment size distribution curve for the sampling period will be compared to the baseline data for that site.

[106] Evans, R.A., and R.M. Love. 1957. The Step-point Method of Sampling: A Practical Tool in Range Research. *Journal of Range Management*10:208-212. (*pdf*)

E.4 Fish

Fish are important components of river ecosystems because they are long-lived and integral to aquatic food webs. They are considered key indicators of environmental change because of their varied life history strategies and their sensitivity to a wide range of hydrologic and water quality conditions (Kleynhans 1999[107], Karr 1981[108], Fausch et al. 1990[109]).

E.4.1 Objective and Rationale

The objectives of fish component of the monitoring program are to routinely measure a set of pre-defined indicators that will:

- detect trends in fish populations;
- detect shifts in the community structure;
- identify any loss of biodiversity;
- observe migration and breeding in tributaries

E.4.2 Indicators for Monitoring

The fish indicators that will be used for monitoring are:

- Fish Community Composition
  - Semi-quantitative sampling, e.g., relative abundance of individual fish species (catch per unit effort) with a particular focus on the following indicator fish species:
  - Mahaseer Tor putitora
  - Alwan Snow Trout Schizothorax plagiostomus (richardsonii)
  - Kashmir Catfish Glyptothorax kashmirensis
  - Garua Bachwa Clupisoma garua
  - Pakistani Labeo Labeo dyocheilus
  - Twin–banded Loach Botia rostrata
- Species diversity using Shannon Weiner Diversity Index;
- Population size structure;
- Gonad stages of fish in tributaries during breeding season.
- Available fish habitat

[107] Kleynhans, C.J. 1999. The development of a fish index to assess the biological integrity of South African rivers. WATER SA-PRETORIA-, 25, 265-278.

[108] Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries, 6, 21-27.

[109] FauscH, K.D., Lyons, J., Karr, J.R. and Angermeier, P.L. 1990. Fish communities as indicators of environmental degradation. In: Adams, S. M., ed. Biological indicators of fish stress. American Fisheries Society, Symposium 8, 1990 1990 Bethesda, Maryland.

E.4.3 Sampling frequency, timings and locations

Three fish surveys will be carried out annually: August/September, December/January and May/June.

The August/September survey will provide an outline of the population distribution of the fish in the different fish habitats (pools, riffles etc.). It will be carried out at specified locations in the main river and tributaries in both the main river and tributaries.

The December/January survey will focus on observing the wintering behavior of fish in the pools at specified locations in the main river. Sampling in tributaries will not be done during this survey.

The May/June survey will be conducted in the tributaries to observe the migration of fish into tributaries during the breeding season (May – July) to as well as to observe the developmental stages of the gonads (that will indicate reproductive success).

The sampling locations are shown in **(Exhibit E.7)** and the fish survey form is given in (**Exhibit E.8)**

E.4.4 Sampling Protocol

August/September

Keeping in view the population structure and species diversity, the Mark and Recapture quantitative method was not considered appropriate for the Poonch River.

Cast netting method will be used to collect the fish during the August/September survey. The fish fauna will be sampled using cast nets of two different mesh sizes, 1 × 1cm, having a circumference of 5m for smaller fish, and 2.5 × 2.5cm having circumference of 10m for larger fish to include all possible size and age variations. Twenty casts, 10 with each kind of net, will be made alternatively at 10 different sampling points at each sampling station, located at a distance of about 100 m from one another along the length of 1 km, starting from downstream to upstream to minimize the impact of adjacent netting. Thus each sampling station will be sampled by a total of 20 casts of nets (10 of each size). The specimens collected from each sampling point will be collected in a bucket, and will be photographed and identified in the field. Number of specimens of each species will be counted and then released. The specimens will be weighed and the body length noted. The voucher specimens will be preserved in 10% formaldehyde solution in the field. All the specimen data and the relevant auxiliary information will be recorded in the data sheet specially designed for these studies.

For assessment of the fish habitat, a rapid visual assessment of the sampled areas will be undertaken. The river habitat (**Exhibit E.5**) and substratum size **(Exhibit E.6)** will be noted.

Exhibit E.5: Morphological Units for Fish Habitat

Category	*Description*
Pool	Deep (>1 m), current speed is barely detectable, little or no disturbance to the surface of the water
Riffle	Fast shallow water, bed particles usually protruding through the surface of the water, trickling flow and small broken standing waves.
Run	Deep (>0.5 m) fast flowing, little or no disturbances on the surface of the water.
Rapid	Deep (>1 m), fast flowing water, disturbances on the surface of the water, large broken standing waves evident.

Exhibit E.6: Substratum Size Classes: estimate of the proportion and size of the bed particles available to fish to use for hydraulic and predation cover or for reproduction

Category	*Size*	*Description*
Silt/Sand	<0.063-2	Mud to course grit
Gravel	2-64	Finger nail to length of small finger
Small Cobble	64-128	Wrist to halfway along finger
Large Cobble	128-256	Elbow to wrist
Boulder	>256	> Armpit to wrist
Bedrock	-	Slabs of rock

December/January

For winter survey gill nets will be used. Focus will be on sampling in pools. Gill nets are effective sampling tools for the collection of commercial fish species. Fish are caught when they become entangled in the mesh. Nets are set in an area from which collections are sought, usually left overnight, and checked the next day. The gill nets generally employ several panels (sections) of various mesh sizes in succession rather than one mesh size throughout the length of the net. This allows a more complete collection of various size classes of most species, as well as smaller species that may not be taken with larger mesh nets. The length and depth of gill nets varies according to size of the pools but 30 m x3 m gill nets with 25-mm, 38-mm, 51-mm, 64-mm, and 76-mm mesh sizes will be used.

For assessment of the fish habitat, a rapid visual assessment of the sampled areas will be undertaken. The river habitat (**Exhibit E.5**) and substratum size **(Exhibit E.6)** will be noted.

May/June

Sampling will be confined to the tributaries during the May/June survey. The fish collected during this survey will be dissected to observe their gonad development. This survey will provide some information about the migratory patterns of the fish and their reproductive health.

E.4.5 Method for Data Analysis

The following method for data analysis will be used:

- Fish community composition: The relative abundance and fish population structure will be assessed. The bi-annual surveys of fish (August/September and December/January) will produce a list of species in each reach plus related information such as relative abundance (Catch Per Unit Effort) and fish size, which will be used to determine whether species are being lost from the system; whether populations are declining or increasing and whether this is attributable to changes in recruitment success or changes in adult mortality.
- Gonad Development: Fish collected during the May/June survey of the tributaries will be dissected to observe the gonads. Relevant keys will be used to determine the gonad stage of both the male[110] and female fish[111] and compared with baseline conditions to identify any anomalies.
- Assessment of fish habitat: Bi-annual assessments of available habitat in terms of river habitat types and substratum size compared with baseline and the requirements of the species in the rivers will be used to give an indication of factors that may be causing or contributing to fish population trends, e.g. whether critical habitats are being lost or created.

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[110] (Smith, B.B. and K.F. Walker (2004). Spawning dynamics of common carp in the River Murray, South Australia, shown by macroscopic and histological staging of gonads. *J. Fish Biol.* **64** (2) 336-354).

[111] Murua, H.; Kraus, G.; Saborido-Rey, F., Witthames, P.R., Thorsen, A. and S. Junquera (2003). Procedures to estimate fecundity of marine fish species in relation to their reproductive strategy. *J. Northwest Atl. Fish. Sci*. **33** 33-54

Exhibit E.7: Proposed Sampling Locations for Fish

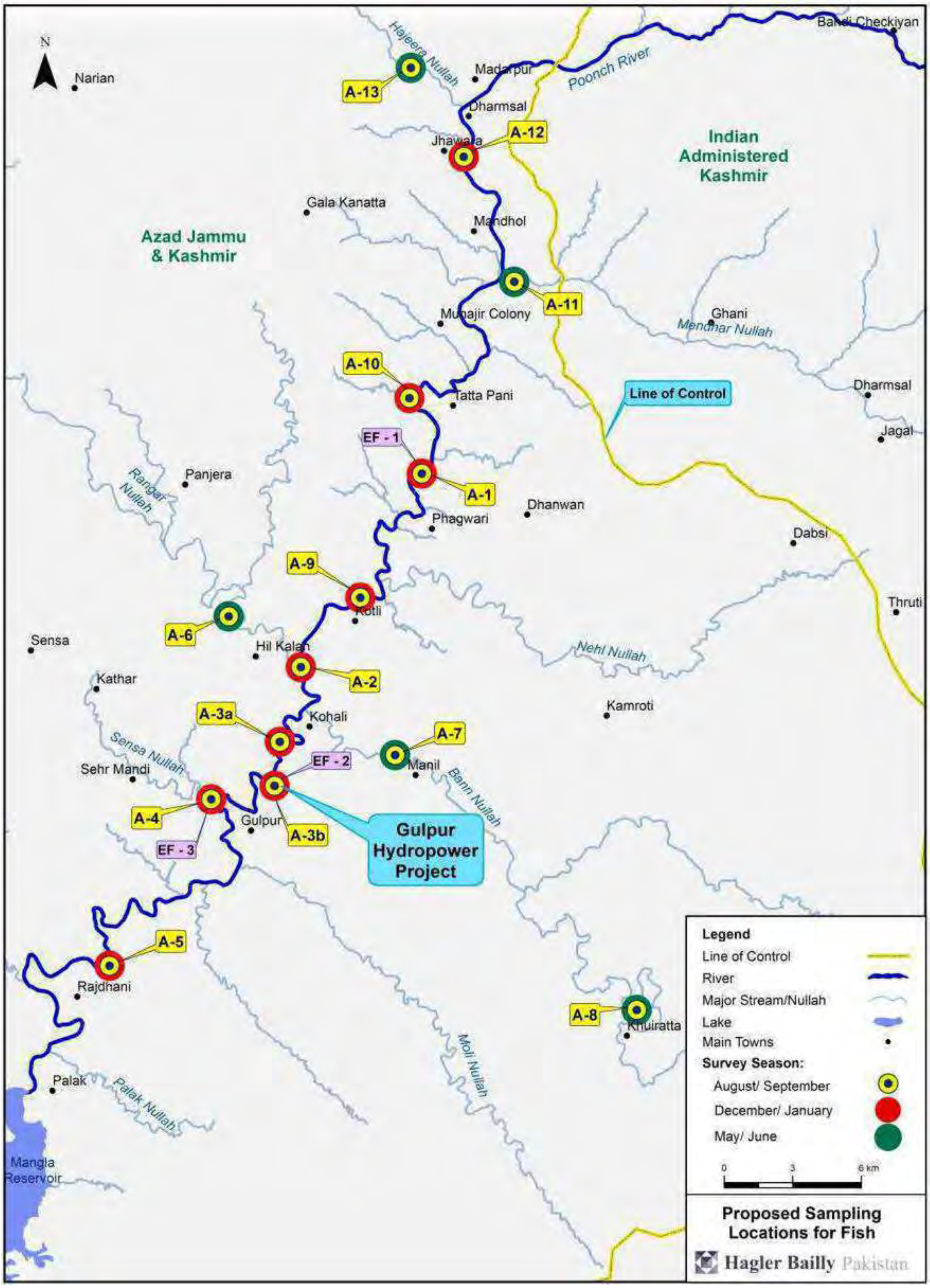

Exhibit E.8: Survey Form – Fish

ID		W P		Observer(s)			
Date	[dd/mm/yy]		Start Time	[HH:MM]	End Time	[HH:MM]	
	Starting Coordinates		**End Coordinates**	Cloud Cover	**%**		
Latitude	N		N	Wind	☐ Light ☐ Moderate ☐ Strong		
Longitude	E		E	Precipitation	☐ Light ☐ Moderate ☐ Heavy		
[Deg Min Sec]				Water Temperature			
River Habitats	☐ Riffles ☐ Pools ☐ Glides ☐ Runs ☐ Rapids				Locality		
	☐ Others/Special Habitats________________________________						
Riverbed	☐ Sand/silt ☐ Gravel ☐ Small Cobbles ☐ Large Cobbles						
	☐ Boulders ☐ Bedrock________________________________						
Depth of Riverbed	________________________						
(Please select only one box for Habitat)							

Elevation (m)		**Temp. (oC)**		**pH**		**DO**		**Turbidity**		**No. of cast nets**	

No.	*Species Name*	*Count*	*Fish Size (in inches)*	*Fish Weight (in kg/g)*	*Comments* *Stage of Gonad Development (for May/June survey in tributaries)*

E.5 Macro-invertebrates

Benthic macro-invertebrates are an important part of the food chain in aquatic ecosystems, especially for fish. Many invertebrates feed on algae and bacteria, which are at the lower end of the food chain. Some shred and eat leaves and other organic matter that enters or is produced in the water. Because of their abundance and position as 'intermediaries' in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients (Williams & Feltmate, 1992)[112].

E.5.1 Objective

The objectives of the macro-invertebrate sampling program are to:

- routinely measure a set of pre-defined indicators that will detect trends in macro-invertebrate populations,
- detect shifts in the macro-invertebrate community composition,
- identify any loss of biodiversity.

Changes in the flow regime that are likely to have profound impacts on the proportions or overall abundance of invertebrates or particular species are:

- Shifts in the availability of hydraulic habitat ("living space" for invertebrates defined by flow forces and substratum type) as a result of slower velocities, sediment deposition or a reduction in wetted perimeter.
- water quality changes – either through increased toxicity or as a result of increased respiratory costs associated with e.g. warmer temperatures.
- changes as a result of periphyton dynamics - in food resources (type of algae) or habitat quality (smothering by high algal biomass).

E.5.2 Description of indicators for monitoring

The macro-invertebrate indicators are:

- species richness and diversity
- community structure

Species richness and diversity will be used to assess biodiversity levels and changes in the abundance of different taxa.

Community structure, which incorporates relative species abundances and proportions of functional groups, is a measure of ecosystem "integrity".[113]

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[112] Williams D. D. and Feltmate, B. W. 1992. Aquatic Insects. CAB International Wallingford, Oxon. 360 pp.

[113] Defined as "the ability of an aquatic ecosystem to support and maintain a community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitats within the target river.

E.5.3 Sampling protocol

Macro-invertebrates will be sampled by adopting the standardized rapid biological assessment sampling techniques (using multi-habitat approach) developed by Barbour et al 1999[114]. A Surber Sampler or D frame kick net will be used for sampling. Twenty efforts will be taken at each sampling station based on percent availability of each biotope. For example if a sampling station comprised of 80% riffle and 20% pool habitat, then 16 efforts of the Surber Sampler will be conducted in the riffles and 4 efforts in pool (ratio of 80% to 20%).

At each sampling location, the collected material will be rinsed using running clean stream water through the net two to three times. The material will be transferred into a large (white) tray or a bucket. The sample will then be transferred to a container and covered with 10% formalin.

In the laboratory, each sample will be put into a sieve of 500 µm mesh size and rinsed with running water (to remove traces of formalin). Macro-invertebrates will then be sorted from the samples and identified using a Kyowa Stereozoom Microscope and the identification keys given in Edmondson, 1959[115]; Ali 1967[116], Ali 1970[117], Bouchard 2004[118].

The abundance of macro-invertebrates per square meter will be calculated and the pollution tolerance of the identified taxa will be taken from HKH bios scoring list (Hindukush Himalayan Score Bio-assessment) (Hartmann et al., Deliverable 10[119]). The Functional Feeding Group of each taxa will be identified.

The proposed sampling locations for macro-invertebrates are shown in (**Exhibit E.9**) and the draft survey form for macro-invertebrates is given in (**Exhibit E.10)**.

E.5.4 Method for Data Analysis

The abundance of the taxa (family) will be entered into MS Excel spreadsheets to provide a species by sample array (species names in rows, each site/date/hydraulic biotope sample entered in columns), as the basis for the analyses to be conducted.

The diversity will be calculated for

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[114] Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

[115] Fresh-Water Biology Fresh-Water Biology, Second Edition. By hb Ward and gc Whipple (wt Edmondson, Editor). John Wiley and Sons, New York. 1959.

[116] Ali, S.R. 1967. The Mayflies (Order: Ephemeroptera) of Rawalpindi District. Pak. J. Sci. 19 (3): 73-86.

[117] Ali, S.R. 1970. Certain Mayflies of West Pakistan. Pak. J. Sci. 22 (3 & 4): 118-124.

[118] Bouchard, R.W. Jr. 2004. Guide to Aquatic Macroinvertebrates of Upper Midwest. Water Resources Center, University of Minnesota, St. Paul, Minnesota. 208pp.

[119] Hartmann, A., O. Moog, T. Ofenböck, T. Korte, S. Sharma and D. Hering. Deliverable No. 10. ASSESS-HKH Methodology Manual describing fundamentals a application of three approaches to evaluate river quality based on benthic macroinvertebrates: HKH screening, HKH score bioassessment & HKH multimatric bioassessment. 80pp. www.assess-hkh.at

- invertebrate taxa richness (the total number of taxa), and the proportional representation of the richness contributed by each of the major Orders, to identify the broader biodiversity characteristics of the system;
- overall abundance: although this is a highly variable measure, extreme changes in abundance are useful to indicate gross ecosystem change, for example massive proliferation of pest species;
- diversity Shannon-Weiner Diversity Index (H'):

Multivariate analysis is useful where the taxa-by-sample arrays are large, patterns in community data not readily apparent. A multivariate package such as PERMANOVA (Clarke and Warwick 2006)[120] may be used for analysis.

[120] Clarke, K.R. and Warwick, R.M. 2006. Change In Marine Communities: An Approach To Statistical Analysis And Interpretation. Plymouth, UK, PRIMER-E.

Exhibit E.9: Proposed Sampling Locations for Macro-invertebrates

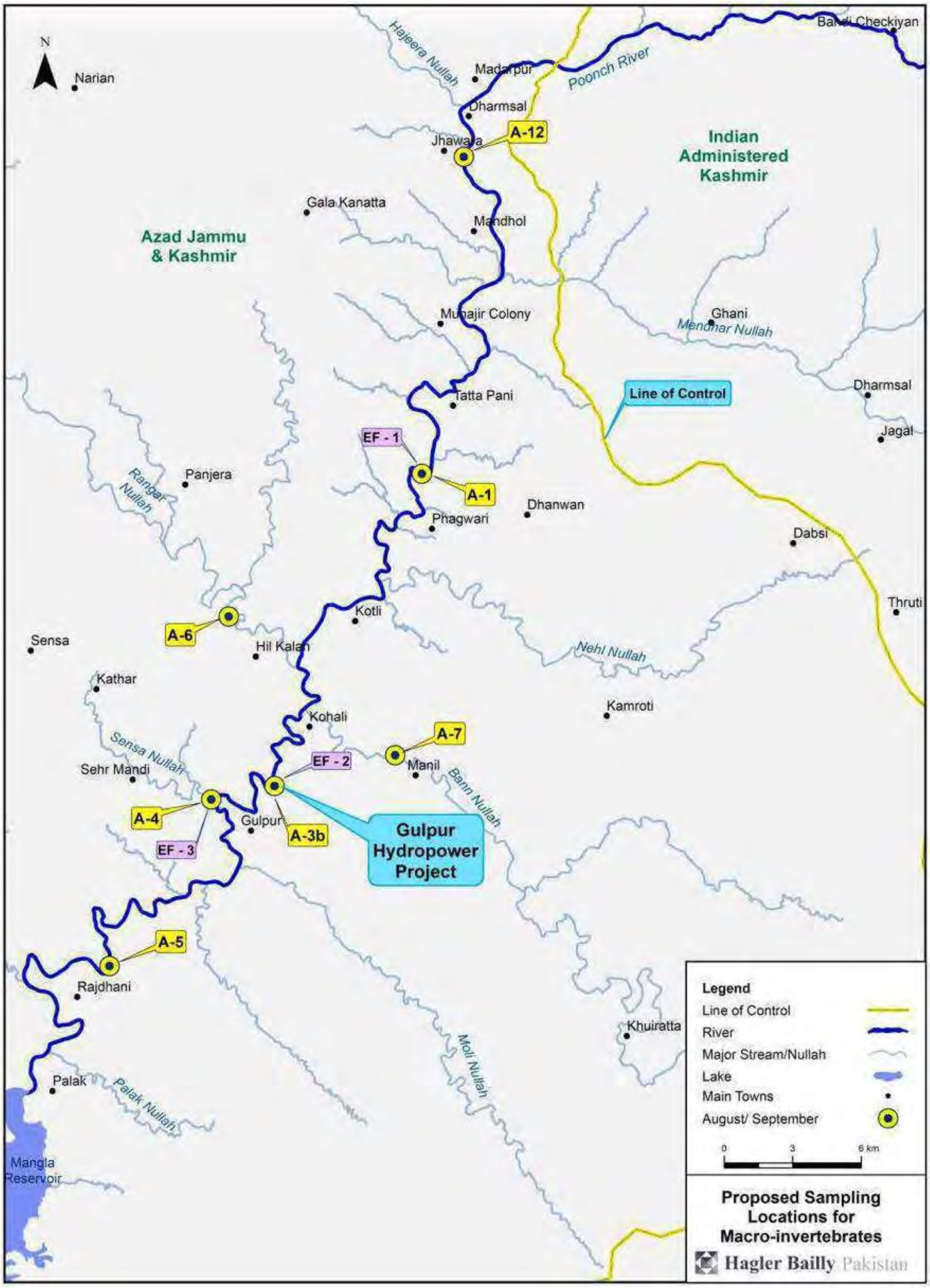

Exhibit E.10: Survey Form – Macro-invertebrates

<table>
<tr><td>ID</td><td></td><td>W P</td><td></td><td>Observer(s)</td><td colspan="2"></td></tr>
<tr><td>Date</td><td colspan="2">[dd/mm/yy]</td><td>Start Time</td><td>[HH:MM]</td><td>End Time</td><td>[HH:MM]</td></tr>
<tr><td></td><td colspan="2">Starting Coordinates</td><td>End Coordinates</td><td>Cloud Cover</td><td colspan="2">%</td></tr>
<tr><td>Latitude</td><td colspan="2">N</td><td>N</td><td>Wind</td><td colspan="2">☐ Light ☐ Moderate
☐ Strong</td></tr>
<tr><td>Longitude</td><td colspan="2">E</td><td>E</td><td>Precipitation</td><td colspan="2">☐ Light ☐ Moderate
☐ Heavy</td></tr>
<tr><td colspan="4">[Deg Min Sec]</td><td>Temperature</td><td colspan="2"></td></tr>
<tr><td>River Habitats
Riverbed
Depth of Riverbed</td><td colspan="4">☐ Riffles ☐ Pools ☐ Glides ☐ Rapids
☐ Sand ☐ Silt ☐ Small Cobbles ☐ Large Cobbles
☐ Boulders ______________☐ Others/Special Habitats____________
_________________________</td><td>Locality</td><td></td></tr>
<tr><td colspan="7">(Please select only one box for Habitat)</td></tr>
</table>

Elevation (m)		**Temp. (oC)**		**pH**		**DO**		**Turbidity**		**No. of cast nets**	

No.	*Taxa/Species*	*Count*	*Comments*

E.6 Periphyton

The term periphyton refers to the film of living matter coating almost all surfaces in streams. It is usually dominated by benthic algae, but also includes bacteria, fungi and other organic matter. Periphyton is dominated by benthic algae, which are the primary producers in rivers, providing food for macro-invertebrates and fish. They are particularly suited for use in monitoring programs because their short life cycle enables them to respond rapidly to changing conditions, and they are often the first organisms to respond to and recover from stress.

E.6.1 Objective

The objectives of the periphyton sampling program are to:

- demonstrate whether or not there are trends in periphyton populations relative to baseline condition as a result of the altered flow regimes,
- identify any loss of biodiversity.

E.6.2 Periphyton Indicators for Monitoring

The algae and periphyton indicator that will be used for monitoring is :

- Periphyton biomass:
    - Chlorophyll a
    - Ash Free Dry Mass (AFDM)
    - Autotrophic Index (AI)

Periphyton biomass is measured as Chlorophyll a (Chl a), which is a proxy for live algal biomass, and Ash Free Dry Mass (AFDM), which is a measure of all the organic matter in a sample, including living algae, heterotrophic organisms (bacteria and protozoa), detritus and dead organic material.

The ratio of Chl a:AFDM is an Autotrophic Index (AI), which provides an indication of the quality of periphyton food resources. AI = 100 - 400 generally represent a community with both autotrophic and heterotrophic components (good quality food), AI > 400 are dominated by heterotrophs and/or organic detritus (poor quality food; Wellnitz et al. 1996[121]; Biggs 2000[122]).

E.6.3 Sampling Methodology

Collect five stones of similar size from slow-flowing areas of the run. Ensure that all five are located a similar water depths. The long axis of each selected stone should be between 150 and 250 mm; depths should be between 20 and 40 cm.

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[121] WELLNITZ, T.A., RADER, B.R. and WARD, J.V. 1996. Light and grazing mayfly shape periphyton in a Rocky Mountain stream. Journal of the North American Benthological Society 15:496-507.

[122] BIGGS, B.J.F. 2000. New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams. NIWA, Christchurch. 121pp.

It is important to:

- keep the algal sampling area separate from the invertebrate sampling area as the kick sampling technique used for invertebrate monitoring dislodges the periphyton;
- only use stones taken from the part of the channel that is inundated all year around.

The sampling protocol for each stone is as follows:

- Measure water depth in situ at each stone location prior to its removal from the river bed.
- Place a stone in a sampling tray and remove the periphyton by scrubbing and rinsing with clean water (sediment –free) brought to site, and until no change in the rinsing water is evident.
- Extract a sub-sample of 30 ml from the sample and preserve in 1 ml Lugol’s solution for further identification of algal species.
- The remainder of the sample slurry should be stored on ice in a cooler box in the field, and frozen within 12 hours of collection, for determination of periphyton biomass.
- Measure the dimensions of each stone as the longest axis (i.e. x), the longest horizontal axis perpendicular to x, (i.e. y) and the longest vertical axis of the stone (i.e. z) and note in the format

E.6.4 Sampling frequency, timings and locations

Sampling for Periphyton biomass will be carried out once a year in December/January at specified locations along the river and tributaries (**Exhibit E.11**). The draft survey form is given in (**Exhibit E.12).**

E.6.5 Methods for sample analysis

When defrosted, each sample should be mixed and divided into two portions for the measurement of three periphyton biomass indicators (normalized to mg /m2) i.e. total dry mass, (ash free dry weight (AFDW), and Chlorophyll a (Chla).

The method for determination of Periphyton Chla and AFDW is:

- Measure total dry weight by filtering the sub-sample portion through Whatmann GFF 4 glass fibre filter papers which are then dried at 60 $_{0}$C overnight. Then ash the samples in an oven at 400 $_{0}$C for 4 hours. The difference between the dry weight and the weight of the ash is the organic component (i.e. AFDM) of the periphyton.
- Extract Chla from each sub-sample with methanol AR, boiled at 70 $_{0}$C for 3 minutes to increase extraction efficiency and to fix the chlorophyll by destroying the enzymes.
- Measure absorbance at a wavelength of 665 nm with a spectrophotometer (Spectroquant Pharo 100).

- Measure background absorbance at 750 nm with a spectrophotometer.
- Chlorphyll degrades naturally as communities age and die, resulting in degradation products called phaeopigments which interfere with the measurement of live Chla using spectrophotometry. Correct for phaeopigments by acidifying the sample with 0.1.M Hydrochloric Acid (HCl) and then neutralizing it with 0.1 M NaOH.
- Re-read absorbances at both 665 nm and 750 nm following the acidification and neutralisation step and correct the measurements (subtract) for the presence of phaeopigments.
- Multiply the values obtained by 36.9, which is the absorption coefficient for methanol to determine Chla concentrations for each stone sampled.

Periphyton Chla and AFDW values for each subsample should be adjusted as follows:

- Divide by 30 and multiply by the total slurry volume to obtain AFDM and Chla values for each stone.

Calculate the surface area of each stone using the following equation:

$$\text{Stone Surface Area} = \frac{0.014(xy+xz+yz) + 33.819}{10{,}000}$$

where stone surface area is in m^2 and x, y, z are the measured stone dimensions in mm.

- Multiply AFDM and Chla values for each stone by the surface area of that stone to obtain a density per unit stone surface area.

E.6.6 Method for Data Analysis

Overall differences in periphyton biomass between, sites and years should be analyzed using a Kruskall-Wallas ANOVA by ranks and Dunn’s post-hoc comparisons for site specific differences. All univariate analyses can be performed using STATISTICA 9.

Exhibit E.11: Proposed Sampling Locations for Periphyton

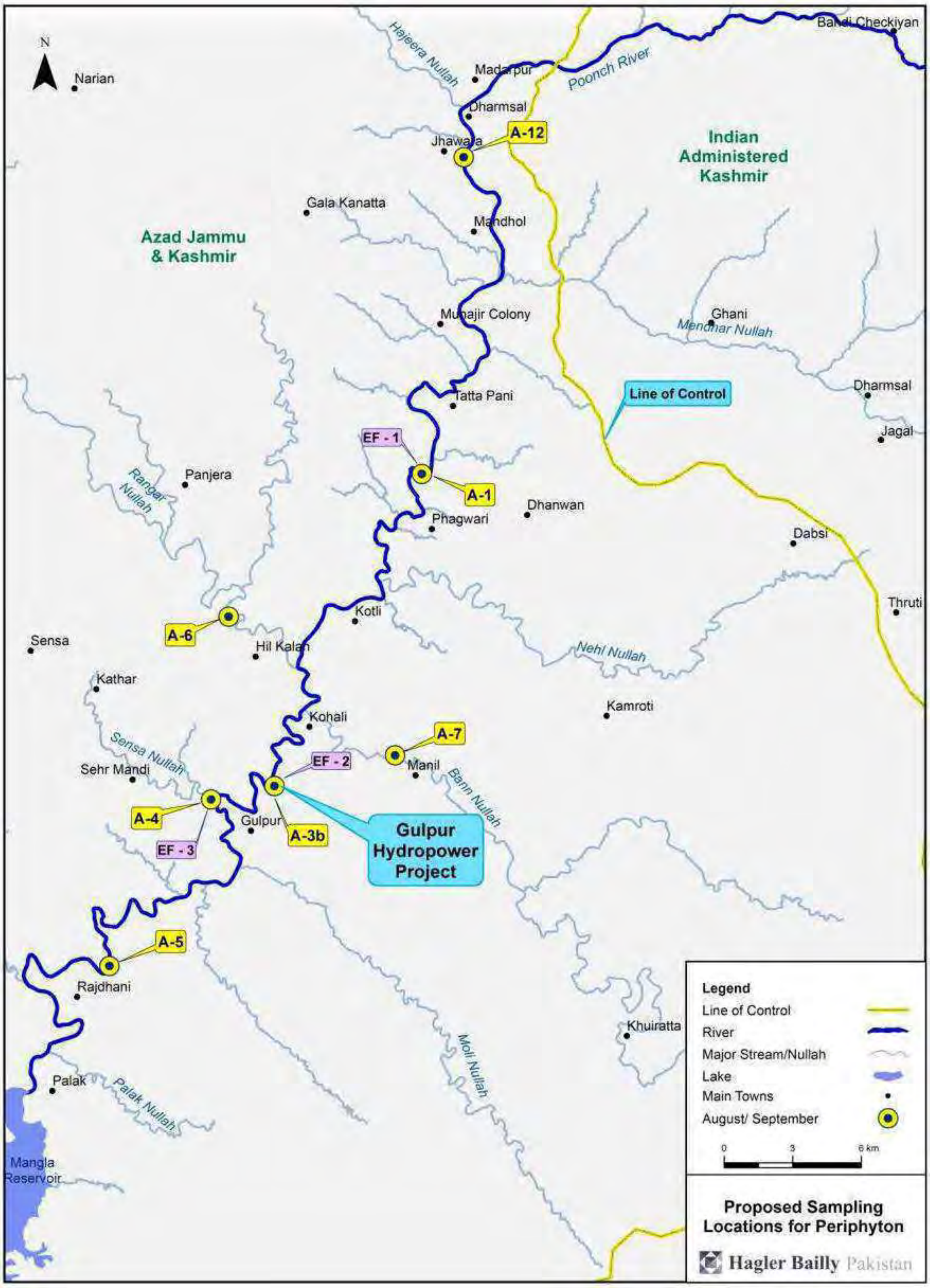

Exhibit E.12: Survey Form – Periphyton

ID		W P		Observer(s)		
Date	[dd/mm/yy]		Start Time	[HH:MM]	End Time	[HH:MM]
				Cloud Cover	%	
Direction	**Starting Coordinates**			**End Coordinates**		
Latitude	N			N		
Longitude	E			E		
[Deg Min Sec]				Temperature		
Type of River Habitat	☐ Pools ☐ Glides ☐ Riffles ☐ Rapids ☐ Sand ☐ Silt ☐ Small Cobbles ☐Large Cobbles ☐ Boulders___________ ☐ Others/Specieal Habitats Nature of river bed _________ Other__________				Water Depth	
(Please select only one box for Habitat)						
Water Attributes	Temp. (°C) _______ pH ______________ DO ____________ Turbidity _________ Elevation _________ Others__________				Locality No.of Cast Nets	

Rock	*Rock Dimensions (xxyxz)*	*Depth (cm) at each stone*
1		
2		
3		
4		
5		

E.7 Otter

Otters are the only aquatic mammals associated with the Poonch River. Keeping in view the habitat available, the species found here is likely to be the Common Otter lutra lutra. The Otter lives in a wide variety of aquatic habitats, including highland and lowland lakes, rivers, streams, marshes, and swamps. This species is listed as Near Threatened in the IUCN Red List 2014[123] due to an ongoing population decline over the years.

[123] IUCN 2014. IUCN Red List of Threatened Species. Version 2014.1. <www.iucnredlist.org>.

E.7.1 Objective

The objective of Otter monitoring is to determine any change in the distribution and abundance of Otters in Poonch River by searching for signs of their presence at a series of sampling points throughout the catchment.

E.7.2 Sampling Method

The methods for sampling Otter are given below:

Direct observation of animals

Although otters are mainly nocturnal, cryptically colored and sparsely distributed, there have been a few studies in which information on otter populations has been gained through direct, systematic observations. The methods require a substantial investment of time and personnel.

Survey of Dens/ Caves/ Crevices

The river banks along the deep and long pools will be surveyed to see the dens of the Otters. This technique clearly has value in rivers where Otters can make dens along the river bank.

Tracks

As Otter foot prints are very distinct, they will be used as evidence of otters during surveys Otter signs indicate only presence or absence, rather than the abundance of Otters.

Spraints (droppings of otter)

The most frequently used technique for detecting the presence of Otters, and in some cases estimating their abundance or relative abundance is to search for spraints in a particular stretch of the river. Otters frequently deposit spraints (droppings of the Otter) under or near bridges, where footprints are also frequently found. By virtue of its wide use, it has become the 'standard method' and was recognized as a major review of surveying methods carried out by Reuther et a1. (2000)[124]. The sites suitable for surveying will be mainly selected for ease of access and are usually adjacent to bridges.

The number of latrine sites of Otters (where spraints or faeces are deposited) in 1 km stretch along the river will be identified at each sampling site. Each site will be characterized with respect to topography, composition of terrestrial vegetation, composition of river substrate, and presence of feces. The locations of otter latrine sites will be plotted on a digital map.

Complete searches of long lengths

Long lengths of river banks (1-2 km) will be surveyed to determine habitat use by Otters. In this method, abundance of spraint will be used as an indicator of Otter activity or habitat.

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[124] Reuther C, Dolch D, Green R, Jahrl J, Jefferies D, Krekemeyer A, Kucerova M, Madsen AB, Romanowski
J, Roche K, Ruiz-Olmo J,Teubner J & Trinidae A (2000). Surveying and monitoring distribution and population trends of the Eurasian otter (Lutra lutra). Habitat 12, 1–148.

Interviews with the local people

Local people specially the fishermen and boatmen, sand miners will be interviewed for presence of the Otter in the areas.

Direct observation of animals

Although otters are mainly nocturnal, cryptically colored and sparsely distributed, there have been a few studies in which information on otter populations has been gained through direct, systematic observations. The methods require a substantial investment of time and personnel.

E.7.3 Sampling frequency, timings and locations

Otter surveys will be carried out once a year in the winter season (December/January) when water volumes are low making Otter observations comparatively easy. The proposed sampling locations for the Otter survey are given in (**Exhibit E.13)** and the draft Otter survey form is given in (**Exhibit C.D.14)**.

E.7.4 Data analysis

- The presence/absence of Otters at each sampling site along the Poonch River will be determined using direct sightings, observation of signs and interviews with locals.
- An estimation of otter population size will be done using Noninvasive Latrine Survey methodology as described in Mowry et al. (2011)[125].

[125] River Otter Population Size Estimation using Noninvasive Latrine Survey, Rebecca A. Mowry, Matthew E. Gompper, Jeff Beringer, Lori S. Eggert, Journal of Wildlife Management, 75(7):1625-1636. 2011, The Wildlife Society-2

Exhibit E.13: Proposed Sampling Locations for Otter

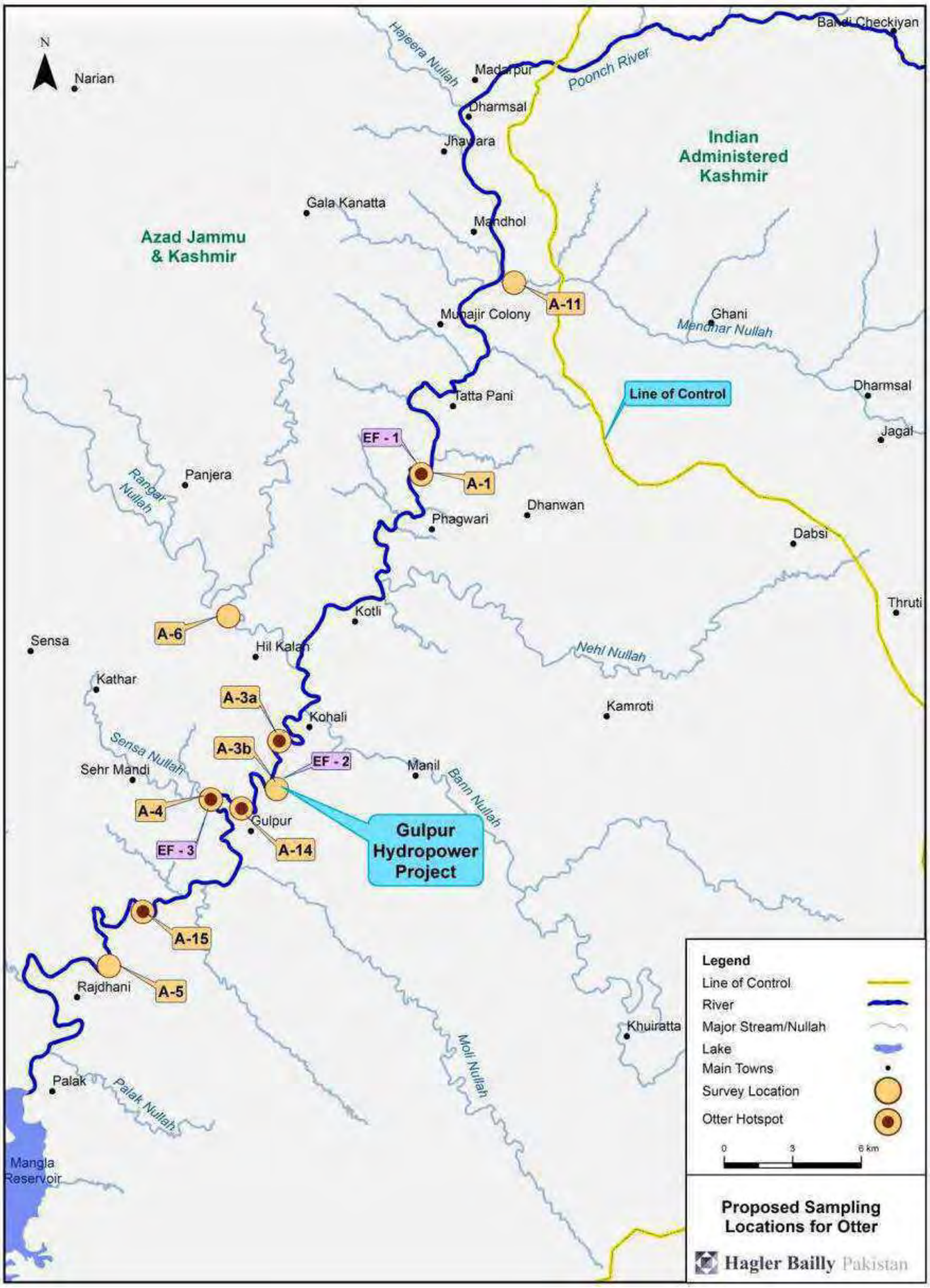

Exhibit E.14: Survey Form - Otter

ID		W P		Observer(s)	
Date	[dd/mm/yy]	Start Time	[HH:MM]	End Time	[HH:MM]
	Starting Coordinates		**End Coordinates**		
Latitude	N		N		
Longitude	E		E		
[Deg Min Sec]			[Deg Min Sec]		
Bank Type	☐ Sandy ☐ Rocky	☐ Muddy ☐ Others ____________________		Locality	
Habitat	☐ Boulders ☐ Trees	☐ Thick Vegetation ☐ Others ____________________		Distance Surveyed (m)	
(Please select only one box for Habitat)					
Distance from Pools (m)		Depth of Pools (m)			

No.	*No of Otter sighting or signs*	*Distance (m)*	*Sighting*	*Type of Sign* *Tracks*	*Scats**	*Den*	*Comments*

Please specify whether scats are dry fragmented (df)/ dry intact (di)/ not dry (nd)

E.8 Riparian Vegetation

Riparian vegetation is the riverine plant community sustained by river flow, groundwater or generally moist conditions along river margins, and is typically distinct in species composition from adjacent terrestrial communities.

Riparian vegetation plays a central role in the functioning of riverine ecosystems: bank erosion is reduced through armoring; water quality is maintained through trapping of sediment, nutrients and other contaminants, and shading regulates river water temperature and thus primary productivity; food is provided for riparian animals in the form of fruits, nuts and leaves, and for aquatic macro-invertebrates in the form of leaf litter; the plants themselves offer a diverse array of habitats as well as a corridor for the movement of migratory terrestrial and semi-aquatic animals (Prosser 1999)[126].

E.8.1 Objectives

The objectives of the riparian vegetation monitoring are to:

- demonstrate whether or not there are shifts, associated with mortality, in water dependent riparian vegetation species due to changes in flow levels,
- identify any potential loss of riparian vegetation biodiversity.

E.8.2 Indicators for Monitoring

The following indicators for monitoring the riparian vegetation will be used.

- Vegetation cover
- Plant count
- Diversity

E.8.3 Sampling frequency, timings and locations

Sampling for riparian vegetation will be carried out once annually in August/September. The proposed sampling locations for the bankside vegetation survey are given in **Exhibit E.15** and the draft riparian vegetation survey form is given in **Exhibit E.16**.

E.8.4 Sampling Methodology

The usual means of sampling vegetation for floristic composition is the quadrat. The vegetation in the marginal zone, flood plain and terrestrial habitats in the Study Area will be sampled by the quadrate method, taking 3 quadrates of 5m x 5m at each sampling site. The first quadrate will be taken at the beginning of the transect, the second at 250 meters and the third at 500 m. All sampling points will include representative habitats, topographic and physiographic conditions of the Study Area. Plants from each quadrate will be noted and collected for the assessment of the plant species if required. Additional plant species in the area adjacent to the quadrate will also be noted down and collected to record the occurrence of the species. Cover, relative cover, density, relative density, frequency, relative frequency percentages and Importance Value Index (IVI) for each species from the study will be calculated by using the following formulae:

---

[126] PROSSER, I.P. 1999. Identifying priorities for riparian restoration aimed at sediment control. Second Australian stream management conference, 8-11 February. Adelaide, South Australia. Pg 511-516.

The Cover and Relative Cover of species will be calculated using the following formula:

$$\text{Cover} = \frac{\text{Total cover (cm) of a specie}}{\text{Number of plants of a species}}$$

$$\text{Relative Cover} = \frac{\text{Total cover (sq cm) of all plants of a species x 100}}{\text{Total cover (sq cm) of plants of all species}}$$

The Density and Relative Density of the species in the area will be calculated using the following formulae:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all quadrats taken}}{\text{Total number of quadrats taken}}$$

$$\text{Relative Density} = \frac{\text{Total number of individuals of a species in all quadrats x 100}}{\text{Total number of individual of all species in all quadrats}}$$

The Frequency and Relative Frequency percentages of the species will be determined using the following formulae:

$$\text{Frequency} = \frac{\text{Number of quadrats of occurrence of a species x 100}}{\text{Total number of quadrats lay out}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of a species x 100}}{\text{Total Frequency of all species}}$$

Importance Value Index (IVI) of all the recorded species will be calculated using the following formulae:

$$\text{IVI} = \frac{\text{Relative cover + Relative frequency + Relative density}}{3}$$

Plants collected will be identified following the nomenclature from Flora of Pakistan (Nasir and Ali 1972-1994[127], Ali and Qaiser, 1995-to date[128]).

Local people will be consulted to gather information about local names, uses, value and cultural values of the plants of the area.

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127 S. I. and Nasir. 1972-1994. Flora of Pakistan Fascicles. Islamabad

128 Ali, S. I. and Qaiser, M. 1995 to date. Flora of Pakistan Fascicles. Karachi

E.8.5 Data Analysis

The vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the recorded riparian vegetation plant species will be compared using a multivariate analysis package, such as PRIMER (Clarke and Gorley 2006)129. This will provide an assessment of how, if at all, the riparian vegetation is changing and whether riparian vegetation biodiversity is affected.

[129] Clarke, K.R. and Gorley, R.N. 2006. Primer v6: User Manual/tutorial. Plymouth, UK, Primer-e.

Exhibit E.15: Proposed Sampling Locations for Riparian Vegetation

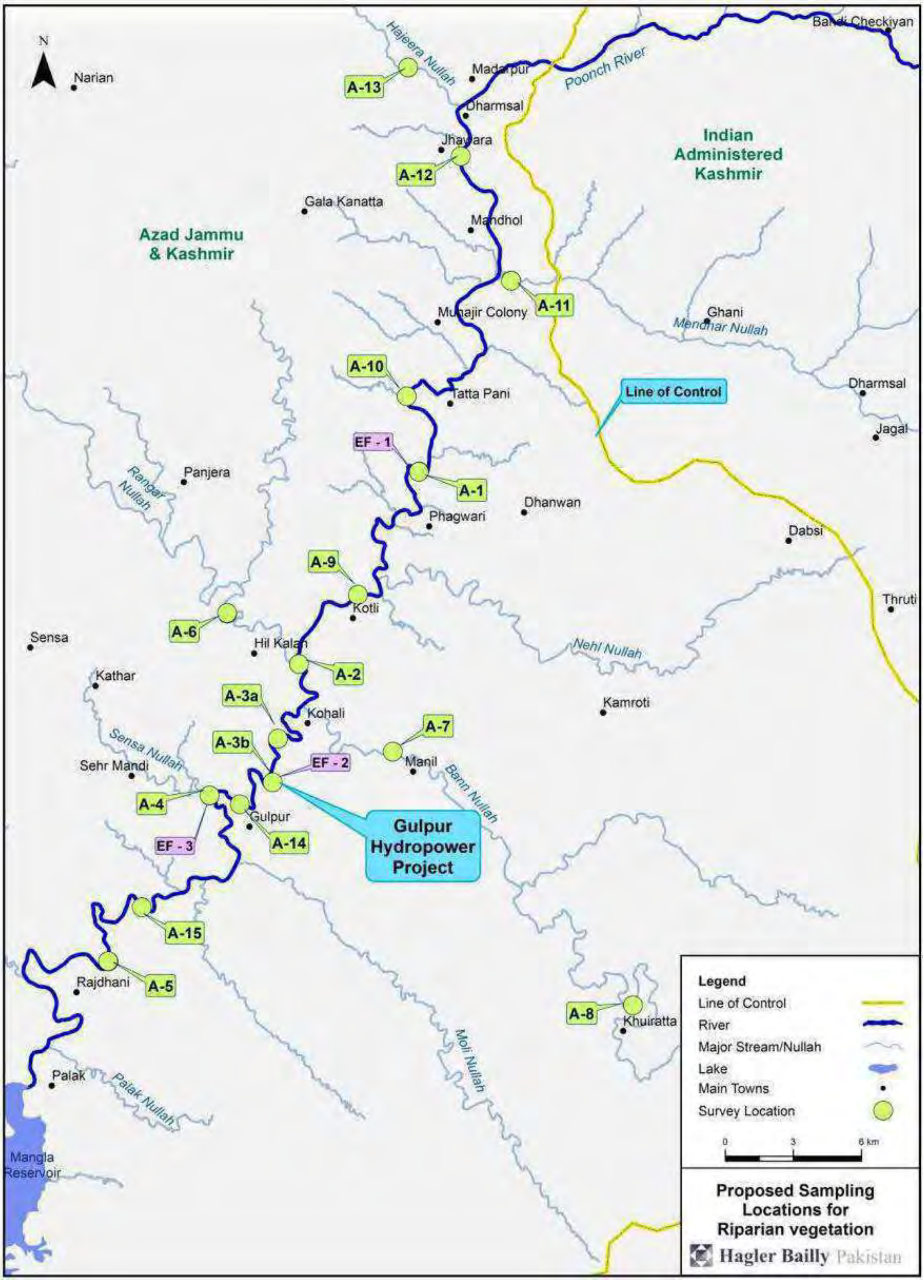

Exhibit E.16: Wildlife Survey Form - Riparian Vegetation/Terrestrial Vegetation

ID		W P		Observer(s)		
Date	[dd/mm/yy]		Start Time	[HH:MM]	End Time	[HH:MM]
	Starting Coordinates			**End Coordinates**		
Latitude	N			N		
Longitude	E			E		
[Deg Min Sec]				[Deg Min Sec]		
Habitat	☐ Riparian ☐ Scrub Forest	☐ Agricultural Fields ☐ Others/Special Habitats____________	☐ Pine Forest	Locality		
(Please select only one box for Habitat)						

No.	*Species Name*	*Circumference (Inches)*						
		Count	*1*	*2*	*3*	*4*	*5*	*6*

E.9 Terrestrial Vegetation

Terrestrial vegetation refers to the plant species that grow on land and are not directly dependent on the River.

E.9.1 Objectives

The objectives of the terrestrial vegetation monitoring are to:

- demonstrate whether or not there are shifts in the population of terrestrial vegetation particularly any increase in the population of alien invasive species.
- identify any potential loss of terrestrial vegetation biodiversity.

E.9.2 Indicators for Monitoring

The following indicators for monitoring the riparian vegetation will be used.

- Vegetation cover
- Plant count
- Diversity

E.9.3 Sampling frequency, timings and locations

Sampling for terrestrial vegetation will be carried out once every three years in April/May. The proposed sampling locations are given in **Exhibit E.17** and the draft terrestrial vegetation survey form is given in **Exhibit E.16**.

E.9.4 Sampling Methodology

The sampling methodology for the terrestrial vegetation will be the same as for the riparian vegetation outlined in **Section C.8** above.

E.9.5 Data Analysis

The vegetation cover, plant count and diversity as well as the IVI (Importance Value Index) of the recorded terrestrial vegetation plant species will be compared using a multivariate analysis package, such as PRIMER (Clarke and Gorley 2006).[130] This will provide an assessment of how, if at all, the terrestrial vegetation is changing particularly if there is an increase in the population of alien invasive species such as Lantana camara.

E.10 Terrestrial Fauna

Terrestrial fauna refers to the animal species that live predominantly or entirely on land. The focus of monitoring the terrestrial fauna will be on the mammals, small mammals and birds (particularly the vultures) that are likely to be impacted by Project construction and operations.

E.10.1 Objectives

The objectives of the terrestrial vegetation monitoring are to:

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[130] Clarke, K.R. and Gorley, R.N. 2006. Primer v6: User Manual/tutorial. Plymouth, UK, Primer-e.

- demonstrate whether or not there are shifts in the population of terrestrial mammals and birds particularly any changes in the abundance of vulture species
- identify any potential loss of terrestrial fauna

E.10.2 Indicators for Monitoring

The following indicators for monitoring the terrestrial fauna will be used.

- Species richness (number of species observed)
- Species abundance (number of individuals of each species observed)

E.10.3 Sampling Frequency and Sampling Locations

Sampling for terrestrial mammals and birds will be carried out once every three years in April/May. A map of the proposed sampling locations is given in **Exhibit E.17** and the survey forms are given in **Exhibit E.18** to **Exhibit E.20**.

E.10.4 Sampling Methodology

The sampling methodology for the terrestrial mammals, small mammals and birds is outlined below.

Large Mammals

Line transects (500 m by 20 m) will be placed at each sampling location to record all animals or their signs detected. All the animals sighted, or their signs (foot marks, droppings, dens) will be recorded. GPS coordinates of the location and habitat type will also be documented. Samples of feces and photographs of tracks will be taken and conserved for potential subsequent confirmatory analysis. Transects will be started as early as possible in the day and will cover all possible habitat types in order to avoid bias of stratification.

In addition, incidental sightings of all mammals will be recorded; number of individuals, location and habitat type will be recorded for each sighting. Anecdotal information regarding specific mammals will be collected from the local people and relevant literature will also consulted.

Live Trapping for Small Mammals

Live trapping for small mammals will be carried out at various sampling sites. Trapped animals will be identified and released alive after taking measurements.

A mixture of different food grains mixed with fragrant seeds will be used as bait to attract the small mammals. Wheat and rice will be used as food grains while peanut butter, coriander, oats, and onion will be used for fragrance. Freshly prepared bait will be used on every trapping day. Only a small amount of bait will be put on the rear side of the traps. Care will be taken while putting the bait on the rear side of the trap to make sure that it is placed properly on the trap platform.

Sherman traps will be used for the present study to collect live specimens. Thirty to forty traps were set at a specific area in two lines approximately 10 m apart. A colorful ribbon to locate traps the next day will be used to mark each trap. The traps will be set in the evening and checked early the next morning, ensuring that the trapped animals are not killed by heat.

The traps will be checked the following morning as early as possible. The trapped animals will be carefully transferred one after the other into an already weighed transparent polythene bag. Utmost care will be taken to avoid direct handling and harassing the specimens. The species of the trapped animals will be noted. The polythene bag along with the specimen will be weighed and the net weight of the animal will be noted down in a note book. The sex of the specimens will also be observed and documented carefully. The important relevant data, such as the date of trap setting, date of data collection, habitat, location, elevation, and weather conditions, will be recorded on the spot on a data sheet.

Birds

The line transects (500 m by 50 m) will be placed at each sampling location to record all birds observed. Transects will be started as early as possible in the morning and in late afternoon and will cover all possible habitats. The start time and coordinates of the starting point will be recorded. The birds will be identified using the most recent keys available in literature (Grimmett 2008)[131]. Abundance of birds (number of individuals of each species observed) and diversity (number of species observed) will be calculated.

E.10.5 Data Analysis

The species richness (number of species observed) and abundance (number of individuals of each species observed) at the specified sampling locations over the years will be compared using a multivariate analysis package, such as PRIMER (Clarke and Gorley 2006)[132.] This will provide an assessment of how, the populations of terrestrial mammals and birds are changing particularly if there is any change in the population of vulture species in the vulture feeding and resting areas (**Exhibit 3.30**).

[131] Grimmett, R., Roberts, T., and Inskipp, T. 2008. Birds of Pakistan, Yale University Press.

[132] Clarke, K.R. and Gorley, R.N. 2006. Primer v6: User Manual/tutorial. Plymouth, UK, Primer-e.

Exhibit E.17: Proposed Terrestrial Ecological Sampling Locations

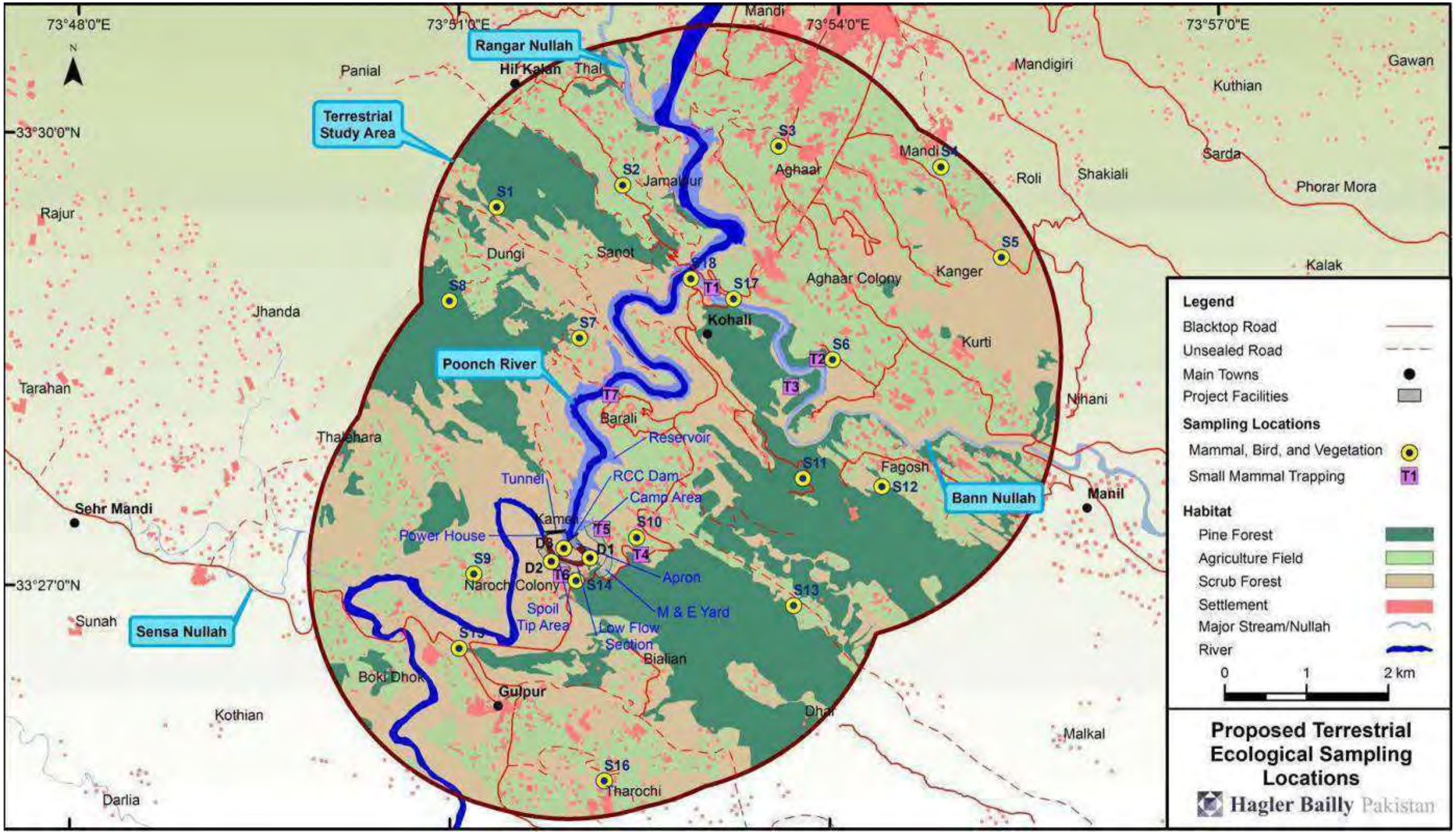

Exhibit E.18: Survey Form - Mammals

ID		W P		Observer(s)	
Date		Start Time		End Time	
	[dd/mm/yy]		[HH:MM]		[HH:MM]
	Starting Coordinates		**End Coordinates**		
Latitude	N		N		
Longitude	E		E		
[Deg Min Sec]			[Deg Min Sec]		
Habitat	☐ Riparian ☐ Agricultural Fields ☐ Pine Forest ☐ Scrub Forest ☐ Others/Special Habitats____________			Locality	
(Please select only one box for Habitat)					

No.	*Species Name*	*Distance* (m)*	*Sighting*	*Type of Sign*			*Comments*
				Tracks	*Scats*	*Den*	

Exhibit C.D.19: Survey Form – Small Mammals

ID		W P		Observer(s)	
Current Date	[dd/mm/yy]	Time	[HH:MM]	Traps Set Date	[dd/mm/yy]
Coordinates		Cloud cover	**%**	Moon Phase	
Latitude	N	Wind	☐ Light	☐ Moderate	☐ Strong
Longitude	E	Precipitation	☐ Light	☐ Moderate	☐ Heavy
[Deg Min Sec]		Temperature			
Grid Size Traps		Distance between traps (m)		Bait	
Habitat	☐ Riparian ☐ Scrub Forest	☐ Agricultural Fields ☐ Others/Special Habitats_____________	☐ Pine Forest	Locality	
(Please select only one box for Habitat)					

No.	*Species Name*	*Count*	*Grid Row*	*Grid Column*	*Weight (g)*	*Sex*	*Re-capt.*	*Comments*
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								

Exhibit E.20: Survey Form – Birds

ID		W P		Observer(s)		
Date	[dd/mm/yy]		Start Time	[HH:MM]	End Time	[HH:MM]
Direction**	**Starting Coordinates**		**End Coordinates**	Cloud Cover	**%**	
Latitude	N		N	Wind	☐ Light ☐ Moderate ☐ Strong	
Longitude	E		E	Precipitation	☐ Light ☐ Moderate ☐ Heavy	
[Deg Min Sec]				Temperature		
Habitat	☐ Riparian ☐ Agricultural Fields ☐ Pine Forest ☐ Scrub Forest ☐ Others/Special Habitats____________				Locality	
(Please select only one box for Habitat)						

No.	*Species Name*	*Distance* (m)*	*Count*	*Comments*

Note:
* Record birds 25 m on each side of transect line, 500 m long
**Direction of transect towards South

Appendix M: Environmental and Social Management System (ESMS) Framework

This document describes the framework for the Environmental and Social Management System (ESMS) that will be developed by Mira Power Limited (MPL) for all aspects of the construction and management of Gulpur Hydropower Project. The framework has been developed with consideration of the requirements of Pakistan's legislation and guidelines, the International Finance Corporation's (IFC's) Performance Standard 1 (Performance Standards and Guidance Notes 2012 edition), Asian Development Bank's (ADB's) Safeguards Policy Statement 2009 and the main principles in the International Standards Organisation (ISO) 14001 Standard (ISO 14001:2004).

Some organizations use different terms for an ESMS; the IFC uses the term "social and environmental management system" or "SEMS" and the International Standards Organisation (ISO) uses "environmental management system" or "EMS". For the purposes of this document, the terms are synonymous.

The IFC Performance Standards state the objectives of an ESMS are to:

- identify and assess social and environmental impacts, both adverse and beneficial;
- avoid, or where avoidance is not possible, minimize, mitigate or compensate for adverse impacts on workers, affected communities, and the environment;
- ensure that affected communities are engaged on issues that could potentially affect them; and
- promote improved social and environmental performance of companies through the effective use of management systems.

IFC Performance Standard 1 goes on to explain an ESMS has the features listed below.

- It is a dynamic, continuous process initiated by management and involving communication between the Project owner, its workers, and the local communities directly affected by the Project.
- It is based on the business management process of "plan-do-check-act" (this is the same basic process used in ISO14001).
- It entails the thorough assessment of potential environmental and social impacts and risks from the early stages of project development.
- It provides order and consistency for mitigating and managing these on an on-going basis throughout the life of the Project.

The basic elements of the ESMS for the Project are outlined in **Exhibit L.1** with more detail on each element, and how it applies, given in the following sub-sections. The elements of the ESMS are discussed under the headings of the "plan-do-check-act" business performance improvement cycle. Emergency planning and response and stakeholder engagement are elements of the ESMS that apply to all steps of the "plan-do-check-act" cycle as shown in **Exhibit L.1**.

Exhibit M.1: Elements of the ESMS for the Gulpur Hydropower Project

Steps of the "plan-do-check-act" cycle	Elements of the ESMS for the Project		Elements applying to all steps of the cycle	
	Elements	**Primary function**		
Plan (Section M1)	**Leadership and accountability**	Produce and communicate a statement of corporate commitment to environmental and social management Establish, document, implement, maintain and improve the Project ESMS	**Stakeholder engagement (Section M5)** An on-going process, throughout the life of the project. Serves to build and maintain a constructive relationship with communities affected by the project	**Emergency planning, response and recovery (Section M6)** Maintain emergency response preparedness through the identification of potential environmental emergencies, development of response plans and allocation of response and recovery resources.
	Legal and other requirements	Identify and provide access to legal requirements and other obligations		
	Aspect identification and impact assessment	Identify aspects ("mechanisms" by which project activities impact on the environment) and assess associated impacts throughout the Project life (the ESIA falls under this element of the ESMS)		
	Objectives, targets and plans	Define objectives, targets, criteria and actions for the management of potential impacts (the ESMP falls under this element of the ESMS)		
Do (Section M2)	**Roles and responsibility**	Provide sufficient management sponsorship of human and financial resources Establish roles and responsibilities for implementation		
	Contractors, suppliers and vendors	Consider environmental and social impact management and performance in the selection and management of third party services		
	Competence, training and awareness	Make personnel aware of their responsibilities and enable them to be capable and competent in meeting their responsibilities		
	Communication	Maintain internal and external communications to enable effective environmental management		
	Operational controls and maintenance	Implement operational controls and maintain equipment to uphold environmental performance and compliance and to manage impacts and risks		
	Documentation and record keeping	Control and maintain documents and records associated with environmental and social management		
Check (Section M3)	**Assessing, correcting and improving performance**	Monitor environmental and social management and performance and take measures to continually improve performance		
	Non-conformance and incident reporting	Promptly report non-conformances and incidents are promptly reported and take corrective and preventative actions to reduce the likelihood of recurrence		
	ESMP and ESMS reporting	Report on compliance with the ESMP and ESMS performance to senior management, regulatory authorities and affected communities		
Act	**Governance/ management**	Require site, regional and senior management to review the suitability, adequacy and effectiveness		

Steps of the “plan-do-check-act” cycle	Elements of the ESMS for the Project		
	Elements	**Primary function**	**Elements applying to all steps of the cycle**
(Section M4)	**review**	of the ESMS and identify improvement actions to facilitate continuous improvement	
	Management of change	Modify the ESMS in response to changes in the Project and to changes in the organisation, personnel, operations and processes	⟺
⟺	***The arrows show where there is integral relationship between stakeholder engagement and other elements of the ESMS.***		

The Environmental and Social Management Program (ESMP) described here is a component of the ESMS that is particularly important with respect to the ESIA report as it presents MPL’s commitments to manage the impacts identified by the impact assessment process. The ESMP falls under the element of the ESMS entitled “objectives, targets and plans for management”.

M.1 Planning Elements

M.1.1 Leadership and Accountability

Policy

The Project is being undertaken in accordance with MPL’s corporate policies. MPL will periodically review the scope and effectiveness of its policies. The policies will be documented, maintained, implemented and communicated to MPL employees, contractors, suppliers and the public.

ESMS

MPL will establish, document, implement, maintain and continually improve an ESMS for the Gulpur Hydropower Project.

M.1.2 Legal Requirements and Other Obligations

The Project’s ESMS needs to take account of both legal and other obligations imposed on the Project. The various types of obligations that need to be considered are shown conceptually in **Exhibit L.2**.

Exhibit M.2: Types of Obligations Relevant to the ESMS

MPL will identify, document and maintain a register of legal requirements and other obligations applicable to the Project. It will also:

- manage recurring legal and other obligations (such as inspections, sampling, analysis and reporting);
- track developing legislation and regulations that may apply to operations and activities to anticipate and prepare for compliance;
- inform employees and others working on behalf of the company of existing and emerging obligations that apply to their job responsibilities; and
- consider the register in the setting and review of objectives, targets and plans for management of impacts.

M.1.3 Aspect identification and impact assessment throughout the Project life

A key element of ESMS is identification of aspects and assessment impacts. The ESIA document is a part of this element of the ESMS.

Procedures will be set up, implemented and maintained for identification of significant environmental aspects and undertaking of impact and risk assessments on an on-going basis through the Project life. These will address:

- aspects not covered by this ESIA;
- any impact arising that was not predicted by the ESIA or did not develop as predicted by the ESIA;
- any changes in the Project or new developments arising subsequent to the completion of this ESIA.

M.1.4 Objectives, targets and plans for management throughout the life of the Project

This element of the ESMS pertains to the setting of objectives and targets for environmental and social management, and plans for the achievement of these objectives and targets at corporate and Project/ site levels. The ESMP described below embodies this element of the ESMS at the Project level.

The primary purpose of the ESMP is to guide environmental and social management throughout the life of the Project. The core of the ESMP is a statement of environmental and social management objectives and associated management measures. The ESMP will be supported by other documentation, such as the original Project design (described in Chapter 4) and specific management plans and operating procedures. The ESMP and its supporting documents serve the same function as the 'Environmental Management Plan' referred to in the Pakistan regulations and the 'Action Plan' used in the Equator Principles and the IFC Performance Standards.

The preliminary ESMP commitments presented are derived from the following sources:

- inherent design or management measures described in the Chapter 4 Project Description of the ESIA;
- mitigation and enhancement measures identified in Chapters 7 and 8 of the ESIA, which are required to manage identified impacts; and
- good practice management measures presented in Chapters 7 and 8 of the ESIA, which may not significantly alter the impact rating but are considered standard industry practice for the management of such impacts.

Recommended components of a preliminary ESMP are listed as follows.

- Impact reference – this specifies the impact/s the proposed management measure influences.
- Objective - statement of the objective of the management action/s, which generally addresses the impact/s.
- Reference number - a unique reference for the management measure, which enables cross referencing if a management measure is applicable to more than one impact group or objective.
- Type – an abbreviation indicating the type of the management measure (ID = inherent design or management, MM = mitigation measure, EH = enhancement measure, GP = good practice measure).
- Management measure - a description of the measure or action, which will be clear, concise and specific enough to enable execution of the action. Where

relevant, the appropriate targets, indicators, trigger points and/or threshold levels will be incorporated into the management measure. If a set of management actions is required to meet the objective, the ESMP will be simplified by making a commitment to develop an appropriate supporting document in which the detail will be provided.

- Project phase – an abbreviation indicating the project phase/s when the management measure is applicable (DD= Detailed design, C = Construction, O = Operation, D = Decommissioning, PD = Post Decommissioning).
- Timing – the time when the management action should be implemented and/or completed, and if relevant, how frequently it should be undertaken.
- Achievement criteria – an indication of how achievement of the management measure will be assessed, which will be used to develop the monitoring, inspection or audit programmes.

The preliminary management measures presented in the ESMP tables have been derived in response to the ESIA; however during the project life, the ESMP may need to be amended to address a specific requirement, such as those included in the obligations register (**Section L.1.2**). Therefore, in subsequent updates of the ESMP, the column entitled ‘Source’ may need to indicate additional sources of commitments, for example conditions of approval included in permits, or commitments made to stakeholders.

MPL will define the necessary roles and responsibility to implement the ESMP as outlined in **Section L.2.1** and will track and report on progress in implementing the ESMP as outlined in **Section L.3**.

ESMP supporting documentation

Management plans and other forms of supporting documentation will be developed by MPL or its contractors, where needed, to provide further detail on how key actions identified in the ESMP will be executed. The need for supporting management plans or other supporting documents has been determined initially during the ESIA, based on the risk posed by or complexity of the impact/s or area requiring management. These are indicated in the preliminary ESMP and discussed below.

Recognising the ESMP could become legally binding, by means of the conditions of approval attached to authorizations (licences/ permits), it is considered desirable that the supporting documentation is separated from the ESMP. This allows for flexibility in meeting the objectives and commitments in the ESMP; the ESMP supporting documents can be dynamic documents, adaptable to changing circumstances, and can be modified without renegotiation of regulatory conditions of approval, providing the modifications are in compliance with the objectives in the ESMP.

ESMP supporting documentation that should be developed, some of which is currently being developed, includes:

- construction management plans for each main Project area
- stakeholder engagement plan;
- employment policy,

- local procurement and supplier policy;
- training and skills development plan;
- community development strategy;
- emergency preparedness, response and recovery plan;
- energy management plan;
- water management plan;
- erosion and sediment control plan;
- waste management plan;
- air quality management plan;
- Biodiversity Action Plan;
- hazardous materials management plan;
- spill prevention and mitigation plan.

The supporting documentation may need to be presented differently, depending on the target audience and Project requirements, for example:

- issues-driven format is often required to facilitate communication with regulatory authorities and stakeholders (for example community development plan); and
- an area/activity-driven format is needed for ease of application by the parties responsible for Project execution.

M.2 Implementation (do) elements

Effective implementation and functioning of the ESMP depends on adequate human and financial resources, clearly defined responsibilities for environmental and social management, appropriate training and good communication. An outline of how these features will be managed for the Project is presented below.

M.2.1 Roles and responsibility

MPL will define, document and communicate the environmental and social management roles and responsibilities of Project personnel, including contractors and others working on behalf of the company, in all phases of Project implementation from detailed design through to post-decomissioning. Personnel with specific roles and responsibilities will have the authority, and be held accountable for, carrying these out.

The basic roles required to implement the ESMP, and establish and maintain the ESMS, are shown in **Exhibit L.3**. These roles need to be reviewed and incorporated into the organisational structures for the various phases of the Project from detailed design through to closure. A key requirement is for the senior environmental management professional to report directly to the on-site senior manager (the Operations/ General Manager).

M.2.2 Contractors, suppliers and vendors

Environmental and social performance, programmes and risk management will be considered in the selection and management of contractors, suppliers and vendors. Contracts will address potential environmental and social liabilities and responsibilities including:

- use of competent, trained staff, including subcontractors;
- consequences for failing to meet obligations;
- monitoring of performance;
- required job-specific, site-specific training;
- compliance with MPL policies and site standards and applicable legal requirements;
- responsibility for chemicals brought on-site and wastes generated on-site; and
- identification of a lead responsible person for both MPL and the contractor.

Contractors, including their employees and associated subcontractors, will be made aware of the environmental risks, associated controls, procedures and standards relevant to their work on-site **(Section L.2.3**). The activities and performance of contractors will be monitored against the terms of the contracts.

Exhibit M.3: Key Roles for Environmental and Social Management

<table>
<tr><th>Roles</th><th>Relevant Responsibilities</th></tr>
<tr><td>MPL chief executive officer</td><td>Endorse the environmental and social management policy and require it to be communicated to the public
Allocate adequate human and financial resources to enable effective functioning and continual improvement of the ESMS
Establish and maintain a governance system</td></tr>
<tr><td>Project site management and MPL senior management</td><td>Policy
Develop, review and update MPL’s policy/s on environmental and social management
Incorporate principles of MPL’s policy/s in business decisions
Compliance
Confirm necessary authorisations (licences/ permits) have been obtained for the Project
Confirm compliance with legal requirements and other obligations pertaining to environmental and social management
Commit contractors and suppliers to meeting relevant environmental and social obligations by means of specific conditions in the contracts of appointment
Roles and responsibility
Define, document and communicate environmental and social management roles, responsibilities and authorities
Provide sufficient appropriately trained human resources and adequate financial resources to enable effective functioning and continual improvement of the ESMS
Hold personnel responsible for meeting their assigned responsibilities
Communication and reporting
Confirm there is adequate on-going stakeholder engagement
Confirm obligations for reporting to regulatory authorities, development financiers and affected communities are met
Management review
Provide leadership in the pursuit of environmental and social management
Examine and review the ESMS periodically to determine its suitability, adequacy and effectiveness
Support action to enhance the ESMS and make improvements in environmental and social management performance</td></tr>
<tr><td>Environmental management</td><td>ESMS
Establish the ESMS, with assistance from the senior management, division managers and community relations managers
Liaise with division managers regarding environmental management roles, responsibilities and authorities throughout operational divisions
Coordinate monitoring and evaluation activities and confirm corrective actions (an action taken to address a non-conformance) are taken to address incidents and non-conformances (a failure to comply with the Project’s ESMS)
Report progress in implementation and functioning of the ESMS to senior management, development financiers, regulatory authorities and stakeholders
ESMP
Keep the ESMP up to date and confirm it addresses all relevant environmental and social obligations
Present the ESMP in an appropriate format for communication with regulatory authorities and other stakeholders
Present the ESMP in an appropriate format for communication with parties responsible for Project execution
Compile ESMP compliance reports
“Sign-off” actions in the ESMP and non-conformances once they have been completed</td></tr>
</table>

Roles	Relevant Responsibilities
Community relations management	• Assist the Environmental Management team with on-going reporting to stakeholders on ESMP and supporting management plans, and progress with implementation of management measures • Assist Environmental Manager and division managers with stakeholder communication where awareness and/ or co-operation of stakeholders are required to implement management measures • Manage the grievance mechanism

Division management	• Confirm the ESMS and ESMP are established, communicated, implemented and maintained in their respective areas
	• Provide leadership in the pursuit of environmental and social management
	• Identify ways to improve environmental and social performance through daily monitoring of their activities and evaluating implementation
	• Review monitoring results, incidents and corrective actions taken
	• Evaluate adequacy and effectiveness of awareness and skills training programmes pertinent to environmental and social management
	• Maintain internal communication of environmental and social matters between the Environmental Manager, Community Relations Manager and other personnel, and promote environmental and social awareness.
	• Examples of key responsibilities of specific Division Managers include:
	  • **Human resources**: Organise in association with the Environment Manager and Community Relations Manager environmental and social related training and maintain linkages between the ESMS and human resources management systems, as necessary
	  • **Finance:** Track budget/spend data used in implementing and maintaining ESMS in association with the Environment Manager and Community Relations Manager
	  • **Operations:** With the support of environment and community relations teams, identify environmental and social aspects requiring management, opportunities for pollution prevention and rational use of natural resources
	  • **Purchasing:** With the support of environment and community relations teams, assess contractors' and suppliers' environmental and social compliance and control purchase and disposal of hazardous materials
	  • **Maintenance:** Implement preventive maintenance programme for equipment
	  • **Health, safety and security:** With the support of community relations teams, confirm safeguarding of personnel and property is carried out without adverse impacts on local communities

All personnel and contractors	• Comply with MCL policies, site standards and applicable legal requirements • Work in accordance with the ESMP and supporting documents • Report problems or deviations from the ESMS or ESMP to division managers and/or environmental managers, as instructed.

M.2.3 Training

Personnel, including contractors' personnel, working for or on behalf of the Project will receive training to maintain awareness of relevant environmental and social aspects, impacts and risks associated with the Project and corresponding controls. The training will also maintain awareness of the environmental benefits of improved personal performance and the potential consequences of departure from specified procedures. Visitors to Project sites will receive relevant environmental and social awareness training as part of site induction training.

Personnel, including contractors' personnel, will be made aware of the particular environmental and social management responsibilities that apply specifically to their jobs. Training needs analyses will be undertaken and personnel will be given adequate training to meet these responsibilities.

The training programme comprises the following elements:

- identification of training needs for all employees specific to their varying responsibilities;
- development of a training plan and schedule to address defined needs;
- verification of training programmes to confirm consistency with organisational requirements;
- training of employees and documentation of training received;
- evaluation of training effectiveness; and
- review and modification of training programmes, as required.

Personnel with direct responsibility for implementation of the ESMP and functioning of the ESMS will have additional training to:

- provide them with the knowledge and skills necessary to perform their work;
- maintain their knowledge of relevant environmental and social obligations; and
- enable them to implement specific measures required under the ESMP in a competent and efficient manner.

Training requirements and completed training will be documented. Procedures to evaluate the effectiveness of such training will be implemented.

M.2.4 Communication

To effectively implement environmental and social management, the relevant managers will maintain lines of internal communication and provide information regarding the ESMP, ESMS and environmental and social management performance, incidents, best practices, lessons learned and concerns to personnel electronically, on notice boards and/or in newsletters. Such communication will be used to inform the personnel of their individual responsibilities with respect to the ESMS and to raise awareness on specific matters. External stakeholder engagement is discussed in **Section L.5**.

A grievance mechanism will be established (**Section L.5**) and will provide a means for Project personnel, including contractors' personnel, to anonymously raise environmental and social concerns (this grievance mechanism will be separate from the system dealing with employee grievances that need to be handled by the human resources department).

M.2.5 Operational controls

Operational controls will be implemented to maintain performance and compliance, and to manage impacts and risks. Operational controls may include:

- administrative controls such as performance standards;
- standard operating procedures and work instructions; and
- engineered controls such as pollution control equipment.

Written operational controls are required where their absence could lead to deviation from environmental obligations or objectives and targets. Written operational controls will be part of the ESMP supporting documentation (**Section L.1.4**).

The adequacy, suitability, and effectiveness of operational controls will be reviewed regularly.

Documentation on the design basis and operating criteria/limits for equipment having the potential to impact environmental performance will be maintained.

Operating equipment, as well as environmental monitoring and measurement devices, will be maintained consistent with manufacturers' specifications and best management practice to reduce the potential for environmental incidents and adverse environmental impacts.

M.2.6 Documentation and record keeping

Elements of the ESMS will be documented and controlled in accordance with a document control system. Records demonstrating compliance with legal requirements and conformance with the ESMS will also be maintained. MPL will establish, implement and maintain procedures for:

- ESMS document control detailing how the creation, review and updating of various types of documents will be managed and who will be responsible; and
- record identification, storage, protection, retrieval, retention and disposal.

Documentation and record keeping controls will include:

- measures to enable relevant documents (including those of external origin deemed necessary for planning and operation of the ESMS) and records to be readily available and identifiable (labelled, dated and properly filed), legible and protected from damage;
- review, revision and approval of documents for adequacy by authorised personnel at least once a year;
- making current versions of relevant documents available at locations where operations essential to the effective functioning of the ESMS are performed;
- suitably identifying obsolete documents retained for legal and knowledge preservation purposes; and
- identification and segregation of confidential and privileged information.

M.3 Check elements

Checks are required to confirm the existence of an effective ESMS and compliance with the ESMP. Checks include monitoring, site inspections and formal audits. Linked to this, measures need to be taken to remedy non-conformances and to continually improve environmental performance. These activities fall under the heading "assessing, correcting and improving performance". Incident reporting (**Section L.3.2**) and reporting on the effectiveness of the ESMS and compliance with the ESMP (**Section L.3.3**) are also classified as "check" elements of the ESMS.

M.3.1 Assessing, correcting and improving performance

Monitoring programmes

The aim of monitoring program is to:

- provide measurements of environmental and social impacts of the Project;
- ascertain and demonstrate compliance with conditions of approval and other legislation;
- provide sufficient evidence to address any claims made against the Project in respect of environmental and social matters;
- track performance of the ESMS and progress in the implementation of the ESMP;
- track and measure key indicators and other performance measures over time to improve the Project's performance and reduce the likelihood of environmental incidents; and
- inform decision processes for determining management actions.

The monitoring programmes cover the physical, biological and social components of the operation and are integrally linked with the assessment criteria stated in the ESMP. Where appropriate and possible, the sampling parameters and locations used in the ESIA baseline studies have been retained to provide data continuity.

The monitoring programme identifies monitoring parameters, sampling locations, sampling frequency and duration and detection limits (where appropriate). It includes control sites, where relevant. The focus and extent of monitoring is commensurate with the risk of impacts occurring, the sensitivity of the surrounding areas and the affected communities' perceptions of risks to their health and environment. For some types of monitoring, thresholds or targets are available (and included in the environmental or social management programmes described above), for example the emission and ambient limits included in the Project's Environmental Design Criteria and Guidance Report. In other cases, the monitoring results will be compared to the baseline data set gathered as part of this ESIA. Lastly, where neither thresholds nor baseline data are available, the initial data collection may form the baseline for future data collection.

Data will be documented and interpreted. Temporal and spatial trends in the data will be discerned and compliance with relevant thresholds will be evaluated. Monitoring reports will be produced to meet internal and external reporting requirements (**Section L.3.2**). If monitoring results indicate non-conformance with stipulated thresholds or if a significant deteriorating trend is observed, it will be recorded as a non-conformance and handled by the non-conformance and incident procedure (**Section L.3.2**).

Preliminary monitoring programmes have been prepared and are presented in **Section 11** of the ESIA, 'Environmental Management and Monitoring Plan'. These provide a framework of monitoring to evaluate performance and assist in predicting and managing impacts. In conjunction with the development of supporting documentation for the ESMP (**Section L.1.4**), detailed monitoring plans, with appropriate sampling protocols where relevant, may need to be developed. These more detailed supporting documents would include the criteria against which the monitoring results will be compared and the actions required if the criteria or thresholds are exceeded. The supporting documents may also cover:

- sample or data collection methods;
- sample handling, storage and preservation;
- sample or data documentation;
- quality control;
- data reliability (calibration of instruments, test equipment, and software and hardware sampling);
- data storage and backup, and data protection;
- interpretation and reporting of results; and
- verification of monitoring information by qualified and experienced external experts.

The frequencies and locations of monitoring may need to be adjusted depending on final Project design and ongoing review of results obtained by the monitoring programmes. Therefore the programs will be reviewed on a regular basis (at least annually) and adjusted, where necessary. Changes to the ESMP or obligations register may also result in changes to the monitoring programme (**Section L.4.2**).

Site inspections

Site inspections will be undertaken regularly in relevant areas of the Project. The inspections will focus on compliance with the ESMP and conformance with the ESMS. The inspections will play an important role in increasing awareness of ESMP and ESMS requirements.

Minor non-conformances will be discussed during the inspection and recorded as a finding in the inspection report. Major non-conformances will be reported as incidents (**Section L.3.2**). Inspection results will be disclosed at management meetings.

Formal audits

Formal audits will be undertaken at planned intervals in accordance with the requirements of MPL, MPL's owners and regulatory authorities. Procedures for audits will be established, implemented and maintained. These will cover the audit criteria, scope, frequency and methods, and will address the responsibilities and requirements for planning and conducting audits, reporting results and retaining associated records.

Negative findings arising from an audit will be dealt with in accordance with the non-conformance and incident procedure (**Section L.3.2**). Results from audits and evaluations of compliance with legal requirements will be reported to site and senior management and subject to management reviews (**Section L.4.1**).

M.3.2 Non-conformances and incident reporting

Non-conformances include the following:

- exceedances of relevant thresholds as identified during routine monitoring;

- non-conformances with the requirements of the ESMP or supporting documentation identified during an internal inspection;
- non-conformances identified during an audit or by regulatory authorities, including legal non-conformances;
- events, such as spills, resulting in potential or actual environmental harm;
- events that did or could result in injury to staff, visitors to site or surrounding communities; and
- significant complaints or grievances received from any source.

Corrective and preventive actions will be identified and implemented in response to these non-conformances. These actions will address the root cause of the non-conformance and will reduce or prevent repeated non-conformances.

A process will be established for the identification, investigation and tracking of non-conformances, including:

- prioritising and classifying non-conformances based on the type and severity of the non-conformance;
- recording of non-conformances and the results of corrective and/or preventive actions, including the actions necessary to mitigate or remedy any associated impacts;
- defining results expected from the corrective and/or preventative actions;
- confirming the corrective and/or preventive actions taken to eliminate the causes of the non-conformance are appropriate to the magnitude of problem and commensurate with the impacts encountered;
- reviewing the effectiveness of the corrective and/or preventive actions taken; and
- implementing and recording required changes in the ESMP or monitoring programme resulting from corrective and preventive action.

Serious non-conformances will be classified as incidents. Incidents will be promptly reported to appropriate management. MPL will prepare a guideline on:

- the types of incidents reportable to internal management at the site, Project and corporate levels, as well as to regulatory authorities and other external stakeholders; and
- standards to be observed when reporting incidents.

The investigation of incidents and evaluation of effectiveness of existing controls and response actions will be undertaken at a level commensurate with the severity of the incident.

M.3.3 ESMP and ESMS Reporting

Progress on compliance with the ESMP and functioning of the ESMS (environmental and social performance) will be reported to:

- Project site and MPL senior management;

- development financiers, if required in terms of the loan agreement;
- regulatory authorities, as required; and
- affected communities and other stakeholders who have an interest in the Project (**Section L.5**).

Annual reports will be prepared.

M.4 Act elements

M.4.1 Governance/management review

Project site management and MPL senior management will review the ESMP and ESMS on a periodic basis to determine its suitability, adequacy and effectiveness. Each management review will initiate a new plan-do-check-act cycle with enhancement of the ESMS and continuous improvements in environmental and social management performance. The management review will cover:

- progress and closure of actions from previous management reviews;
- monitoring programmes findings/ the extent to which objectives and targets have been met;
- findings of audits (**Section L.3.1**);
- incidents and the status of corrective and/or preventative actions (**Section L.3.2**);
- impact and risks assessments (**Sections L.1.3 and L.4.2**);
- changing circumstances, including changes to operations, Pakistan legislation or guidelines, ownership, socio-political circumstances (**Section L.1.2**);
- legal compliance and compliance with other obligations (**Sections L.1.2**);
- stakeholder concerns, requests or complaints (**Section L.5**);
- adequacy of policies, ESMP, monitoring plans, support documents and overall functioning of the ESMS to meet operational and corporate requirements; and
- recommendations for improvement.

M.4.2 Management of change

Changes to the Project can be expected throughout the life of the Project. These can range from changes to operations and infrastructure, new developments (such as an expansion), changes to personnel and the Company, changes in legislation and changes to the environment of the Project (such as a new settlement established near Project infrastructure). These changes could result in changes to the significance of environmental and social impacts and risks. This may necessitate updates to existing authorisations/ permits, changes to the ESMP, which may have to be approved by regulatory authorities, and general changes to the ESMS framework.

A procedure for the management of change will be established and maintained by MPL. This will:

- observe the corporate owners' requirements for the management of change;

- identify proposed changes that could alter environmental or social impacts and risks and/ or require new authorisations/ permits or changes to existing authorisations/ permits; and
- define the impact and risk assessments appropriate to different types of changes, which need to be undertaken by competent personnel.

Changes will not be made without the required authorisations/ permits in place. The measures identified as necessary to mitigate impacts and risks will be implemented. The various elements of the ESMS will be modified as required in response to the change,

A procedure specifically for changes to the policy/s, ESMP, monitoring plans and supporting documentation will be established. This will detail:

- how the changes are to be recorded;
- who has responsibility for overseeing changes and checking they do not conflict with any planning conditions or other obligations;
- the process of review and sign off in response to changes; and
- how changes to the ESMP should be communicated internally and externally.

M.5 Stakeholder engagement plan

Stakeholder engagement provides stakeholders with opportunities to express their views on project risks, impacts and impact mitigation measures and involves appropriate consideration of the views and responses by project management (IFC 2007**).** **Exhibit L.1** shows stakeholder engagement applies to each of the steps of ESMS “plan-do-check-act” cycle and is an integral part of several ESMS elements. The relationship between stakeholder engagement and these elements is explained further in **Exhibit L.4**.

MPL has established a program of stakeholder engagement for the Project and this will continue throughout the life of the project. Currently, this program includes:

- disclosure of information and consultation with stakeholders as part of the ESIA process (**Section L.3.3**); and
- a grievance mechanism, for receiving concerns about the Project’s environmental and social performance and for facilitating the resolution of the concerns (the grievance mechanism applies to Project stakeholders, including potentially affected communities and Project personnel (**Section L.2.4**).

When the Project enters the construction phase, and throughout the remaining life of the Project, stakeholder engagement will include:

- reporting on the implementation of the ESMP and relevant supporting management plans;
- opportunities for stakeholders to respond to the information received; and
- constructive dialogue on environmental and social issues and performance.

The stakeholder engagement process will be documented, including:

- maintenance of a stakeholder database with stakeholder details;
- records of information disclosed to stakeholders;
- records of stakeholder engagements; and
- records of inputs from stakeholders and responses to these.

Exhibit M.4: General Overview of the Relationship between Stakeholder Engagement and the ESMS Elements

Steps of the "plan-do-check-act" cycle	ESMS elements that stakeholder engagement is integral to	
	ESMS elements	**Role of stakeholder engagement**
Plan	ESIA	During the ESIA, the focus of stakeholder engagement has been the involvement of stakeholders in project-planning and project-approval decision-making processes. It facilitated identification of stakeholder's concerns so they could be addressed in the Project design and/or ESMP. It forms the basis for stakeholder engagement throughout the life of the Project.
	ESMP	Stakeholders will be involved in the review and approval of the preliminary ESMP. Throughout the life of the Project, there will be ongoing reporting to stakeholders on progress in the implementation of the ESMP and supporting management plans that are of interest to them. The ESMP and supporting management plans may need to be revised in response to stakeholders' concerns.
Do	Communication	Communication with stakeholders will be required to implement some management actions. The communication will be required to raise awareness and/or co-operation of potentially affected communities and other stakeholders. MCL will determine effective communication methods for making affected communities aware of actions they may need to take to avoid exposure to operation-related hazards and how they can maximise on opportunities resulting from the operation.
Check	Assessing, correcting and improving performance	Participatory monitoring is desirable. This entails involvement of stakeholders, particularly affected communities, in monitoring and verifying information to check that impact mitigation measures are appropriate.
		Grievances will be handled as incidents and managed through the incident procedure to enable the grievance to be received, documented, addressed and results fed back to the complainants. This procedure will protect the confidentiality of the persons raising the complaint, where necessary. The feedback will be easily accessible and understandable to members of the affected community and/or staff.
	Reporting	Stakeholders affected by the Project will be informed of progress in the implementation of the management plans and of the effectiveness of management measures.

M.6 Emergency preparedness and response

The Project will implement and maintain an Emergency Preparedness. Response and Recovery Plan (EPR&R). The purpose of the EPR&R is to provide a framework for a comprehensive system to:

- establish a process to identify potential emergency situations prior to their occurrence;
- take steps to prevent or minimize the impact of potential emergencies;
- train personnel to appropriately identify, report and respond to emergencies;
- provide and maintain emergency response resources and equipment to mitigate potential emergencies;
- define detailed procedural steps to respond and manage various types of potential emergencies;
- provide information to and consult with the surrounding community regarding environmental risks and response measures;
- co-ordinate with external emergency response organizations;
- test communications, emergency procedures and equipment on a periodic basis;
- contain, where practicable, any emergencies and their effects within Project site boundaries;
- safely return to normal operations following an emergency;
- identify the cause(s) of an emergency event and the corrective and preventative measure to avoid a reoccurrence; and
- review and update plans and procedures based on lessons learned from tests and responses to actual emergencies.

The EP&R will be prepared in accordance with:

- IFC Performance Standards (PS) PS3 Pollution Prevention and Abatement and PS4 Community Health and Safety, which require that a plan is in place to effectively respond to emergencies associated with project hazards and that local communities are involved in the planning process;
- World Bank Group General EHS Guidelines, Volume 3 Community Health and Safety, Emergency Preparedness and Response and the equivalent sections of the Sectoral EHS Guidelines relevant to the Project;
- United Nations Environment Programme (UNEP) guidelines for Awareness and Preparedness for Emergencies at Local Level (APELL), including the guidelines for dangerous goods transport (UNEP 2000); and
- the UNEP guideline on good practice in emergency preparedness and response (2005).

For the purposes of the EPR&R, the term "emergency" will refer to an unplanned event when a project operation loses control, or could lose control, of a situation that may result in risks to human health, property or the environment. The EPR&R will not cover safe work practices for frequent upsets or events, which will be covered by occupational health and safety plans.

The EPR&R will contain the following elements:

- administration (relevant policy, purpose, distribution, definitions, scope, criteria for triggering the EP&R, date and frequency of updates);
- organisation of emergency areas (for example command centres and medical stations);
- roles and responsibilities;
- communication systems (worker notification and communication, community notification, media contacts and media relations strategy);
- emergency resources (finance and emergency funds, fire services and medical services, mutual aid agreements provide a clear basis for response by mutual aid providers, contact list);
- emergency equipment (such as location of isolation valves, helicopters and equipment for fire fighting, toxicity testing, personal protection and pollution prevention equipment);
- training and drills;
- updating (to account for changes in equipment, personnel, and facilities);
- checklists (role and action list and equipment checklist);
- business continuity and contingency (including measures to allow business continuity following an emergency, back-ups of critical information in a secure location to expedite the return to normal operations following an emergency and alternative supplies of resources such as water); and
- clean up (options and procedures for clean-up following accidents);
- emergency scenarios and risks (identified scenarios, people and environments at risk, maps of risk areas, locations of hazardous substances and properties of hazardous substances);
- emergency response procedures for each emergency scenario (with specific information on specific procedure triggers, response actions, equipment, relevant notification procedures, relevant communication procedures, alarm systems, relevant evacuation procedures, relevant media procedures, medical procedures, assessment, monitoring and recording of the progress of the accident, procedures for operational shut down if necessary, relevant procedures for clean up, recording of actions taken to respond and de-activation of the procedure); and
- review (to identify missing or weak elements, consistency with any regional and national disasters plans and compliance with relevant legislation and codes).
- The emergency scenarios covered by the EPR&R will be determined by means of risk assessments. Procedures will be developed for at least the following events:
- off-site chemical, oil or fuel spills;
- on-site chemical, oil or fuel spills;

- emergencies arising from natural hazards such as earthquakes, sandstorms, extreme heat/cold, flash floods, monsoons, earth moving, and extreme precipitation;
- security incidents such as lost contact/ missing person, sabotage or a threat to kill/injure employees;
- vehicle or equipment accidents;
- medical emergencies;
- fire; and
- blasting and explosives accidents.

The EPR&R will distinguish between two types of emergencies as follows:

- Type 1 – emergencies contained within Project site boundaries requiring use of MPL's emergency resources, but not requiring external resources;
- Type 2 – emergencies not contained within the Project site boundaries and/ or requiring involvement of external resources.
- Type 2 emergencies require application of relevant APELL guidelines. The primary goals of APELL are:
- to raise awareness of local communities living close to industrial activities on how to react if an accident happens; and
- to establish adequate coordination and communication in situations where the public might be affected by accidents and emergencies arising from natural hazards (such as floods).

APELL is a multi-stakeholder dialogue working through a stepwise process comprising the 10 steps listed in the textbox below.

The APELL process

- **Step 1** – identify emergency response participants and establish their roles, resources and concerns;
- **Step 2** – evaluate risks and hazards that may result in emergency situations in the community and define options for risk reduction;
- **Step 3** – have participants review their own emergency plan, including communication for adequacy relative to a coordinated response;
- **Step 4** – identify the required response tasks not covered by existing plans;
- **Step 5** – match to resources available from the identified participants;
- **Step 6** – make changes necessary to improve existing emergency plans, integrate them into an overall community plan and gain agreement;
- **Step 7** – commit the integrated community plan to writing and obtain endorsement for it and relevant approvals;
- **Step 8** – communicate final version of integrated plan to participating groups and ensure that all emergency responders are trained;
- **Step 9** – establish procedures for periodic testing, review and updating of the plan; and
- **Step 10** – communicate the integrated plan to the general community.