Environmental and Social Impact Assessment (Draft)

Project Number: 47929
September 2013

PAK: Gulpur Hydropower Project

Prepared by Mira Power Limited

MIRA POWER LIMITED

Ref: D3V01ESIA

September 20, 2013

Environmental and Social Impact Assessment (ESIA)

and

Environmental and Social Management and Monitoring Plan (ESMMP)

100MW Gulpur Hydropower Project

Kotli, Azad Jammu and Kashmir - Pakistan

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LIST OF ACRONYMS

ADB	Asian Development Bank
AJK	Azad Jammu & Kashmir
AJK-EPA	Azad Jammu & Kashmir Environmental Protection Agency
AJK-EPC	Azad Jammu & Kashmir Environmental Protection Council
AJK-HEB	Azad Jammu & Kashmir Hydro Electric Board
BACT	Best Available Control Technology
BOD	Biochemical Oxygen Demand
BOOT	Build, Own, Operate and Transfer
BP	Bank Procedures
BPEO	Best Environmental Practicable Option
CBD	Convention on Biological Diversity
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CEMP	Construction Environmental Management Plan
CEO	Chief Executive Officer
CFC	Chlorofluorocarbon
cfu	Colony Forming Unit
CITES	Convention on International Trade in Endangered Species
CMP	construction management plan
CMS	Conservation of Migratory Species
COD	Chemical oxygen demand
COO	Chief Operating Officer
CSC	Construction Supervision Contractor
CSR	Corporate social responsibility
Cumecs	Cubic Meter per Second
DHQ	District Headquarter
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
El.	Elevation
EMMP	Environmental Management and Monitoring Plan
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EPA	Environmental Protection Agency
EPC	Environmental Protection Council
EPC	Engineering, Procurement and Construction
EPRRP	Emergency Preparedness, Response and Recovery Plan
ER	Encounter Rate
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
FAP	First Aid Post
FCCC	Framework Convention on Climate Change

FGDs	Focused Group Discussions
GCP	Ground Control Points
GHG	Green House Gas
GHPP	Gulpur Hydropower Project
GIIP	Good International Industry Practice
GIS	Geo Information System
GoP	Government of Pakistan
GWh	Gigawatt Hour
HCFC	Hydro Chlorofluorocarbon
HSE	Health Safety Equipment/ Health, Safety and Environment
IDC	Indirect Costs
IEE	Initial Environment Examination
IFC	International Finance Cooperation
IP	Indigenous Peoples
IPP	Independent Power Producer
IR	Involuntary Resettlement
IUCN	International Union for Conservation of Nature
KDA	Kotli Development Authority
KOSEP	Korea South East Power Company
LAA	Land Acquisition Act
LAC	Land Acquisition Collector
LARP	Land Acquisition and Resettlement Plan
LDL	Lowest Detection Limit
LOI	Letter of Interest
LOS	Letter of Service
LPDAAC	Land Processes Distributed Active Archive Center
LPG	Liquid Petroleum Gas
M&E	Maintenance and Engineering
MAF	Million Acre-Foot
MCH	Mother Child Health Care
MCM	Million Cubic Meters
MPL	Mira Power Limited
MSDS	Material Safety Data Sheet
MW	Megawatt
NASA	National Aeronautics and Space Administration's
NCS	National Conservation Strategy
NDVI	normalized difference vegetation index
NEQS	National Environmental Quality Standards
NESPAK	National Engineering Services Pakistan
NOC	No Objection Certificate
NOL	Normal Operation Level
OM	Operations Manual
OP	Operational Policy
PIC	Prior Informed Consent

PM	Particulate Matter/Project Manager
PPE	Personal Protective Equipment
PPIB	Private Power & Infrastructure Board
PS	Performance Standard
PWD	Population Welfare Department
RCC	Reinforced Cement Concrete
SCP	Spill Contingency Plan
SPA	Share Purchase Agreement
SPS	Safeguard Policy Statement
SR	Safeguards Requirement
SSC	Species Survival Commission
TBT	Tool Box Talks
TDS	Total Dissolved Solids
TNTC	Too Numerous to Count
USBR	United States Bureau of Reclamation
WAPDA	Water and Power Development Authority
WCMC	World Conservation and Monitoring Centre
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

Today Pakistan is facing multifarious problems and challenges. These challenges are not a product of sudden incident; rather it is a cumulative outcome of lack of planning and misplaced priorities of the state. Among these challenges, energy crises is the acute one as it is energy that derives the engine of economy and overall functions of modern economic order. The power sector in Pakistan has been facing shortages of electricity generating capacity due to low pace of development of new power plants to meet the growing demand for electricity. This has been aggravated by the rising price of oil, shortage of natural gas and lesser focus on hydropower development. The effect of the large gap between demand and supply of electric power has led to massive load shedding in Pakistan and in Azad Jammu and Kashmir. Due to the widening of this gap, all walks of life from industry to domestic are being adversely affected.

The primary cause for this worse energy crisis among others is the expensive energy mix which is predominantly fossil fuel based resulting heavy dependency on expensive oil imports and depleting natural gas reserves. For the long term energy security of the country and to ensure sustainable development of the country, hydropower development is considered as the most feasible option, which is in abundance in Pakistan. Development of hydropower is also considered as attractive to help improving the management of the national water resources which supports one of the largest irrigation systems in the world, upon which agriculture of the country is heavily dependent. Given the gravity of situation in energy sector and opportunities it provides for private sector to invest, a 100 MW Hydropower Project in Gulpur on the Poonch River is proposed by the Private Power & Infrastructure Board (PPIB).

This study assesses the environmental and social impacts associated with the construction and operation of the Gulpur Hydropower Project. The Environmental Social Impact Assessment (ESIA) was performed in four main phases of scoping, baseline data collection, impact assessment and documentation. Scoping phase entails project data compilations, review of published literature, legislative review and identification of potential impacts. While preparing the report great attention is paid to ensure that the ESIA process and results are prepared according to the relevant guidelines set by the Environmental Protection Agency (EPA), ADB and IFC.

Policy, Legal and Administrative Framework

Any development initiative specially related to hydropower has to take into consideration the legal responsibilities of the proponent in the context of the environment and sustainable development, and the requirements of the institutions that may influence the environmental management of the proposed project. The Pakistan National Conservation Strategy (NCS) that was approved by the federal cabinet in March 1992 is the principal policy document on environmental issues in the country as well as AJK (EUAD/IUCN, 1992). The core areas that are relevant in the context of the proposed project are pollution prevention and abatement, restoration of rangelands, increasing energy efficiency, conserving biodiversity, supporting forestry and plantations, and the preservation of cultural heritage. The Government of Pakistan promulgated “Pakistan Environmental Protection Act” in 1997. The same was adopted by the Government of AJK. However, this act was adapted to meet the state’s requirements and notified in 2000 as Azad Jammu and Kashmir Environmental

Protection Act, 2000. Environmental Protection Agency headed by a Director General has the responsibility for establishing Biodiversity Action Plan at a country level.

Under Section 11 of the 2000 Act, a project falling under any category (qualifying IEE or EIA) requires the proponent to file IEE or EIA with the AJK-EPA. In the absence of AJK-EPA guidelines for environmental assessment, those laid down by Pak- EPA have been followed. The Pak-EPA has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development projects. Other important policy documents and legal requirements of the project are: National Environmental Quality Standards (NEQS), National Resettlement Policy and Ordinance, The Land Acquisition Act, 1894, The Forest Act, 1927 and the Forest (Amendment) Act 2010, The Jammu and Kashmir Forest Regulations, 1930, The AJK Wildlife (Protection, Preservation, Conservation and Management) Act, 1975, Azad Jammu and Kashmir, Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2012, The Antiquities Act, 1975, The Motor Vehicles Ordinance, 1965, and Rules, 1969, The Factories Act, 1934, The Pakistan Penal Code, 1860, The Explosives Act, 1884

Owing to its magnitude the proposed project involves various stakeholders and institutions. Therefore, it is indispensable to interaction with different agencies. This engagement will ensure that the project complies with the laws and regulations controlling the environmental concerns of dam construction and operation, and that all pre- construction requisites, such as permits and clearances are met. Besides providing overview of Policy, Legal and Administrative Framework, the section 2 also adumbrates guidelines of Asian Development Bank and requirements of IFC related to the Project.

Project Description

The Gulpur Hydropower Project site is administratively located in Kotli District of Azad Jammu and Kashmir. It is located at latitude 33°27’ and longitude 73°51’, which is about 5 km South of Kotli Town. The site is approximately 167 km from Islamabad and 285 km from Lahore, and is accessible directly from Islamabad and Lahore by a two-lane (and partially paved) mountainous road. The proposed Gulpur Hydropower Project will exploit the water resources of the Poonch River for power generation. It will comprise four main components, viz., Weir, Intake Structure, Power Tunnel and Power House. The Weir will be located near Aghar Colony on the Poonch River at about 5 km downstream of Kotli Town and about 250 m downstream of the confluence of Ban Nullah with the river. The Intake Structure and intake portal of the Power Tunnel will be located on Ban Nullah about 2 km upstream of its confluence with the Poonch River. The Power House and outlet portal of the Power Tunnel will be located on Poonch River about 6.5 km downstream of the Weir structure.

Land Acquisition requirements of the Project are directly related to the consideration of design alternative to construct the earthen Dyke in the submerged area. The proponent has carried out detailed analysis of land requirements and resettlement requirement under following the two options. Under Option 1 an earthen Dyke shall be constructed in the submerged area to curtail the land acquisition and land resettlement while under Option 2 “No Dyke” was proposed. Under the selected Option 2 Under “No Dyke” option the project will consume 13% (113 Acres) of the total area for building structures, reservoir, colony, and camp and approach roads. About 87 percent (804 Acres) of the land required for the proposed project will be utilized for the reservoir. In total the

proposed project will required 920 Acres of land; major portion (74 percent) of this land is owned by the Government while only 26 percent land in privately owned.

A 2-stage river diversion plan has been proposed for the construction of the Weir. The diversion will be manipulated within the river section by constructing coffer dams. It is anticipated that the Project would take about 45 months for its completion and commissioning.

It has been estimated that the project will employ about 700 skilled, semi-skilled and unskilled workforces for its construction and commissioning. 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. The project falls in a terrain that is constituted of high hills having steep slopes with narrow valleys in between. The contractor would need to develop access roads for all the sites. The section on project description provides plan of alternative and access roads. The Project will deploy various types of machineries for construction purposes. These will include bulldozers, excavators, shovels, tunneling machine, dumpers, batching plant, tankers, trucks, etc. The project cost will be approximately US$ 340.00 million.

Description of the Physical Environment

Baseline data on physical environment within the area of project influence has been compiled to cover these areas: land, climate and meteorology, water (water resources, water quality, source of pollution and hydrology and air Quality and Noise (noise levels). Some of these areas are directly affected while others may be influenced indirectly. This section highlights the areas of most concerns. Most of the potentially affected areas, except the ones related with the quarries, would fall within a strip of about 4 km wide (on the average 2 km on either side of the Poonch River) and about 10 km in length covering the river stretch from Kotli up to the Power House site.

The study area is a part of land formations developed at the foothills of Himalayan Ranges through tectonic events subsequent to those that caused building of Himalaya. The Project area contains middle Siwalik formations developed from the sedimentary deposits 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. Mostly the mountains are covered with primary soils, except along the river and nullahs where the beds are almost devoid of soil material.

Major geological formations in the project area are; Pleistocene and Recent Deposits Overburden, Secree, Talus and Vegetation, Classification of Rocks, Sandstone, and Clay stone/Siltstone. 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 few large earthquakes with magnitude greater than 7.

The towns of Poonch, Sehra, Tatta Pani and Kotli are situated on the banks of this river. It has two major tributaries in Pakistan, Batar and Mendher. The Poonch River originates at an elevation of more than 3500 m and traverses about 110 km from east to west up to the proposed weir site and

fed by many big and small streams on both the banks. Most of the tributaries join the river on its right bank. The relief in the catchment area of Poonch River varies from 200 m to 4500 m. This elevation range was divided into 9 elevation bands with 500 m interval.

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.

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. The average annual precipitation in the area is 1,237 mm. Temperature in different parts of the tract varies according to the elevation. 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.

Mean monthly discharges computed from the mean daily flows shows a minimum value of 12 cumecs observed in January 1966 and maximum value of 830 cumecs in September 1992. The data depicts that mean monthly flows vary between 41 cumecs (106 MCM) in November to 279 cumecs (746 MCM) in August.

Main water resources in the district Kotli are surface water and ground water. The microbiological analysis of the water sample in the project area show that nearly every sample has some biological contamination. Especially the drinking water in Jamal Pur and Aghar Colony has highest microbial count. 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.

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 particulate matter PM_{10} was found 97.14 ug/m^3 at proposed power house site, 87.90 ug/m^3 at proposed camp area, 75.19 ug/m^3 at proposed weir site and 66.77ug/m^3 at proposed batching plant are within standard value of 150 ug/m^3.

The noise level was found in range of 59.7 to 68.1 (dBA) at proposed power house site, 37.0 to 57.0 (dBA) at proposed camp site, 37.3 to 54.8 (dBA) at proposed weir site and 35.9 to 48.9 (dBA) at proposed batching plant.

Description of Biological Environment

The biological component of the study focused on the aquatic ecology, flora, mammals, birds, and reptiles and amphibians. The forests of the area are characterized by the presence of subtropical broad leaved vegetation and are fundamentally Chirpine forest type. These forests are mainly dominated by *Pinus roxburghii* in an altitudinal range of 700-1800m. The sub-tropical forests of the area were mainly dominated by *Pinus roxburghii*. But present figures show that Pinus-Themeda community is becoming sparse which would eventually transform the area into a degraded scrub-

land. Now, the area is characterized by the dominance of herb and shrub layer, comprising *Themeda anathera, Poa annua, Carissa opaca and Adhatoda vasica* over *Pinus roxburghii*.

Most of the population of the area dwells in remote areas that are not easily accessible and thus left with no other option but to rely on medicinal plants for general treatment. Notable among these floras are *Justicia adhatoda, Acacia nilotica, Calotropis procera, Ricinus communis, Morus nigra, Dodonaea viscosa, Achyranthes aspera, Ipomoea carnea, Taraxacum officinale, Eriobotrya japonica, Cissus carnosa, Melia azedarach, Eucalyptus citriodora* and *Ficus carica*.

The data shows that these forests are faced with the problems of overgrazing and deforestation. Regarding floral Diversity that a total of 186 vascular plant species were identified from the area including 3 species of pteridophytes. The Leguminosae and Asteraceae were the largest families of dicotyledons, whereas, Poaceae was largest of the monocotyledons. Biogeographically the area of the Project falls into Irano-Turanian region Floristic region. The Himalayan endemics included 19 species, whose details are provided in the section. Among the rare species *Fraxinus raiboearpa* was the plant that is confined to few localities in north Pakistan and Afghanistan. None of the species found in GHPP study area is listed in the WCMC list in endangered categories.

The project area lies in the humid subtropical zone influenced by monsoon Mediterranean disturbances as well. The forests can be grouped into and Subtropical Broadleaved Forest, and Subtropical Pine Forests. The dominant land use at the project facilities will be agriculture/settlements. Areas devoid of forest make about 25% of the land cover. Overall forest cover is only 18 % that can be treated to be closest to primary; otherwise, the forest cover is not so dense. Similarly for the direct impact areas (project facilities) the forest cover is around 35% with only about 5% being dense.

River Poonch is generally rich in fish diversity and even 21 fish species have been recorded from a stretch of about 10 km. This diversity is quite high for this small river stretch. Among the recorded species, majority of fish fauna belongs to the family Cyprinidae which is comprised of 13 species. Other 8 species are divided among seven families in such a way that five families are represented only by one species and the rest two each by two species. Among the fish fauna of the project area, two species are endemic in Pakistan including AJK, one is endangered, two are Vulnerable, and one is Near Threatened. Quite a good number of species are commercially important. The species *Tor putitora* and *Clupisoma garua* are considered among the esteemed fishes and have very high commercial value.

The Project is located in the "Mahasher National Park" which was notified recently to protect the Endangered Mahasher Fish (*Tor putitora*). The national park through relevant legislation restricts various forms of species exploitation to ensure that the habitat remains pristine and congenial for the indigenous species.

Thirty one families of macro-invertebrates were identified from 546 benthic macro-invertebrate individuals collected during the whole study period. A number of mammalian species including common leopard, black bear, barking deer, jackal, fox and rhesus monkey were reported from the Kotli district of Azad Jammu and Kashmir in past. In order to assess human-wildlife interaction and site two surveys were carried out. Jackal has highest annual sighting rate at 25 animals per

respondent per year followed by fox; 4.7, and rhesus monkey; 2.8. Black bear, leopard cat and wild boar have negligible sighting rates.

Only 12 cases of predation on livestock and poultry were recorded. Jackal was the main predator responsible for almost 92% predations majority; 93%, of which was poultry while remaining were goats. Goats were killed while grazing and poultry was capture from cage most of the time. Only one case of common leopard depredation was reported in which predator attacked on a coral and killed 30 goats at a time.

Seventeen species of small mammals have been collected from the study area belonging to eleven families and five orders. Among reptiles snakes and frogs of different are found in the area. Manzoor et al. (2013) while assessing the biodiversity of the Pir Lasura National Park in District Kotli, Azad Kashmir reported six amphibian and 24 reptilian species. No crocodilians and tortoises are found in the study area; Kotli, AJK and the existing species in the study area include; freshwater turtles, lizards and snakes. Some of the reptilian species are nocturnal in their feeding habits like gekkonid lizards and elapide snakes whereas others are diurnal like agamid, lacertid, varanid and scincid lizards, freshwater turtles and colubrine snakes. A number of surveys were carried out which includes reptile and amphibian diversity survey. Total 21 species of herps including six amphibians and 15 reptiles were recorded during the present study.

Analysis of data on residential status revealed that out of 61 bird's species, 76% were year round resident, remaining were summer breeders, winter visitors and passage migrant. In term of the abundance of recorded species, the undisturbed area depicted the higher diversity of avian fauna.

The Habitat destruction, anthropogenic pressure in the form of tree cutting, firewood collection, grass cutting, and cattle grazing were also observed in these study sites. Out of 21 species found in Poonch River, 12 species are species of special importance. This section on Baseline Ecology provides lists of the species.

Socio-Economic Environment

This section presents a description of the socioeconomic characteristics of the project area, and where available utilizes national and regional level data for providing a more cogent understanding of the context. Socio-economic survey in the project area covered 8 villages/settlements namely 1) Aghar, 2) Barali, 3) Dharang and 4) Gulharin, 5) Hill Kalan, 6) Hill Khurd, 7) Jamal Pur and 8) Mandi.

The district Kotli is the second largest in terms of population in Azad Jammu and Kashmir. The population of the district was 365,000 in 1981 and an increase of 54.37 percent was recorded over the last seventeen (17) years i.e 1981-1998. The human habitation in district Kotli is predominantly determined by its topography as the hilly mountainous terrain limits options for human habitation. Hence, most of the human habitation in the project area is scattered.

Traditionally, the social set up of Kotli was largely based on kinship. The overall social arrangement was based around different clans (baraderi). In the decades of 1960-70s migration of people to abroad for earning shifted the basis of economy. With increasing exposure to market forces and exogenous lifestyle the pattern of interface between different communities also witnessed drastic changes. Despite modernization people still rely on pre-modernization social structure and social

interaction and politics is largely shaped by social dynamics and power relationships. However, access of opportunities in the country and abroad enabled people to find increasing role in the society. The major tribes residing in the district are Syed, Gujar, Jat, Rajput, Awan and Sudhan. Hindko, Gojri and Pahari are the indigenous languages of the district.

Generally the area is peaceful as there are no chronic social and communal conflicts among the communities living in the project area. Major crops are maize, wheat & rice whereas minor crops include vegetables, grams, pulses (red lobia) and oil-seeds. Major fruits are apple, pears, apricot and walnuts. The main economic activity in area remains in agriculture, livestock and service sectors. Of the total land area of about 414,019 acres of Kotli District, 20% is available for cultivation while 80% of the land bears forest, settlements, infrastructures or lie in the form of uncultivable waste land. The survey results show that 11% of the male workforce is comprised of unskilled laborers, whereas no female works as a laborer.

According to the information received from Department of Education AJK, apart from a campus of University of Azad Jammu and Kashmir there is one post graduate college for men and 12 degree colleges for men and women in the district. In the project area each settlement has primary level government schools for boys and girls within an average distance of 2 km. Overall 27% of the population falling above the eligible age of 10 years population is illiterate (20% men and 36% women). Population Health Profile

There is one District Headquarter (DHQ) Hospital in District Kotli, three Rural Health centers, 20 First Aid Posts (FAPs) and 16 Mother Child Health Care (MCH) Centers along with other health facilities at grassroots level. The housing pattern is lavish in terms of size and construction as more than 88% of the structures are pukka, made of cement and bricks with RCC structures. According to Government of AJK, currently 80% of the urban population and 66% of rural population has been provided with a piped water supply through house connections and public stands. The entire population (95%) in the project area has access to drinking water in their houses. 23% use water from wells and 50% use water from both wells and pipeline. 32% have facility of sewerage system, and 57% use septic tank. 7% percent use a pit latrine and 4% use open fields. The majority of households do not have drainage facility (68%).

Electricity connection is available to all the households (100%) in the project area. The women have no formal role in the authority structure of the nearby villages. They are about 48% of the population in these villages; the literacy rate for above 10 years of female population is 67% (80% for males). There is none falling under the category of ultra-poor as all the households have a monthly income which is above PKR 5,000/- and expenditure accordingly. There are some shrines of saints.

Analysis of Alternatives

Alternatives are essentially, different ways through which the proponent can feasibly achieve sustainable development by carrying out a different type of actions, choosing design alternatives or adopting a different technology or design for the Project to create win-win scenario for all stakeholders. Alternatives and mitigation, therefore, cover a spectrum ranging from a high level to very detailed aspects of project design. This section of the report presents the analysis of the alternatives considered for the proposed project. The different alternative proposed are: no project

scenario, alternate methods of power generation, alternate location of the Project, design alternatives and selection of access roads and alignment.

The "No Project" option is least considered option for Pakistan. The country is currently going through the worse power crisis of the history. Energy crisis is considered as major development hurdle in Pakistan and has resulted in massive load shedding in the country hugely deteriorating the economic development and growth. In year 2012-13 reveal that the power shortfall touched the figured of 6,390 MW with average shortfall of 3,886 MW. The total generation was 95,364 GWh during year 2011-12 which represent only 47% capacity utilization. "No Project" scenario is considered or adopted it would mean that the already power deficient economy would suffer even more and at current rate if no power is added to the national grid. Given the gravity of energy crisis and its repercussion on the economy, Pakistan cannot afford to deprive itself of a major project of cheap source of electricity

There are different options available to generate electricity which include but are not limited to production using furnace oil, natural gas, coal, solar and hydel. Out of total 95,364 GWh produced during year 2011-12, only 30% has been generated by Hydel resources, 29% has been produced using natural gas while the 35% generation was dependable on expensive furnace oil. The nuclear energy contributed 5.5%, whereas a minor part of energy also came through diesel and coal.

Non-renewable options such as solar and wind are not brought into the national grid at any of the location in Pakistan, however, few wind projects are at different stages of implementation/ construction. Pakistan imports oil from other countries to meet domestic needs whilst the gas reserves of the country are fast depleting and hence cannot be presently considered as reliable sources of power generation. The only coal used in Pakistan is imported from Indonesia and South Africa. The Thar Coal resources are still in early stages of exploration and are yet to be further evaluated for potential to generate electricity. Wind power is currently in the experimental stage and few projects are under implementation and having lower efficiency and power potential cannot be considered as a replacement or full time substitute of other sources of power generation. Numerous perennial and seasonal rivers are flowing in the north south direction in Pakistan. Hence Hydel power is considered a viable option for a country rich in surface water resources. For a developing country like Pakistan minimum O&M cost makes the hydel power as a viable option.

Hydropower is the cheapest source of electricity in terms of per unit cost and maintenance of the generation system when compared with other alternatives, such as the furnace oil or gas run power plants. Hydropower requires significant initial investment compared with thermal options, however, once the debts are paid back the cost of electricity generation reduces significantly resulting in long term energy security of the country. A typical hydropower project in private sector has a levelized cost around 8-9 US cents/KWh with a generation cost of about 3 US cents/KWh after debt repayments are complete. In comparison the thermal projects (furnace oil based) currently have the levelized cost of around 16.0 US cents/KWh and keep on increasing with time due to continuous increase in oil prices.

In Pakistan the hydro power plants have a plant load factor in the tune of 50% - 60% which is slightly lesser than that for conventional power generation sources with higher load factor of 60% - 80%. However, it is higher than those of other renewable energy options such as wind and wave energy.

The proposed project is located in a greener area where installation of a combustion based power plant would only deteriorate the environment, while installation of hydro power station would not have any greenhouse emissions from plant operations and the positive economic impact would help reduce the pressure on the local natural resources. It is obvious that hydro power plants are the lowest ranked in terms of greenhouse emissions into the environment while the coal power plants are the most notorious when it comes to greenhouse gas emissions.

Series of technical feasibility studies have been carried out for the analysis of the optimum location for the construction of the dam at Gulpur. Two alternative options were considered for possible Poonch River development in two main combinations. Combination-A comprised four sites, which include Sehra, Kotli, Barali and Rajdhani dam sites whereas Combination-B consisted of three sites namely Sehra, Kotli and Gulpur dam sites. Further studies concluded that a new site, which is located near Gulpur Village approximately 7 Km downstream of the Barali dam site which was different from the earlier identified Gulpur site. During the initial stages of the feasibility study, it was noticed that the reservoir level (El 475 m) of proposed Rajdhani Hydropower Project would submerge the newly identified Gulpur site; therefore the site was shifted to an upstream location above the reservoir level of Rajdhani Hydropower Project. During design stage, several locations were examined to find a suitable site where a high storage dam could be built to maximize the power potential and final site location will ensure that the Kotli and Rajdhani Dam can also be constructed along with the Gulpur Dam. To ensure the natural and social environment are not disturbed numerous tweak in the design are included.

During the finalization of the feasibility study of the Project Consultants initially recommended the normal operating level (NOL) of reservoir at El. 550 m. The Project layout involved submergence of about 646 houses and 1800 acres of inhabited area affecting nearly 5,000 people. In an effort to reduce the environmental and social impacts three options were Option 1 was based on the earlier concept where a 75m high dam with NOL at El. 550 m and an underground powerhouse was proposed. Option 2 was essentially Option-1 but with a reduced dam height of 60 m and NOL at El. 535 m. Option 3 was based on the concept wherein the head is partly created by a weir and partly by a tunnel utilizing the steep gradient of the river. Following the selection of Option 3 as the most viable option, further design optimization and studies were based on such option under which maximum reservoir level was fixed at El. 540.0 m to avoid submergence of surrounding villages and Project was conceived as run-of river with small storage. In an effort to further curtail the resettlement and minimizing environmental impacts for selected Option 3 (as explained above) different options were further studied and it is proposed to build Earthen Protection dyke, Collection Drain with Dewatering Arrangement were proposed in the expected resettlement area.

The EPC Contractor initially proposed the construction of temporary facilities and access roads at those locations which were resulting in high resettlement in terms of houses, cultivable land and other infrastructure and also having negative environmental impacts. The proponent and EPC Contractor deliberated extensively on this matter to find the engineering solution which results in lesser resettlement and lesser environmental impacts.

Stakeholder Consultations

Apart from gathering of quantitative data through household survey of the area of influence of the project and 100% survey of project affected people a total of 16 consultations (qualitative) were conducted with the affected persons and other local community to share the information about the project and record their concerns/ feedback associated with this project. The consultation was in two stages of scoping and stakeholder's consultation. Consultative sessions discussed the topics related to land acquisition and resettlement issues, employment and livelihoods of communities, gender and women issues, contractor's camp and access and environmental issues.

The section of stakeholder consultations provides details of outcomes of consultations and covers issues and concerns showed by the stakeholders regarding land acquisition and resettlement. To address the issues and concerns raised by the stakeholders a mitigation plan has been developed and made part of the ESIA. The stakeholders supported the Gulpur Hydro Power project provided that environmental and issues are addressed through mitigation measures. To address the issues an ESIA and Land Acquisition and Resettlement Plan (LARP) are developed and shared with stakeholders for their feedback and suggestions.

Impact Assessment and Mitigation

Environmental impacts have been and will continue to be considered, eliminated or reduced throughout the lifecycle of the Project. The prediction and evaluation of impacts of the Project has been considered against the baseline in the ESIA. The study has considered direct, indirect, permanent and temporary impacts of the project. Each of the environmental impact are categorized into two; beneficial and adverse impacts. Wherever, the Project is likely to result in unacceptable impact on the environment, mitigation measures are proposed.

Potential impacts that may arise from the execution of the project activities can result in soil contamination, soil erosion, water contamination, change in drainage pattern due to weir construction, water resource depletion, fugitive dust emissions, vehicular and generator exhaust emissions, damage to infrastructure due to blasting and noise nuisance due to blasting, drilling and batching plant. To minimize the impact of environment the section on Impact Assessment and Mitigation has identifies potential impacts and thorough suggested mitigation and good practice measure, and monitoring.

The project area represents a human dominated landscape, and the vegetation has been subject to human influence over a long period of time. There are no threatened plant species found in the area. The dominant land use at the project facilities was agriculture/ settlements, and areas devoid of forest make about 25% of the cover. Since the majority land cover impacted by the project will be either cultivated land or sparse broad leave forest which already have poor ground cover, impacts of the project on vegetation are anticipated to be minor.

Based on the factors described above other potential impacts identified are: land disturbance due to construction and operation of project facilities resulting in disturbance, fragmentation, displacement and direct loss of animal, plants, reptiles amphibian and birds; deterioration of area's water resources and river if pollutants are mixed with surface runoff during rain and, or if pollutants leach into the ground or carried to River. Domestic waste (sanitary and kitchen discharge) or release of oil

and grease, fuel from project related machinery or equipment, and reduction in water flow beyond weir, which can alter ecology of the area, and lead to decline in abundance of fishes, especially of Mahasher, and imparts habitat fragmentation or affects connectivity of Mangla Reservoirs fishes to Poonch River. To mitigate the threat a details measures and good practices has been suggested.

In order to minimize social impact of the projected it is suggested to appropriately follow the operational manual and collaborate effectively with local communities in every phase of the project. Operational impacts of the proposed project are associated with the movement of vehicular traffic on it and allied activities. These include air and noise pollution, safety hazards and other similar impacts. Potential socio-economic impacts that may arise from the execution of the project activities are: provision of job opportunities, access to the health facilities, permanent acquisition of land and non-land assets for the project, people lose their productive assets to the project, diseases incidences, blockade of access of local community due construction activities, disturbance of privacy and conflict between workers and local community.

Traffic Assessment Study

Currently the road(s) in the project area can cater for the needs of the traffic that is using these approach roads but with the anticipated increase in heavy and light traffic there are likely to be impacts on the existing road infrastructure. This study mainly focused on the routes that may be used for project related traffic and the likely impacts that may be caused due to the proposed project.

The site is located about 167 Km from Islamabad and 285 km from Lahore, it is directly approachable from Islamabad and Lahore by a two-lane, all-weather paved road. Access to the Project site from Islamabad is via Kahuta-Kotli to Gulpur. The other route is from Lahore via GT Road to Dina and then to Gulpur via Mirpur. GT road is the main access route for all heavy transport vehicles for domestic needs and also for transit trade with Afghanistan also is a main trade route for India and Indian held Kashmir via AJK. Considering that most of the machinery and manpower would come from the southern regions of the country and it would be easier for them to approach the project site via Dina-Mangla-Mirpur-Kotli route. Machines for the proposed power plant would be imported via sea and then transported by road from Karachi.

The study has not considered railway because AJK does not have railway track. This study advises on the routes that are economic and time saving. The nearest international airport is located in Islamabad that is around 150km (approx.). Traffic count surveys were conducted at three different locations in and around Kotli. Data analysis of traffic reveals that the traffic activity varies with the different times of the day starting from lower number of vehicle in early morning to gradually increasing towards the mid-day and then there is a dip in the afternoon and then another rise in traffic count in the evening and finally a drop towards the later of the evening and still lower in the late night of the hours.

In terms of the traffic activity there are three main peaks 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 lunch time 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 the 1700 hours time mark because this is the time when people leave their work places and rush towards their homes.

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.

If we compare the traffic patterns on two approach roads simultaneously it can be seen that the volume of traffic attracted towards Gulpur and then traffic away from the Gulpur area 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 to for business to Gulpur in the morning and then go back and hence the greater activity in that direction.

The traffic counts may be higher for a hilly area but majority of the count accounts for motor bikes which would, in the project scenario, be less of an issue with reference to the expected rise in traffic volumes. Another important observation is that daily around 200 trucks are moving along the roads which would be used for project activities, which means that the risks associated with the movements of these vehicles are known to the people. Furthermore these roads are frequently used by trucks so there would not be a need for roads improvement at least in the initial phases of the project, in time if the requirement arises, different options can be assessed as per the demand of the situation then.

The traffic baseline surveys and traffic assessment clearly suggest that the current road conditions are appropriate for the project related traffic during the construction and operation. The traffic load is also as calculated PCE values are very low in comparison to HCM 2000. With implementation of the proposed mitigation measure and development and implementation of the project traffic management plan the impact will be minimized.

Environmental and Social Management and Monitoring Plan

The section on Environmental and Social Management and Monitoring Plan (ESMMP) summarizes the organizational requirements, management and monitoring plans. The environmental and social management and monitoring plan (ESMMP) presented in this section is a component of the overall environmental management that 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.

Effective implementation and functioning of the ESMMP depends on adequate human and financial resources, clearly defined responsibilities for environmental and social management, appropriate training and good communication. To be effective, this ESMMP 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 study provides organization setup of MPL with commitments to be achieved.

Issues related to environment have been embedded within the role and responsibilities of client, contractor and sub-contractors. Environmental and social management plan includes impact reference, description of the impact, mitigation/management measure, project phase and targeted residual impact.

Monitoring of environmental components and mitigation measures during implementation and operation stages is a key component of the ESMMP to safeguard the protection of environment.

Monitoring program includes regular monitoring of construction and commissioning activities for their compliance with the environmental requirements as per relevant standards, specifications and ESMMP. 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.

The framework environmental monitoring plan is provided in the document. 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. 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 tools and process of monitoring involve preliminary monitoring programmes, documentation and Record Keeping, non-conformances and incidents, formal audits and site inspections.

Cost estimates are prepared for all the mitigation and monitoring measures proposed in the ESMMP. The budget has been calculated for a duration of 45 months of the construction phase. The costs for implementation of environmental and social 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. 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).

The cost estimates and the budget during design and construction phase for the mitigation and monitoring measures is estimated to be around one and half million united states dollars (USD 1.5 million).

The cost estimates for control measures and some of the mitigation measures that were already part of Engineers estimate are not included in the ESMMP. The cost estimates also includes the budget for environmental monitoring, implementation, institutional strengthening and capacity building of project staff and environmental enhancement/compensation measures.

Personnel, including contractors' personnel, working for or on behalf of the Project will be informed of potential significant environmental and social 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. Personnel, including contractors' personnel, will be made aware of their specific environmental and social management responsibilities. Training needs analyses will be undertaken and personnel will be given adequate training to meet these responsibilities.

Spill Contingency Plan in the document devised a mechanism for identification of potentially polluting substances and pollution scenarios and suggests spill prevention strategies and general response action. 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. Details of specific responsibilities and procedures to be followed during prevention, planning, and spill response activities are given in the section.

The biodiversity conservation and management plan or which may refer to biodiversity action plan will be integral part of the ESMMP and ESIA. As part of the ESIA completion an ecology survey of the project area has been conducted. The survey included: qualitative and quantitative assessment of flora, mammals, reptiles and birds; identification of key species, their population and their conservation status in the area and reports of wildlife sightings and fish captured in the area by the resident communities. Further surveys shall also be conducted as part of biodiversity action plan.

Air pollution 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. 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.

Waste management plan has been prepared to meet the Local regulatory requirement, equator principle and EHS guideline of IFC and ABD. The Plan lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing the overall impacts of resource use and improving the efficiency of such use. This Plan introduces an approach that takes into account the whole life-cycle of products and processes and not only their waste phase. 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.

Waste management activities include medical waste management, final destination, waste transportation, waste storage, waste segregation and collection, waste identification and classification. 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 and the waste does not harm people. The document also provides details of muck disposal plan, traffic management plan, health and safety plan and emergency preparedness and response plan.

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1 INTRODUCTION

Mira Power Limited (MPL) is an Independent Power Producer (IPP), which is planning to develop Gulpur Hydropower Project in the Azad Jammu & Kashmir (AJK). This is a run-of-the-river project that will be developed in private sector on Build, Own, Operate and Transfer (BOOT) basis under the Policy for Power Generation Projects 2002 formulated by Government of Pakistan and adapted in the AJK.

The power sector in Pakistan has been facing shortages of electricity generating capacity due to low pace of development of new power plants to meet the growing demand for electricity. This has been aggravated by the rising price of oil, shortage of natural gas and lesser focus on hydropower development. The effect of the large gap between demand and supply of electric power has led to massive load shedding in Pakistan and in AJK. Due to the widening of this gap; all walks of life from industry to domestic are being adversely affected. Presently, hydropower projects contribute about 6,500 MW of power as installed capacity and mostly are owned and run by WAPDA. Only about 10% of the achievable hydropower potential has been utilized so far. The lower values for coal and hydro in the energy mix and major reliance on use of imported oil for electricity generation has caused a spurt in the price of electricity and highlights the potential role and importance that both coal and renewable energy could play in meeting the future energy needs of Pakistan.

Development of hydropower is also considered as attractive to help improving the management of the national water resources which supports one of the largest irrigation systems in the world, upon which agriculture of the country is heavily dependent.

In order to increase the share of hydropower, optimal utilization of the country's hydroelectric potential has been given priority in the future power development strategy. Accordingly, the Private Power & Infrastructure Board (PPIB) has identified a number of potential sites attractive for their hydropower potential. According to the same strategy, one particular site located on the Poonch River in AJK, i.e., 100 MW Gulpur Hydropower Project was offered for development to the private sector.

The Letter of Interest (LOI) for the development of the Project was issued to MPL on March 12, 2005 vide Letter No. 1(101) PPIB-1017/05/PRJ by the PPIB, Ministry of Water & Power, and Government of Pakistan under the Power Policy 2002.

As per the terms of the LOI and the Power Policy 2002, the sponsors appointed a consortium comprising of ACE Pakistan Limited, NESPAK and NorConsult International as consultants to conduct a feasibility study for the Project which, after subsequent comments of the PPIB Panel of Experts was approved by PPIB.

In an effort to help Pakistan in its energy crisis and to ensure the expeditious development of the Project a renowned South Korean Consortium comprising of Korea South East Power Co. Ltd. (KOSEP), Sambu Construction Co. Ltd. (Sambu), Lotte Construction Co Ltd (Lotte) and Daelim Group expressed their desire to fully acquire the Project and in this respect formal Share Purchase

Agreement (the SPA) was signed with the previous sponsors on 1 October 2012 after the completion of extensive financial, technical and legal due diligence.

Following the completion of various codal formalities including satisfying the prequalification requirements the PPIB issued the no objection certificate to Korean Consortium to acquire the Project on 30 July 2012 followed by the issuance of amended LOS on 19 December 2012.

The acquisition process was fully completed on 31 December 2012 after the satisfaction of remaining conditions precedents of the SPA.

The new Sponsors embarked on the process of full scale project development immediately and achieved considerable progress in short span of time including the completion of EPC bidding and securing the initial interest of leading multilateral banks.

Keeping in view the progress achieved by the new Sponsors in a short span of time and to allow reasonable time to the new Sponsors to achieve the financial closing, the Company's request for extension of LOS until 29 April 2014 has been approved by PPIB.

The project requires Environmental and Social Impact Assessment (ESIA) to fulfill the requirements of laws of government of Pakistan and AJK, and project lenders including International Finance Cooperation (IFC) and Asian Development Bank (ADB).

1.1 Project Overview

The proposed project will have 100 megawatt (MW) power generation capacity with annual generation capability of 465 gigawatt-hour (GWh). The Project site falls administratively in the Kotli district of AJK and located about 5 km south of Kotli town on the Poonch River, a tributary of Jhelum River. The site is about 170 km from Islamabad and 285 km from Lahore. The Project will require construction of a weir on the Poonch River just downstream of its confluence with Bann Nullah. The dam will create a reservoir in the Poonch River and the Bann Nullah with a volume of 21.9 million cubic meters. The water from the reservoir will be diverted to a 3.1 km head race tunnel. The intake of the tunnel will be located in the Bann Nullah about 2 km upstream of the confluence of the Bann Nullah with the Poonch River. A powerhouse will be constructed on the left bank of Poonch River about 6 km downstream of the weir. The water, after passing through the powerhouse, will be discharged back into the Poonch River.

1.2 Project Area

The project area refers to the geographical area in which the activities related to the construction and operation of the project are proposed to take place and in which the environmental impacts of the activities are likely to happen. Unless otherwise specified or implied by context, the term 'project area' will refer to the area in the surrounding of each proposed component.

The project will utilize the flow of the Poonch River, the full length of which within AJK has been notified as a national park by the AJK Wildlife and Fisheries Department in the year 2010.[1] Keeping in view the environmental sensitivity of the area, the company is giving greater focus and consideration for environmental assessments of the proposed project in consultation with project lenders.

The location and components of the proposed project are shown in **Figure 1.1**.

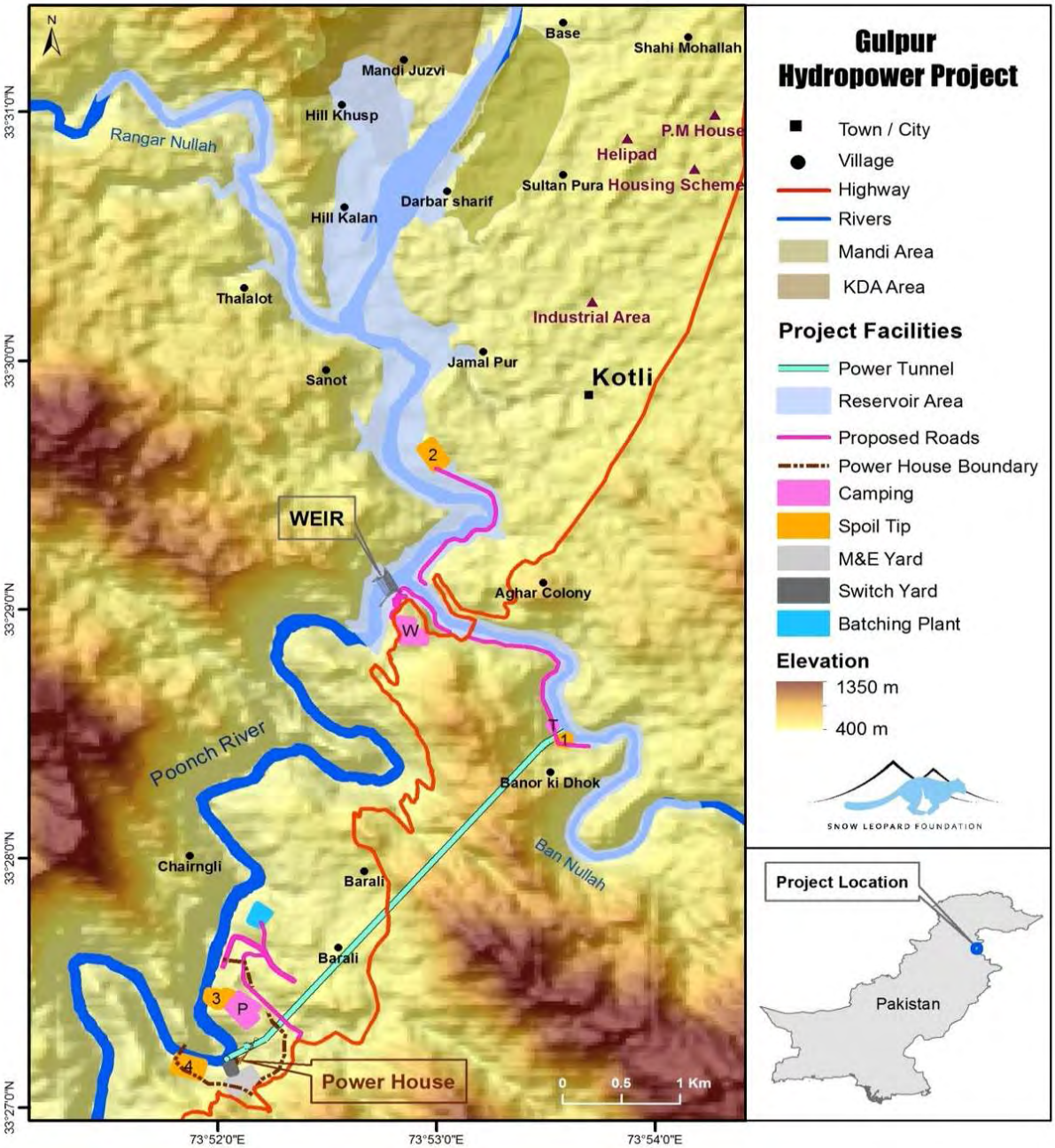


Figure 1.1: Project Location and Components

[1] Notification from Secretariat Forests/KLASC/Wildlife & Fisheries, Azad Government the State of Jammu & Kashmir. NO. SF/PA/11358-72/2010.

1.3 Introduction of the ESIA

1.3.1 Objectives of the ESIA

The objective of the study is to assess the environmental and social impacts associated with the construction and operation of the Gulpur Hydroelectric Power Project (hereafter described simply as the 'Gulpur Project' or 'the project' or 'GHPP').

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.
- 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), ADB and IFC.

The study will result in the following deliverables:

- Environmental and Social Impact Assessment (ESIA) Report; and a
- Environmental and Social Management and Monitoring Plan (ESMMP);

1.3.2 Approach and Methodology

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

1.3.2.1 Scoping

The key activities of this phase included:

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

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

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

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

1.3.2.2 Baseline Data Collection

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 and alternatives of the power plant.

1.3.2.3 Impact Assessment

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
- A rapid cumulative impact assessment of multiple hydroelectric projects in the catchment of Poonch River.

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.

1.3.2.4 Documentation

This report documents the ESIA process and results are prepared according to the relevant guidelines set by the Environmental Protection Agency (EPA), ADB and IFC. A term of reference for this study was developed and agreed jointly by the ADB, IFC and the Company. Two separate assessments are to be incorporated with this report upon the finalization which includes: a critical habitat assessment and a rapid cumulative impact assessment.

1.3.3 Organization of this Report

Section 2 (Policy, Statutory, and Institutional Framework) briefly discusses existing national policy and resulting legislation for sustainable development and environmental protection, and then presents the legislative requirements and the requirements of ADB and IFC that need to be followed while conducting an ESIA.

Section 3 (Project Description) describes the proposed Project.

Section 4 to 6 (Description of the Environment) details the project area's existing physical, biological, and socioeconomic condition, including geomorphology and soils, water resources, and air quality, flora and fauna, and demography.

Section 7 (Analyses of Alternatives) presents the project alternatives that were considered, and the reasons for their selection or rejection.

Section 8 (Stakeholder Consultation) explains the process of public consultation and disclosure of the report at the District Council Office as well as important public library(s). It makes this document a legal public document.

Section 9 (Impacts Assessment and Mitigation) presents an assessment of the project's impact and their required mitigation measures to the physical, biological, and socioeconomic environment.

Section 10 (Traffic Assessment Study) reviews, assesses and proposes the existing and potential traffic conditions of the road network available to the proposed project site.

Section 11 (Environmental and Social Management and Monitoring Plan) contains comprehensive prescriptions regarding environmental and social impacts and their mitigation. This also includes institutional arrangements and various monitoring, control and management plans.

2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

'Sustainable Development' is a concept that has emerged over the past three decades to describe a new framework that aims at economic and social development, while maintaining the long-term integrity of the ecological system. The principles of sustainable development are in the process of being incorporated into national policies and legislation in Pakistan through various statutory instruments. This chapter describes the current legal responsibilities of the proponent in the context of the environment and sustainable development, and the requirements of the institutions that may influence the environmental management of the proposed project.

2.1 National Policy and Administrative Framework

2.1.1 Overview

The Pakistan National Conservation Strategy (NCS) that was approved by the federal cabinet in March 1992 is the principal policy document on environmental issues in the country as well as AJK (EUAD/IUCN, 1992). The NCS outlines the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has 68 specific programs in 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant in the context of the proposed project are pollution prevention and abatement, restoration of rangelands, increasing energy efficiency, conserving biodiversity, supporting forestry and plantations, and the preservation of cultural heritage. The Government of Pakistan promulgated "Pakistan Environmental Protection Act" in 1997. The same was adopted by the Government of AJK. However, this act was adapted to meet the state's requirements and notified in 2000 as Azad Jammu and Kashmir Environmental Protection Act, 2000. This was made effective with the establishment of the Environmental Protection Council (AJK-EPC) which is the policy formulating body and Environmental Protection Agency (AJK- EPA), which is an implementing agency. Prime Minister of AJK is the Chairman and the Minister of Environment is the Vice Chairman of the AJK EPC. Environmental Protection Agency headed by a Director General has the responsibility for establishing Biodiversity Action Plan.

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 has constituted a Biodiversity Working Group under the auspices of the Ministry of Environment, Local Government and Rural Development to develop a Biodiversity Action Plan for the country. After an extensive consultative exercise, a draft Action Plan has been developed. The draft Plan[2], which has been designed to complement the NCS and the proposed provincial conservation strategies, identifies the causes of biodiversity loss in Pakistan and suggests a series of proposals for action to conserve biodiversity in the country.

[2] The plan needs approval from the Ministry of Environment.

2.1.2 The AJK, Environmental Protection Act, 2000

The AJK, Environmental Protection Act, 2000 empowers the AJK –EPA to:

- Administer and implement the provisions of the Act and the rules and regulations made there-under to comply with the environmental policies approved by the Council;
- Enforce the provisions of the Act through environmental protection orders and environmental tribunals headed by magistrates with wide-ranging powers, including the right to fine violators of the Act.
- Prepare or revise, and establish the Environmental Quality Standards with the approval of the Council;
- Develop environmental emission standards for parameters such as air, water and land.
- Identify categories of projects to which the Initial Environment Examination (IEE) or Environmental Impact Assessment (EIA) will apply.
- Develop guidelines for conducting initial environmental examinations (IEE) and EIA's and procedures for the submission, review and approval of the same.
- Review IEE or EIA with the objectives that these meet the requirements of the Act.
- Public participation shall be ensured during review process of IEE or EIA reports.

2.1.3 Regulations for Environmental Assessment

Under Section 11 of the 2000 Act, a project falling under any category (qualifying IEE or EIA) requires the proponent to file IEE or EIA with the AJK-EPA. Within stipulated time the agency will confirm that the document submitted is complete for the purpose of review. During this time, should the agency require the proponent to submit any additional information, it will return the IEE or EIA to the proponent for revision, clearly listing those aspects that need further discussion. Subsequently, the agency shall make every effort to complete an IEE or EIA review within four months of filing the case.

2.1.4 Guidelines for Environmental Assessment

In the absence of AJK-EPA guidelines for environmental assessment, those laid down by Pak- EPA have been followed.

The Pak-EPA has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development projects. The guidelines that are relevant to the proposed project are listed below, followed by comments on their relevance to the proposed project:

A. GUIDELINES FOR THE PREPARATION AND REVIEW OF ENVIRONMENTAL REPORT:

The guidelines on the preparation and review of environmental reports target the project proponents, and specify;

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

- 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.

B. GUIDELINES FOR PUBLIC CONSULTATION:

These guidelines deal with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures that their concerns are incorporated in any impact assessment study.

2.1.5 National Environmental Quality Standards (NEQS)

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.

These standards apply to gaseous emissions and liquid effluents discharged by batching plants, asphalt plants, camp sites, 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.

These NEQS are presented in **Table 2.2** to **Table 2.10**.

2.1.6 National Resettlement Policy and Ordinance

At this point, the only legislation relating to land acquisition and compensation is the Land Acquisition Act (LAA) of 1894. The LAA is, however, limited to a cash compensation policy for the acquisition of land and built-up property, and damage to other assets, such as crops, trees, and infrastructure based on market prices. The LAA does not consider the rehabilitation and resettlement of disrupted populations and the restoration of their livelihoods.

Experience with large-scale infrastructure development projects implemented by institutions such as the Pakistan Water and Power Development Authority (WAPDA) has demonstrated the need for a cohesive national policy for resettlement. In spite of the fact that a National Resettlement Policy and related legislation has been drafted, it has not been officially notified. In the absence of this, the safeguard policy of the World Bank as spelled out in OP/BP 4.12 will form the basis for managing the resettlement needs arising from the project.

2.1.7 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 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.

2.1.8 The Forest Act, 1927 and the Forest (Amendment) Act 2010

The Act, inter alia, deals with the matters related with protection and conservation of natural vegetation/habitats. In that matter it empowers the concerned agency to declare protected and reserved forest areas and maintaining these. In spite of the fact that it recognizes the right of people for access to the natural resources for their household use, it prohibits unlawful cutting of trees and other vegetation.

Therefore, for cutting trees for the construction purposes or otherwise, prior permission is required from the forest department of the concerned province.

2.1.9 The Jammu and Kashmir Forest Regulations, 1930

The main legislation for management and protection of forest and rangeland in AJK is the Jammu and Kashmir Forest Regulation of 1930 and its later amendments of 1973, 1976, 1977 and 1980. The amendments are mostly related with penal provisions for forest offences. According to the AJK Forest Regulations, the forests are designated as 'Demarcated" or "Un-demarcated". The former forests, like Reserved Forests under Forest Act of 1927 that is in vogue in Pakistan, are under the control of Forest Department, while the latter are under the control of Board of Revenue through Deputy Commissioner. There are two other categories of forests in AJK denominated as "Village Forests" and "Private Forests". The former are established under Section 14 (a) of the AJK Forest Regulations, while the latter are established under the Private Forest Rules of AJK Land Revenue Act 1955. Moreover, "Tree Plantation & Maintenance Act 1977 has been enacted to ensure planting and maintenance of at least 3 trees per acre in farmland.

Under the provision of the forest related legislations there are regulations on usufruct right of the communities or individual for using the area for grazing, acquiring wood for fuel wood or timber. However, for cutting trees for the construction of a project special permission would be needed from the Forest Department and Revenue Department/Local Administration depending upon the type of forest encountered.

2.1.10 The AJK Wildlife (Protection, Preservation, Conservation and Management) Act, 1975

In addition to empowering AJK wildlife department to establish game reserves, parks, and wildlife sanctuaries, this Act regulates the hunting and disturbance of wildlife. While reviewing the ESIA, the AJK-EPA may consult the AJK wildlife department in case the project has an impact on wildlife.

The AJK-EPA may require the proponent to coordinate with the AJK wildlife department for the implementation of the project and monitoring activities during construction and operation of the project.

2.1.11 Azad Jammu and Kashmir, Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2012

The Chapter VI of the ordinance is on Protected Areas. Section 43 of the ordinance is covering National parks. The department of wildlife and fisheries shall be responsible to ensure the implementation of this ordinance as per rules of business. The section 43 of the ordinance of National Park States that:

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 so 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 AJK 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 of 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 and routes;
    xi. blowing of pressure horns within one kilometer radius of the park boundary; and
    xii. playing music or using radios, or making noise.
6. The Department may, however for scientific purpose or betterment of the National Park or 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 and certifying that it does not impair the objectives of establishment of the park, in a specified manner.

7. Whoever contravenes or fails to comply with any of the provisions of this Section or abets in commission or furtherance of any such acts 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 rupees ten thousand and may extend to rupees thirty thousand, or with both, in addition to such compensation as the convicting court may direct to be paid, which shall not be less than the value of the damage assessed by the department.
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 equipments 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.

2.1.12 The Antiquities Act, 1975

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. Invariably, for the implementation of new projects an archeological survey is required and in the light of this clearance is sought from the federal. In spite of the fact that Provincial Archaeological Departments exists, the pertinent authority for issuing clearance is the Federal Department.

2.1.13 The Motor Vehicles Ordinance, 1965, and Rules, 1969

The Motor Vehicles Ordinance, 1965, has been extended with effect from March 05, 1978, to the whole of Pakistan. It deals with the licensing requirement for driving; powers of licensing authority, Regional Transport Authority and those of Court vis-à-vis disqualification for license and registration requirements to control road transport; compensations for the death of or injury to a passenger of public carrier; powers of Road Transport Corporation; traffic rules, power to limit speed, weight, use of vehicles; power to erect traffic signs; specific duties of drivers in case of accident and powers of police officers to check and penalize traffic offenders.

2.1.14 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. As the construction activity has also been classified as an 'industry', the regulations will be applicable to the Contractors.

2.1.15 The Pakistan Penal Code, 1860

The Act deals with the offences where public or private properties and human lives are affected due to intentional or accidental misconduct of an individual or a mass of people. It also addresses violation to any law of the country.

2.1.16 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.

Sector-wise legislation applicable in Pakistan is given in **Table 2.1**.

Table 2.1: Sector-Wise Legislation

Serial	*Sector*	*Legislation*
1	Environmental protection	The Pakistan Penal Code (1860)
		Pakistan Environmental Protection Act (2000)
2	Land use	The Land Improvement Loans Act (1883)
		The West Pakistan Agricultural Pests Ordinance (1959) and Rules (1960)
		The Regulation of Mines and Oil-Fields and Mineral Development (Government Control) Act, 1946.
3	Water quality and resources	The Pakistan Penal Code (1860)
		The Canal and Drainage Act (1873)
		The Factories Act (1934)
		On-Farm Water Management and Water Users' Associations Ordinance (1981)
		Indus River Water Apportionment Accord (1991)
4	Air quality	The Pakistan Penal Code (1860)
		The Factories Act (1934)
		The Motor Vehicles Ordinance (1965) and Rules (1969)
5	Noise	The West Pakistan Regulation and Control of Loudspeakers and Sound Amplifiers Ordinance (1965)
		The Motor Vehicle Ordinance (1965) and Rules (1969)
		NEQS, 2000
6	Toxic or hazardous substance	The Pakistan Penal Code (1890)
		The Explosives Act (1884)
		The Factories Act (1934)
		The Agricultural Pesticides Ordinance (1971) and Rules (1973)
7	Solid wastes and effluents	The Factories Act (1934)
		Pakistan Environmental Protection Act (2000)
8	Forest conservation	The Forest Act (1927)
		The West Pakistan Firewood and Charcoal (Restrictions) Act (1964)
		The Cutting of Trees (Prohibition) Act (1975)
9	Parks and wildlife conservation protection	The West Pakistan Ordinance (1959)
10	Cultural environment	The Antiquities Act (1975)
11	Livestock	West Pakistan Goats (Restriction) Ordinance (1959)
		The Grazing of Cattle in the Protected Forests (Range Lands) Rules (1978)
		Pakistan Animal Quarantine (Import and Export of Animals and Animal Products) Ordinance (1979/80)
12	Public health and safety	The Pakistan Penal Code (1860)
		The Boilers Act (1923)

Serial	Sector	Legislation
		The Public Health (Emergency Provisions) Ordinance (1944)
		The West Pakistan Factories Canteen Rules (1959)
		The West Pakistan Epidemic Diseases Act (1979/80)

2.2 Interaction with other Agencies

The proponent is responsible for ensuring that the project complies with the laws and regulations controlling the environmental concerns of dam construction and operation, and that all pre-construction requisites, such as permits and clearances are met. This section describes the nature of the relationship between the proponent and line departments.

2.2.1 AJK- EPA

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.

2.2.2 Revenue Departments of AJK

Under the national law, matters relating to land use and ownership are provincial subjects, and for the purposes of this project, the respective Revenue Departments of AJK are empowered to carry out the acquisition of private land or built-up property for public purposes. In order to depute land acquisition collectors (LACs) and other revenue staff who will be responsible for handling matters related to acquisition of land and the disbursement of compensation, the proponent must lodge applications with the AJK government.

The proponent will provide logistical support and assist in preparing the documents necessary for notification. It will also need to liaise with the departments of agriculture, horticulture, and forestry in order to evaluate affected vegetation resources, such as trees and crops, etc., for compensation purposes. Where public buildings/infrastructure is involved, the proponent will approach the relevant departments for valuation of the affected building or infrastructure before removing the facilities.

Likewise, the proponent will liaise with other relevant departments/agencies for relocation of public facilities such as electricity and telephone poles, public water supply schemes, public buildings, etc.

2.2.3 AJK of Forestry and Wildlife Departments

The project is expected to involve clearing of vegetation and trees within the proposed project area. The project contractor will be responsible for acquiring a 'No-Objection Certificate' (NOC) from the respective Forest Departments and Local Administration depending upon the type of forest, viz., demarcated, un-demarcated or individual forests under threat. The application for an NOC will need to be endorsed by the proponent.

Where construction is to be carried out in close proximity of protected forests and wildlife areas, the proponent is required to coordinate with the departments to ensure that impacts on vegetation and wildlife are minimized.

2.2.4 Local Government and Municipalities

The proponent and its contractors must ensure that the project meets the criteria of the governments of AJK for the establishment of construction camps and plants, use of the water resources and the safe disposal of wastewater, and toxic materials. These matters lie in the jurisdiction of Local Governments. Therefore, the Contractor should liaise closely with the concerned body. The project Proponent will coordinate and monitor environment-related issues.

The project proponent will liaise with local government/administration and municipalities on the matters related to resettlement of squatters and removal of encroachments or sources of congestion. In specific cases, the project proponent will enter into agreements with the municipality, local government, or other service provider on the resettlement of displaced squatters.

2.3 Applicable International Conventions

Environmental problems which migrate beyond the jurisdiction (Trans-boundary) require power to control such issues through international co-operation by either becoming a Contracting Party (CP) i.e. ratifying treaties or as a signatory by officially signing the treaties and agreeing to carry out provisions of various treaties on environment and social safeguards. The relevant international conventions are as provided.

2.3.1 Montreal Protocol on Substances that Deplete the Ozone Layer

Pakistan ratified its accession of the Montreal Protocol along with its London Amendment on 18 Dec 1992 and also ratified the Copenhagen, Montreal and Beijing Amendments of 2003. The Montreal Protocol on Substances that Deplete the Ozone Layer regulates many radioactively powerful greenhouse gases for the primary purpose of lowering stratospheric chlorine and bromine concentrations. These gases include the CFCs, HCFCs, chlorocarbons, bromocarbons and halons.

2.3.2 UN (Rio) Convention on Biological Diversity

Pakistan is a signatory to this convention since 5 June 1992 and ratified the convention on 26 July 1994. The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: 1. the conservation of biological diversity, 2. the sustainable use of the components of biological diversity and 3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources

2.3.3 The Convention on Wetlands of International Importance Especially as Waterfowl Habitat, 1971 (Ramsar Convention)

Pakistan ratified the Ramsar Convention in 1975 and there are currently 19 Ramsar sites in Pakistan, covering an area of 1,343,627 hectares (3,320,170 acres). The convention requires protection of identified wetlands of international importance as identified under Ramsar convention. The Ramsar Convention (formally, the Convention on Wetlands of International Importance, especially as

Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands.

2.3.4 Conventions on the Conservation of Migratory Species of Wild Animals and Migratory Species

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims to conserve terrestrial, aquatic and avian migratory species throughout their range.

2.3.5 Convention on International Trade in Endangered Species of Wild Fauna and Flora

Pakistan is a party to CITES, with the conventions implementation through "Pakistan Trade Control of Wild Fauna and Flora Act (2012)". CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

2.3.6 Kyoto Protocol

The Kyoto protocol was signed by Pakistan in 2005 and in February, 2006, the national CDM operational strategy was approved. The convention pertains to the United Nations framework on Climate Change. The 3rd Conference of the Parties to the Framework Convention on Climate Change (FCCC) in Kyoto in December 1997 introduced the Clean Development Mechanism (CDM) as a new concept for voluntary greenhouse-gas emission reduction agreements between industrialized and developing countries on the project level.

2.3.7 The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure

Pakistan signed the Rotterdam Convention on the Prior Informed Consent (PIC) Procedure on 9 September 1999 and subsequently ratified the convention on 14 July 2005. The Rotterdam Convention (formally, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade) is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labeling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged make sure that producers within their jurisdiction comply.

2.3.8 International Labour Organization conventions

Pakistan has also ratified many of the International Labor Organization conventions that are relevant to the Project including:

- C1 Hours of Work (Industry) Convention, 1919;
- C5 Minimum Age (Industry) Convention, 1919:

- C11 Right of Association (Agriculture) Convention, 1921:
- C14 Weekly Rest (Industry) Convention, 1921;
- C29 Forced Labor Convention, 1930 & C105 Abolition of Forced Labor Convention, 1957;
- C100 Equal Remuneration Convention, 1951;
- C107 Indigenous and Tribal Populations Convention, 1957
- C111 Discrimination (Employment and Occupation) Convention, 1958

2.4 IFC's Requirements

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. The Performance Standards may also be applied by other financial institutions electing to apply them to projects in emerging markets. 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:

- 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

2.4.1 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.

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. Also 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.

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 also ensure that the contractors / subcontracts (subcontractors of the contracts) appointed by MPL all follow the IFC performance standards on Environmental and Social Sustainability.

2.4.2 Environmental, Health and Safety General Guidelines

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 on the basis of 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:

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.

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

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.

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.

2.4.3 IFC's Environment, Health and Safety Guidelines for Electric Power Transmission and Distribution

The EHS Guidelines for Electric Power Transmission and Distribution include information relevant to power transmission between a generation facility and a substation located within an electricity grid, in addition to power distribution from a substation to consumers located in residential, commercial, and industrial areas. The various aspects comprising this guidance are industry specific impacts and management and performance indicators and monitoring.

2.5 ADB Guidelines

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; [3]

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.

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

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).[4] 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.

The ADB's requirements for environmental assessment are specified in its Environmental Assessment Guidelines. [5] 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.

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

[3] Available from http://www.adb.org/Documents/Manuals/Operations/default.asp
[4] 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.
[5] ADB. 2003. Environmental Assessment Guidelines. Manila: ADB.

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.

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.

The ADB, however, recognizes that the specific construction and operational activities may not be well enough defined 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.

2.5.1 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. 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 have 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.

2.5.2 Social Protection Requirements

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[6] for the ADB financed portion of the Project:

a. 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);
b. 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;
c. engage contractors and other providers of goods and services:
    (i) who do not employ child labor[7] or forced labor;[8]
    (ii) 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
    (iii) whose subcontracts contain provisions which are consistent with paragraphs (i) and (ii) above.

[6] 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;

[7] child labour 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 Labour Organization Convention No. 138 'Minimum Age Convention" (www.ioo.org)

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

2.5.3 Public Communications Policy 2011

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.

2.5.4 Gender and Development Policy 1998

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.

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.

Table 2.2: Selected NEQS for Waste Effluents

Parameter	*Unit*	*Standards (maximum allowable limit)*
Temperature increase	°C	< 3
pH value (acidity/basicity)	pH	6/9
5-day biochemical oxygen demand (BOD) at 20 °C	mg/l	80
Chemical oxygen demand (COD)	mg/l	150
Total suspended solids	mg/l	200
Total dissolved solids	mg/l	3,500
Grease and oil	mg/l	10
Phenolic compounds (as phenol)	mg/l	0.1
Chloride (as Cl)	mg/l	1,000
Fluoride (as F)	mg/l	10
Sulfate (SO_4)	mg/l	600
Sulfide (S)	mg/l	1.0
Ammonia (NH_3)	mg/l	40
Cadmium	mg/l	0.1
Chromium (trivalent and hexavalent)	mg/l	1.0
Copper	mg/l	1.0
Lead	mg/l	0.5
Mercury	mg/l	0.01
Selenium	mg/l	0.5
Nickel	mg/l	1.0
Silver	mg/l	1.0
Total toxic metals	mg/l	2.0
Zinc	mg/l	5.0
Arsenic	mg/l	1.0
Barium	mg/l	1.5
Iron	mg/l	8.0
Manganese	mg/l	1.5
Boron	mg/l	6.0
Chlorine	mg/l	1.0

Notes:

1. The standard assumes that dilution of 1:10 on discharge is available. That is, for each cubic meter of treated effluent, the recipient water body should have 10 m3 of water for dilution of this effluent.
2. Toxic metals include cadmium, chromium, copper, lead, mercury, selenium, nickel and silver. The effluent should meet the individual standards for these metals as well as the standard for total toxic metal concentration.

Source: Government of Pakistan (2000) (SRO 549 (I)/2000).

Table 2.3: NEQS for Industrial Gaseous Emissions

Parameter	*Source of Emission*	*Standards (maximum allowable limit)*
Smoke	Smoke opacity not to exceed	40% or 2 Ringlemann Scale or equivalent smoke number
Particulate matter [1]	(a) Boilers and furnaces:	
	i. Oil fired	300
	ii. Coal fired	500
	iii. Cement Kilns	300
	(b) Grinding, crushing, clinker coolers and related processes, metallurgical processes, converters, blast furnaces and cupolas	500
Hydrogen Chloride	Any	400
Chlorine	Any	150
Hydrogen fluoride	Any	150
Hydrogen sulphide	Any	10
Sulphur Oxides [2, 3]	Sulfuric acid/Sulphonic acid plants	5,000
	Other Plants except power Plants operating on oil and coal	1,700
Carbon Monoxide	Any	800
Lead	Any	50
Mercury	Any	10
Cadmium	Any	20
Arsenic	Any	20
Copper	Any	50
Antimony	Any	20
Zinc	Any	200
Oxides of Nitrogen [3]	Nitric acid manufacturing unit	3,000
	Other plants except power plants operating on oil or coal:	
	i. Gas fired	400
	ii. Oil fired	600
	iii. Coal fired	1,200

Explanations:

1. Based on the assumption that the size of the particulate is 10 micron or more.
2. Based on 1% Sulphur content in fuel oil. Higher content of Sulphur will cause standards to be pro-rated.
3. In respect of emissions of Sulphur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to NEQS specified above, comply with the standards provided separately.
4. Units are in mg/Nm^3 unless otherwise stated

Source: Government of Pakistan (2000) (SRO 549 (I)/2000).

Table 2.4: National Environmental Quality Standards for Ambient Air[9]

Pollutants	Time-Weighted Average	Concentration in Ambient Air		Method of Measurement
		Effective from1st July 2010	Effective from 1st January 2013	
Sulfur Dioxide (SO_2)	Annual Average*	80 µg/m^3	80 µg/m^3	Ultraviolet Fluorescence
	24 hours**	120 µg/m^3	120 µg/m^3	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	40 µg/m^3	40 µg/m^3	
Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m^3	40 µg/m^3	Gas Phase Chemiluminescence
	24 hours**	80 µg/m^3	80 µg/m^3	
Ozone (O_3)	1 hour	180 µg/m^3	130 µg/m^3	Non-dispersive UV absorption
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m^3	360 µg/m^3	High Volume Sampling, (Average flow rate not less than1.1 m^3/minute).
	24 hours**	550 µg/m^3	500 µg/m^3	
Respirable Particulate Matter. PM_{10}	Annual Average*	200 µg/m^3	120 µg/m^3	β Ray absorption
	24 hours**	250 µg/m^3	150 µg/m^3	
Respirable Particulate Matter. $PM_{2.5}$	Annual Average*	25 µg/m^3	15 µg/m^3	β Ray absorption
	24 hours**	40 µg/m^3	35 µg/m^3	
	1 hour	25 µg/m^3	15 µg/m^3	
Lead (Pb)	Annual Average*	1.5 µg/m^3	1.0 µg/m^3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2.0 µg/m^3	1.5 µg/m^3	
Carbon Monoxide (CO)	8 hours**	5 mg/m^3	5 mg/m^3	Non-Dispersive Infra-Red (NDIR)
	1 hour	10 mg/m^3	10 mg/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.

Source: Government of Pakistan (2010) (SRO 1062 (I)/2010).

[9]Full text of the Standards is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

Table 2.5: NEQS for Motor Vehicles Exhaust and Noise for In-use Vehicles[10]

Sr. No.	*Parameter*	*Standard (Maximum Permissible Limit)*	*Measuring Method*	*Applicability*
1	Smoke	40% or 2 on the Ringlemann Scale during engine acceleration mode.	To be compared with Ringlemann Chart at a distance 6 or more.	Immediate effect
2	Carbon Monoxide	6%	Under idling conditions: Non-dispersive infrared detection through gas analyzer.	
3	Noise	85 dB (A).	Sound meter at 7.5 meters from the source.	

Table 2.6: NEQS for Motor Vehicles Exhaust and Noise for New Diesel Vehicles, Passenger Cars and Light Commercial Vehicles (g/Km)

Type of Vehicle	Category/Class	Tiers	CO	HC+ NOx	PM	Measuring Method	Applicability
Passenger Cars	M 1: with reference mass (RW) up to 2500 kg. Cars with RW over 2500 kg to meet NI category standards.	Pak-II IDI	1.00	0.70	0.08	NEDC (ECE 15+ EUDCL)	All imported and local manufactured diesel vehicles with effect from 01-07-2012
		Pak-II DI	1.00	0.90	0.10		
Light Commercial Vehicles	NI-I (RW<1250 kg)	Pak-II IDI	1.00	0.70	0.08		
		Pak-II DI	1.00	0.90	0.10		
	NI-II (1250 kg< RW <1700 kg0	Pak-II IDI	1.25	1.00	0.12		
		Pak-II DI	1.25	1.30	0.14		
	NI-III (RW>1700 kg)	Pak-II IDI	1.50	1.20	0.17		
		Pak-II DI	1.50	1.60	0.20		
Parameter	*Standard (maximum permissible limit)*					*Measuring Method*	
Noise	85 dB (A)					Sound meter at 7.5 meters from the source.	

[10] Full text of the Standards is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

Table 2.7: NEQS for Motor Vehicles Exhaust and Noise for New Diesel Vehicles, Heavy Duty Diesel Engines and Large Goods Vehicles (g/Kwh)

Type of Vehicle	*Category/ Class*	*Tiers*	*CO*	*HC*	*NOx*	*PM*	*Measuring Method*	*Applicability*
Heavy Duty Diesel Engines	Trucks and Buses	Pak-II	4.0	1.1	7.0	0.15	ECE-R-49	All Imported and local manufactured diesel vehicles with the effect 1-7-2012
Large goods Vehicles	N2 (2000 and up	Pak-II	4.0	7.0	1.1	0.15	EDC	
Parameter	*Standard (maximum permissible limit)*					*Measuring Method*		
Noise	85 dB (A)					Sound meter at 7.5 meters from the source.		

Table 2.8: NEQS for Motor Vehicles Exhaust and Noise for New Petrol Vehicles (g/km)

Type of Vehicle	Category / Class	Tiers	CO	HC+ NOx	Measuring Method	Applicability
Passenger	M 1: With reference mass (RW) up to 2500 kg. Cars with RW over 2500 kg. to meet N1 category standards	Pak-II	2.20	0.50	NEDC (ECE 15 + EUDCL)	All imported and new models* locally manufactured petrol vehicles with effect from 1st July, 2009**
Light Commercial Vehicles	N1-I (RW<1250 kg)	Pak-II	2.20	0.50		
	N1-II (1250 kg>RW <1700 kg)	Pak-II	4.00	0.65		
	N1-III (RW>1700 kg)	Pak-II	5.00	0.80		
Motor Rickshaws & motor Cycles	2.4 strokes <150 cc	Pak-II	5.50	1.50	ECER 40	
	2.4 strokes>150 cc	Pak-II	5.50	1.30		
Parameters	*Standard (maximum permissible limit)*				*Measuring Method*	
Noise	85 dB (A)				Sound meter at 7.5 meters from the source	

Explanations for Table 2.4 to 2.7:

DI: Direct Injection
IDI: Indirect Injection
EUDCL: Extra Urban Driving Cycle
NEDC: New Urban Driving Cycle
M: Vehicles designed and constructed for the carriage of passengers and comprising no more than eight seats in addition to the driver's seat
N: Motor vehicles with at least four wheels designed and constructed for the carriage of goods.
* New model means both model and engine type change
** The existing models of petrol driven vehicles locally manufactured will immediately switch ever to Pak-II emission standards but not later than 30th June, 2012

Source: Government of Pakistan (2009) (SRO 72 (KE)/2009).

Table 2.9: National Standards for Drinking Water Quality[11]

Properties/Parameters	*Standard Values for Pakistan*
Bacterial	
All water intended for drinking (E. Coli or Thermo tolerant Coliform bacteria)	Must not be detectable in any 100 ml samples
Treated water entering the distribution system (E. Coli or thermo-tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml samples
Treated water in the distribution system (E. Coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml samples In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12- month period.
Physical	
Color	≤15 TCU
Taste	Non-objectionable/Accept able
Odor	Non-objectionable/Accept able
Turbidity	< 5 NTU
Total hardness as $CaCO_3$	< 500 mg/l
TDS	< 1000
pH	6.5 – 8.5
Chemical	
Essential Inorganic	***mg/Liter***
Aluminum (Al)	≤0.2
Antimony (Sb)	≤0.005 (P)
Arsenic (As)	≤ 0.05 (P)
Barium (Ba)	0.7
Boron (B)	0.3
Cadmium (Cd)	0.01
Chloride (Cl)	<250
Chromium (Cr)	≤0.05
Copper (Cu)	2
Toxic Inorganic	***mg/Liter***
Cyanide (Cn)	≤0.05
Fluoride (F)*	≤1.5
Lead (Pb)	≤0.05
Manganese (Mn)	≤ 0.5
Mercury (Hg)	≤0.001
Nickel (Ni)	≤0.02
Nitrate (NO_3)*	≤50
Nitrite (NO_2)*	≤3 (P)
Selenium (Se)	0.01 (P)
Residual chlorine	0.2-0.5 at consumer end; 0.5-1.5 at source
Zinc (Zn)	5.0
Organic	
Pesticides mg/l	PSQCA No. 4639-2004, Page No. 4 Table No. 3 Serial No. 20- 58 may be consulted**
Phenolic compound (as phenols) mg/l	WHO standards: ≤ 0.002
Polynuclear Aromatic hydrocarbon (as PAH) g/L	WHO standards: ≤ 0.01v(by GC/MS method)
Radioactive	
Alpha Emitters bq/L or pCi	0.1
Beta Emitters	1

[11] Full text of the Standards is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

* indicates priority health related inorganic constituents which need regular monitoring.
** PSQCA: Pakistan Standards Quality Control Authority.
Source: Government of Pakistan (2010) (SRO 1063(I)/2010).

Table 2.10: National Environmental Quality Standards for Noise[12]

Category of Area/Zone	*Limit in dB(A) Leq**			
	Effective from 1st July 2010		Effective from 1st July 2012	
	Day time	Night time	Day time	Night time
Residential area	65	50	55	45
Commercial area	70	60	65	55
Industrial area	80	75	75	65
Silence zone	55	45	50	45

Notes:
1. Day time hours: 6:00 a.m. to 10:00 p.m.
2. Night time hours: 10:00 p.m. to 6:00 a.m.
3. Silence zone: Zones that are declared as such by the competent authority. An area comprising not less than 100 m around the hospitals, educational institutions, and courts.
4. Mixed categories of areas may be declared as one of the four above-listed categories by the competent authority.

* dB(A) Leq: Time weighted average of the level of sound in decibels on Scale A which is relatable to human hearing.
Source: Government of Pakistan (2010) (SRO 1064(I)/2010).

[12] Full text of the Standards is available at the Pak-EPA website: (http://www.environment.gov.pk/info.htm).

3 PROJECT DESCRIPTION

The Gulpur Hydropower Project will exploit the water resources of the Poonch River for power generation. It will comprise four main components, viz., Weir, Intake Structure, Power Tunnel and Power House. The Weir will be located near Aghar Colony on the Poonch River at about 5 km downstream of Kotli Town and about 250 m downstream of the confluence of Ban Nullah with the river. The Intake Structure and intake portal of the Power Tunnel will be located on Ban Nullah about 2 km upstream of its confluence with the Poonch River. The Power House and outlet portal of the Power Tunnel will be located on Poonch River about 6.5 km downstream of the Weir structure. **Figure 3.1** illustrates the layout plan of the Project.

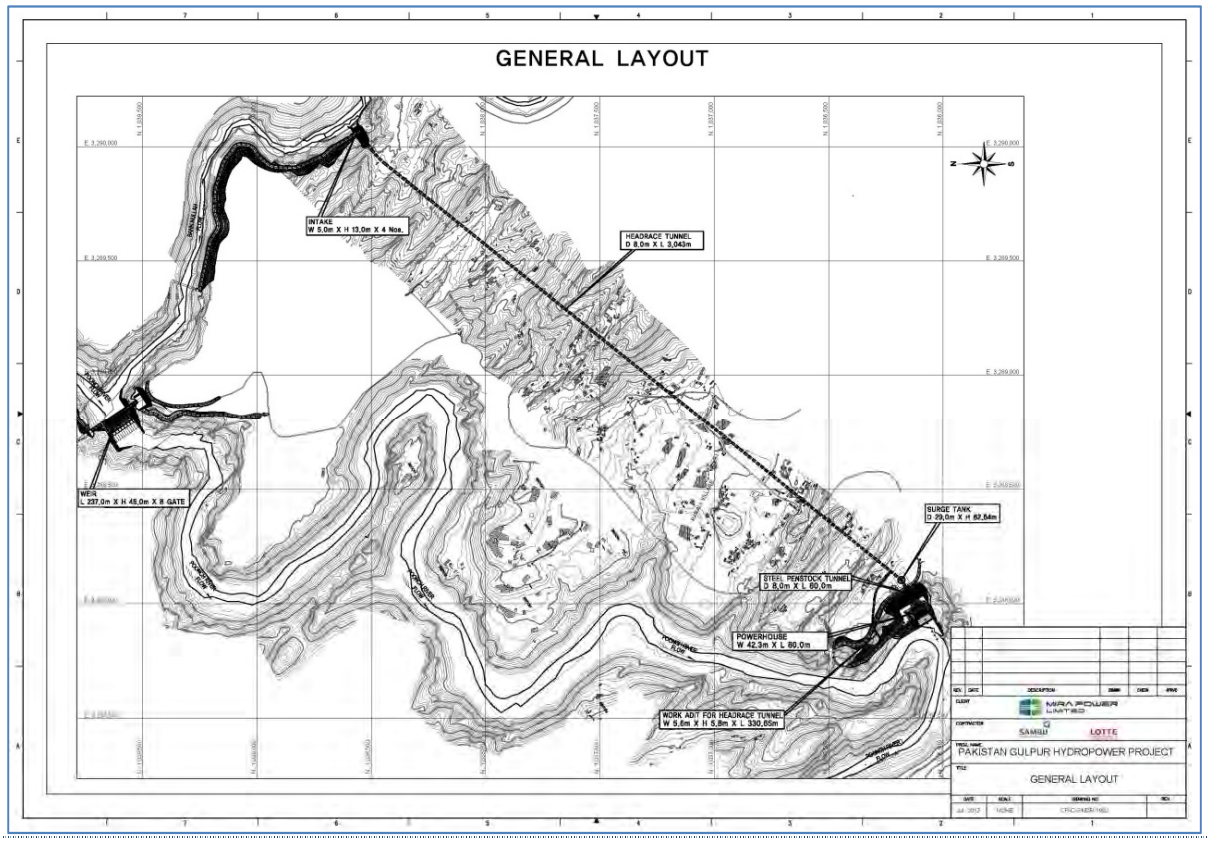


Figure 3.1: Project General Layout Plan

The Normal Operating Level (NOL) of the Project shall be at El. 540 m. At present a freeboard of 2 meters is proposed for the land acquisition and resettlement. **Figure 3.2** shows the inundation area at El. 542.0 m.

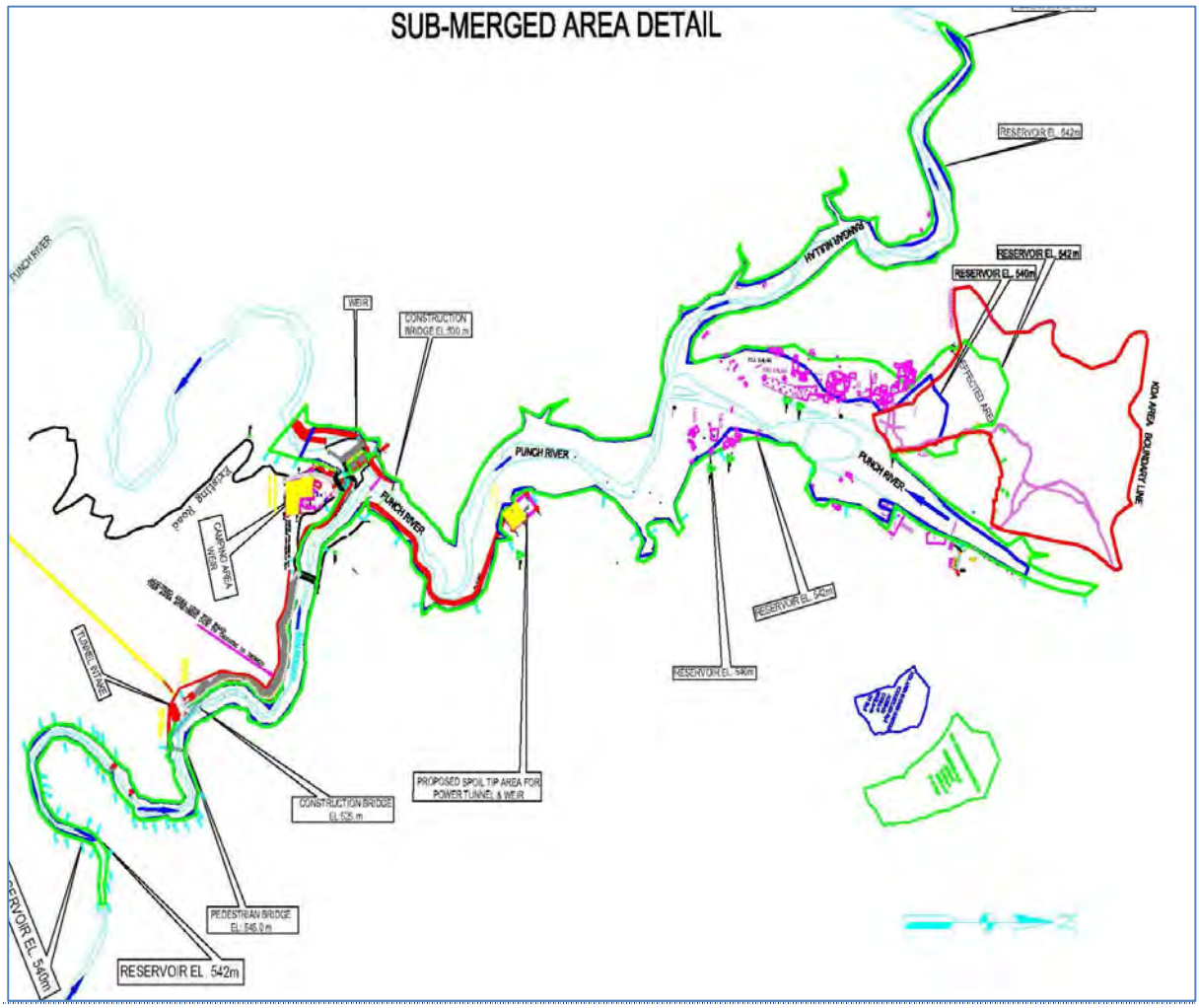


Figure 3.2: Inundated Land/Houses by the Reservoir

3.1 Location of the Project

The Project site administratively belongs to Kotli District, Azad Jammu and Kashmir. It is located at latitude 33°27' and longitude 73°51', which is about 5 km South of Kotli Town. The site is approximately 167 km from Islamabad and 285 km from Lahore, and is accessible directly from Islamabad and Lahore by a two-lane (and partially paved) mountainous road. It can be also accessed from Islamabad via Kahuta or from Lahore using a GT road to reach Dina where connects to Mirpur first and then Gulpur. At the Project site, river flows in a narrow gorge at a slope of about 1V:200H.

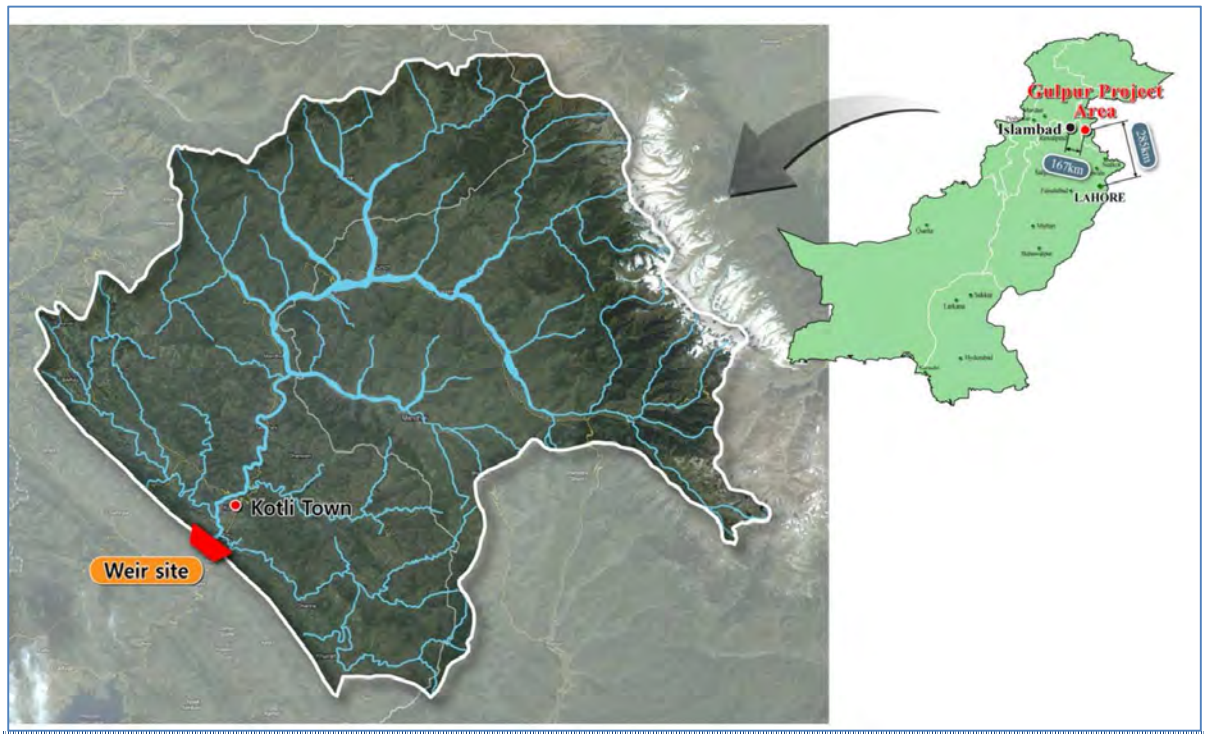


Figure 3.3: Project Location

3.2 Land Required for Project

The area to be consumed by the Project structures, reservoir, colony, and camp and approach roads is given in **Table 3.1** below. The table shows that the private land constitutes about 26.4 percent of the total area to be consumed by the Project. It is only this area that is privately owned, while the rest of the area is government land. About 88 percent (803 Acres) of the land required for the proposed project will be utilized for the reservoir. In total the proposed project will required 919.85 Acres of land, major portion (74 percent) of this requirement will be fulfilled through usage of government wasteland.

Table 3.1: Area Requirement for the Proposed Project

S. No.	*Structure/ Item*	*Total Area (Acres)*	*Private Land*		*Government Land*			
			Ownership	*Shamilat*	*Auqaf*	*KDA*	*Forest*	*Wasteland*
1	Power Complex	2	-	-	-	-	-	2
2	Weir	10	-	-	-	-	-	10
3	Intake	1	-	-	-	-	-	1
4	Reservoir	803.85	127.64	84.80	39	57.25	8.81	486.36
5	Spoil Dumping Areas	36	3	1	-	-	14	18
6	Colonies/Camps/Stores/Workshops	54	24	2	-	-	2	26
7	Access Roads for Power House	13	-	-	-	-	-	13
	Total	**919.85**	**154.64**	**87.80**	**39**	**57.25**	**24.81**	**556.36**
Percentages		**100%**	**16.8%**	**9.5%**	**4.2%**	**6.2%**	**2.7%**	**60.5%**

3.3 Main Components of the Project

3.3.1 The Weir

The weir type has been determined as concrete gravity dam (CGD) with dimensions of W45.0 m × L237.0 m to prevent overflow even in case of probable maximum flood (PMF). 100-year frequency flood (13,334 m^3/s) 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 and Q&M. The discharge capacity of the spillway has been designed to maintain the normal operation level (EL.540.0 m) in case of the 100-year frequency flood. Eight gates (W 11.5 m ×H 26.0 m EA) are installed inside the weir body to prevent overflowing the weir crest (El.545.0 m) even in case of probable maximum flood (PMF). A 9.5 m wide roadway bridge with its crest at El. 545.0 m will provide access from one bank to other bank of the river. Bridge shall also be used to operate gate hosting equipment.

Ogee shaped crests for weir portion is connected to submerged roller bucket type energy dissipater through concrete chutes. The project site displays an extremely high downstream level due to relatively large amount of flow compared to the river width. It was observed that the downstream level becomes higher than the water level after hydraulic jump in case of floods higher than 2- year frequency flood (4,190 m^3/s). Submerged roller bucket type has been chosen as a result due to excessive excavation and absence of major structures at downstream.

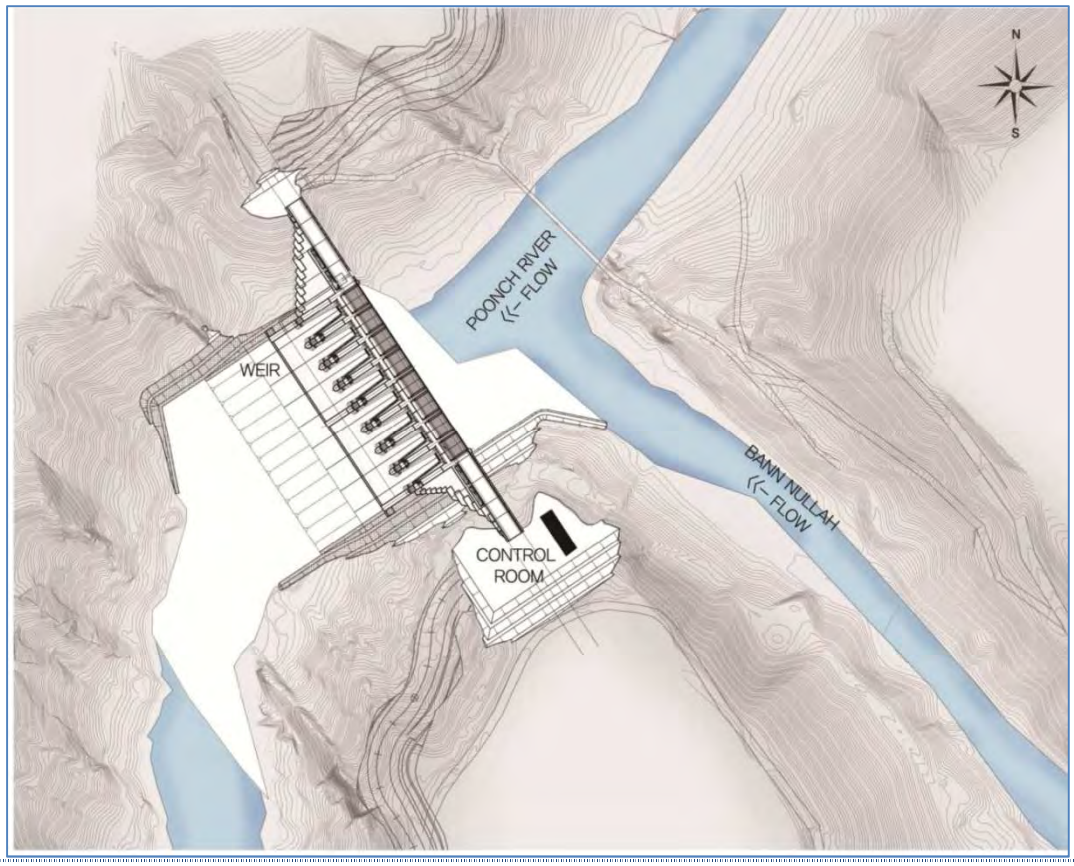


Figure 3.4: Details of Weir Structure

3.3.2 Power Tunnel and Penstocks

The power tunnel off-takes from the left bank of Bann Nullah at a location about 2 km upstream of its confluence with Poonch River. The tunnel will be concrete lined and circular in shape having a total length of 3.04 Km. The invert of tunnel intake is kept at El. 523 m to avoid vortices and air entrance. The intake structure will have a bell-mouthed entrance with trash-rack and a gate shaft. A road along the left bank of Bann Nullah will be constructed for operation & maintenance of this structure. The intake arrangements are shown on **Figure 3.5** and **Figure 3.6**.

First part of the power tunnel is designed as a low pressure tunnel of 8.0 m dia, concrete lined, almost bored straight in the hill up to a 62.64 m high surge shaft. Downstream of surge shaft, tunnel will connect to a vertical pressure tunnel which will connect to an 8.0 m dia steel penstock which will be divided into three steel penstocks each 3.75 m dia up to the powerhouse.

Hydraulic features of the power tunnel/penstocks are as given below:

Design discharge	198 cumecs
Shape and size of tunnel	Circular, concrete lined, 8 m
Slope of tunnel invert	0.0025
Length of tunnel	3.04 km
Invert elevation	
Upstream	El. 523.0 m
Downstream	El. 514.0 m
Size of penstock	8 m Ø, circular, steel pipe converted into 3.75 m pipe
Length of penstock	62 m
Head Loss	
Tunnel	5.69 m
Penstocks	0.85 m

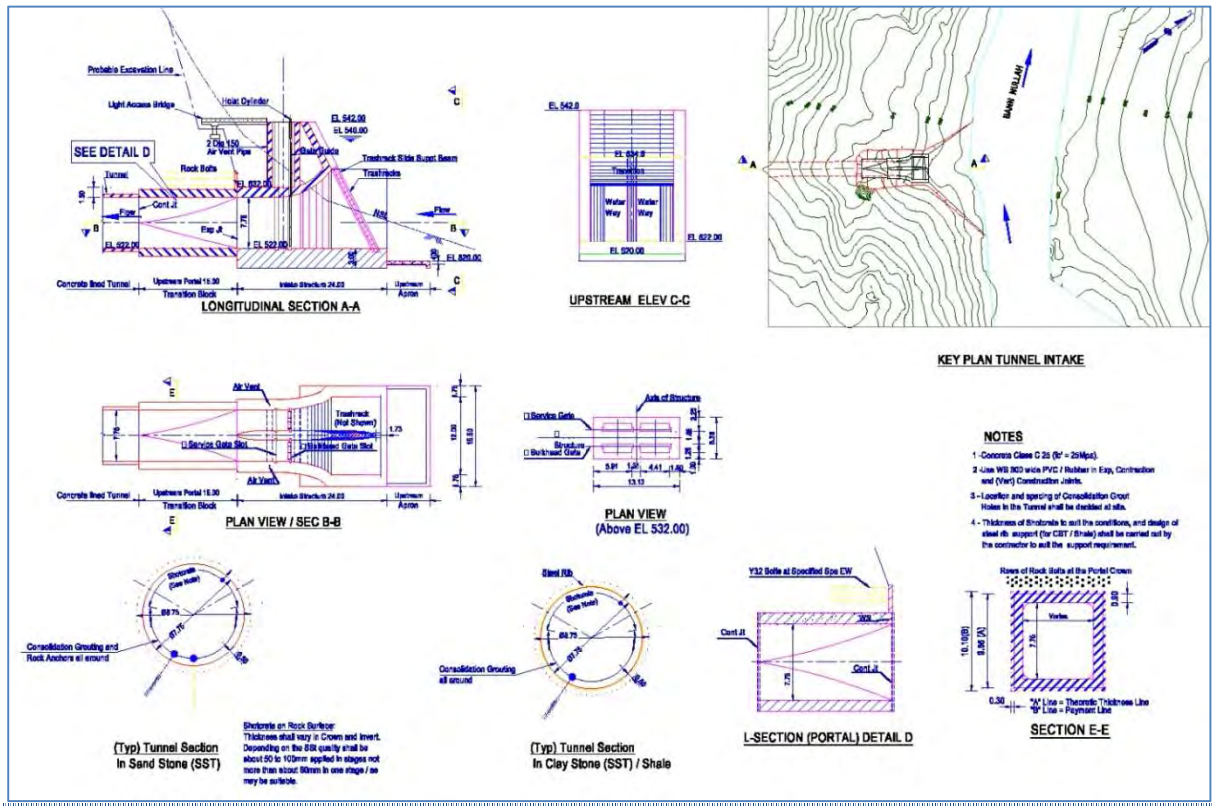


Figure 3.5: Details of Tunnel Intake

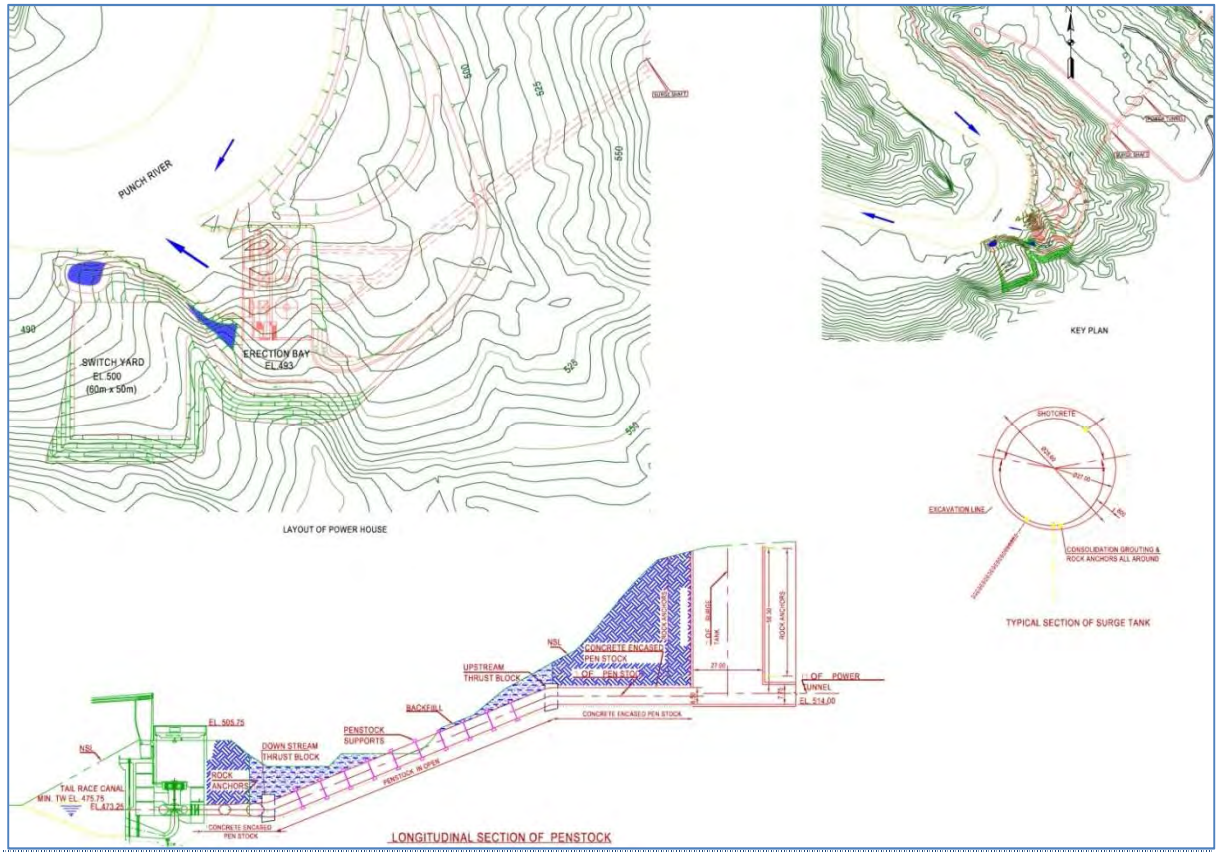


Figure 3.6: Penstock Profile and Details

3.3.3 Powerhouse

The priority for the horizontal alignment of the tunnel was to set the length as shortest as possible, but a curvature was inevitable due to the relocation of the tunnel (84 m downstream from the Feasibility Study location). The radius of the curvature has been determined as 300 m in order to provide sufficient space additionally 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 sounder, and for the tunnel axis to intersect with major fault zones as perpendicularly as possible. Sufficient cover thickness was also taken into account in case the tunnel route crosses below gullies or valleys. Total installed capacity of the powerhouse is 100 MW and power will be generated with the help of 3 vertical axis Francis turbines. The powerhouse is 80 m long and 42.3 m wide. 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.

The proposed powerhouse is a surface type and will be located on left bank of the river at a massive bed of sandstone. Layout of the powerhouse is shown in **Figure 3.7**, **Figure 3.8** and **Figure 3.9**. The basic parameters are given below:

Power Station and Equipment	
Structure	
Powerhouse	Surface type
Number of Units	3
Distance between centerline of units	15.0 m
Overall length	42.3 m
Width	
Overall height	59.55 m
Turbines	
Type	Francis (Vertical Shaft)
Discharge at rated head	33~66 m^3/s
Rated net head	55.8 MW
Output at rated net head	34.0 MW
Specific speed	227.3 rpm
Synchronize speed	187.5 rpm
Runaway speed	
Runner diameter	3.0 m

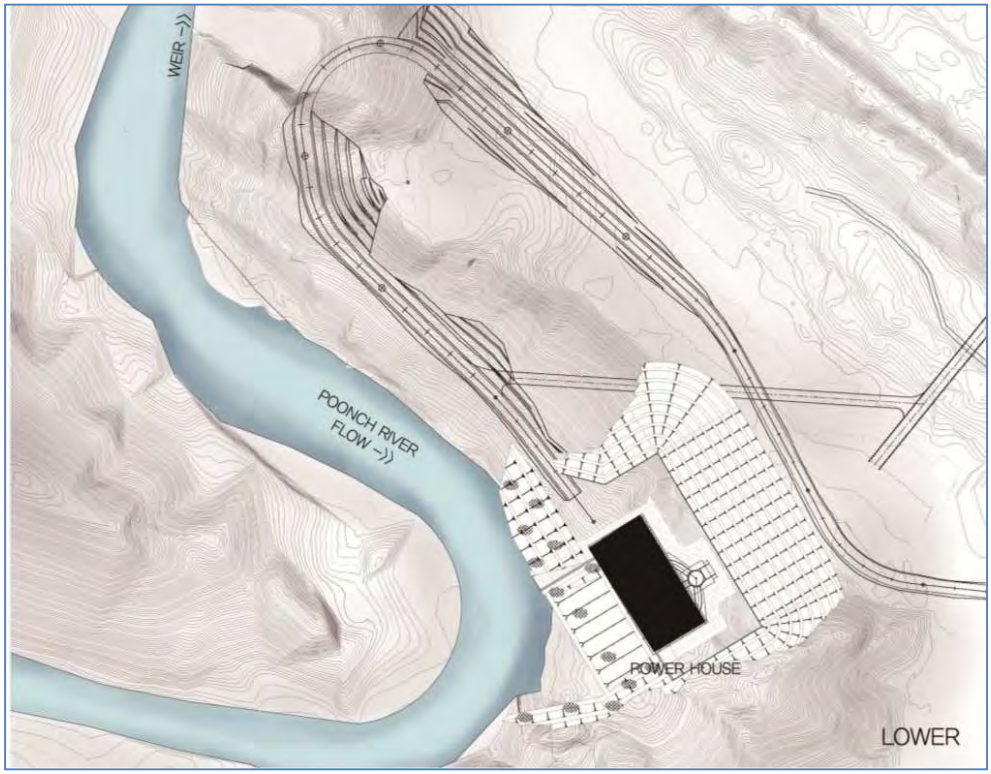


Figure 3.7: Power House Security Plan

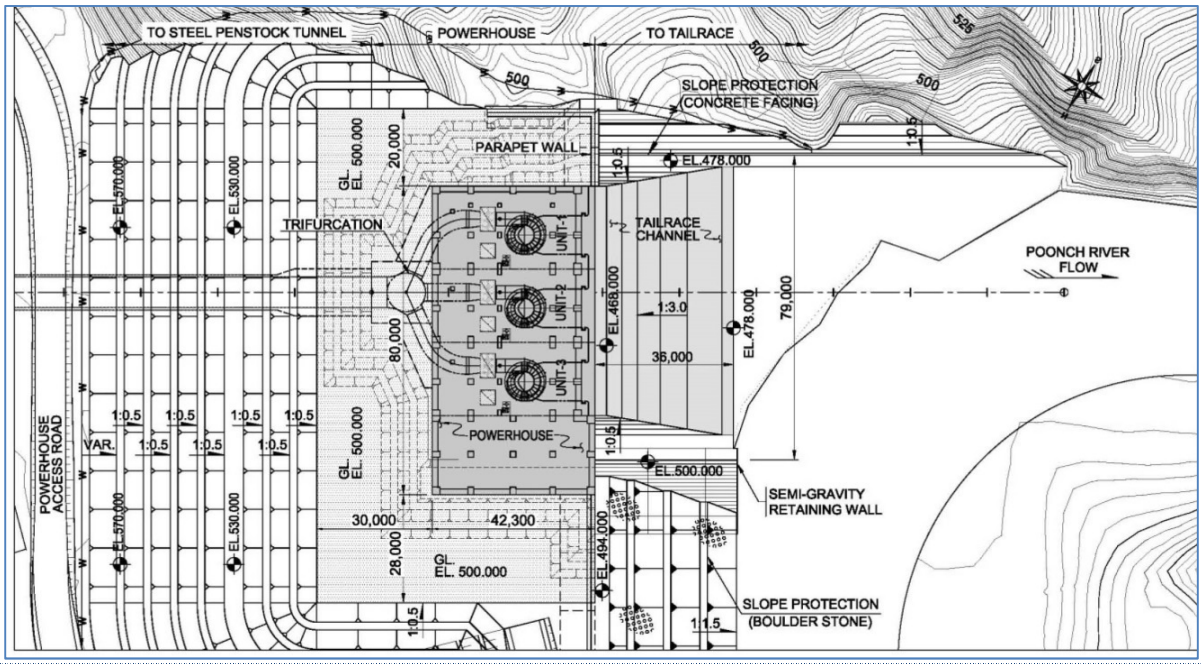


Figure 3.8: Power House Plan

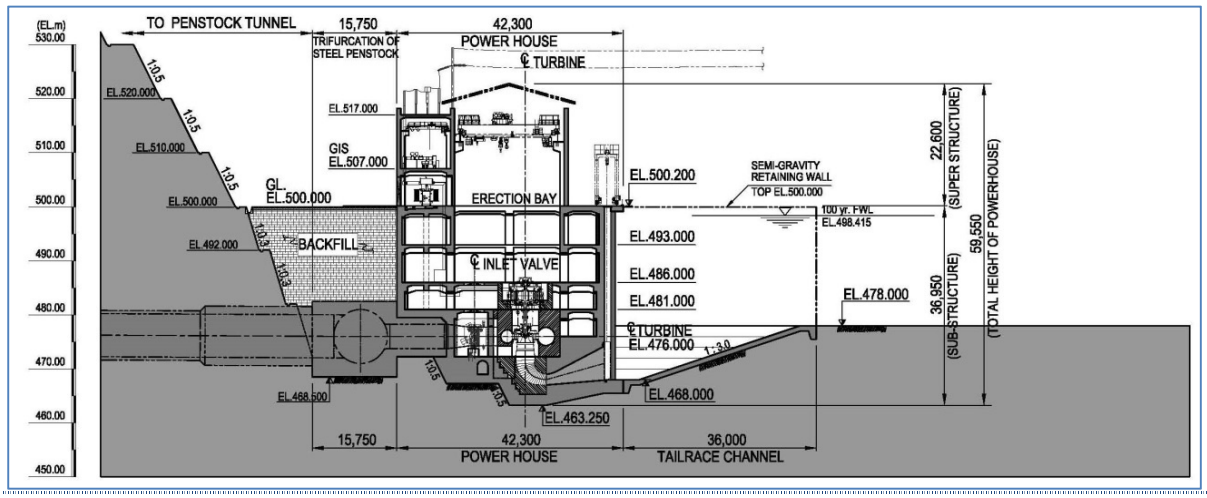


Figure 3.9: Power House Longitudinal Section

3.3.4 River Diversion

A 2-stage river diversion plan has been proposed for the construction of the Weir. The diversion will be manipulated within the river section by constructing coffer dams. This will save the additional cost of diversion tunnels. Two coffer dams will also be provided for the construction of other components, one for Intake Structure for the Power Tunnel and the other for Power House.

Diversion of river flows during construction is required at three locations:

1. At the weir
2. At intake structure of power tunnel in Bann Nullah and
3. At powerhouse

To facilitate the construction of weir, diversion installation consists of 1st cofferdam and 2nd cofferdam. The crests of the first and second cofferdams have been computed by using HEC-RAS based on the 1-year frequency flood. Firstly, 1st cofferdam is constructed on the left bank. As a result of water levels estimated for the design flood, the crest of the 1st cofferdam has been determined as EL.525.0 m due to the water level of EL.524.02 at the 1st cofferdam upstream, and the water level of EL.524.0 m has been determined separately for the downstream where the water level is EL.523.44m. Due to the narrow river width, the 2nd cofferdam is installed by connecting a retaining wall to the structure installed during construction of the 1st cofferdam, and water flow is induced into the weir structure installed. The water level was computed as EL.525.3 m and the crest has been determined as EL.526.0 m. The intake structure of the power tunnels will be separated from Ban Nullah by constructing a cofferdam around the intake area. Similarly the powerhouse will be isolated from the main river through another cofferdam.

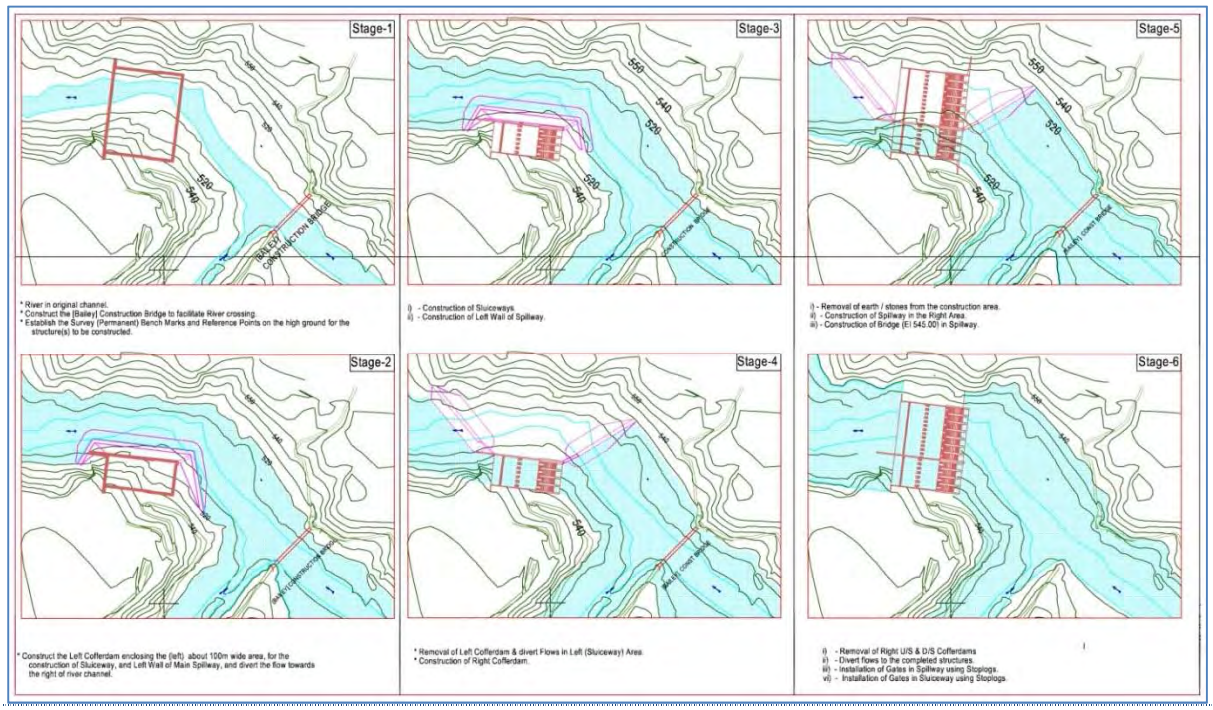


Figure 3.10: Diversion Scheme for Weir Sluesway

3.3.4.1 River Flows and Cofferdams Heights

Weir

The construction work on weir structure will be carried out during low flow period of nine months extending from October to June and during the main flood months of July, August and September construction activity will cease and construction machinery and equipment will be retrieved to higher ground.

Power Tunnel Intake Structure

Work on intake structure of the power tunnel is an independent activity and can be accomplished during the low flow period of October through June. Cofferdam has been designed to isolate the intake structure area from nullah flows. Crest of the cofferdams is worked out as El. 527.0 m.

Powerhouse

Construction work on powerhouse will be continued throughout the year. The crest of cofferdam has been worked out as El. 485.0 m.

3.3.5 Dyke

In order to minimize resettlement due to inundation of the cultivated land and the number of houses, MWH/NESPAK conducted a study and concluded a technically viable option. MWH/NESPAK applied these studies to minimize the resettlement on the right as well as left bank of the upstream submerged area and emphasized to save Hill Kalan, Hill Khurd, KDA and Mandi Juzvi on the right bank (Zone-A), Laloi area (Zone B) & Mandi area (Zone C) on the left bank of the river.

Figure 3.11: Zones for Dyke Structure

NESPAK has recommended earthen filled dyke and varied the length of the dyke on the right bank of river to get optimum solution by comparing it with that of tentative resettlement cost and recommended best suitable length for building of earthen filled dyke on right bank of the river. In order to take care of catchment water of mountains and other area, NESPAK has divided the whole catchment area into two portions by proposing a Collection Drain at about El. 540 m. to get the catchment water of the mountains and areas above 540 level to this Collection Drain and throw the same into the river without any de-watering arrangement. For remaining catchment areas of about 70 Acres (from dyke to 540 level), another drain is proposed adjacent to the dyke which will be catered through some de-watering arrangements or through flip-flop valves in the dyke. (**Figure 3.12** showing different options for dykes)

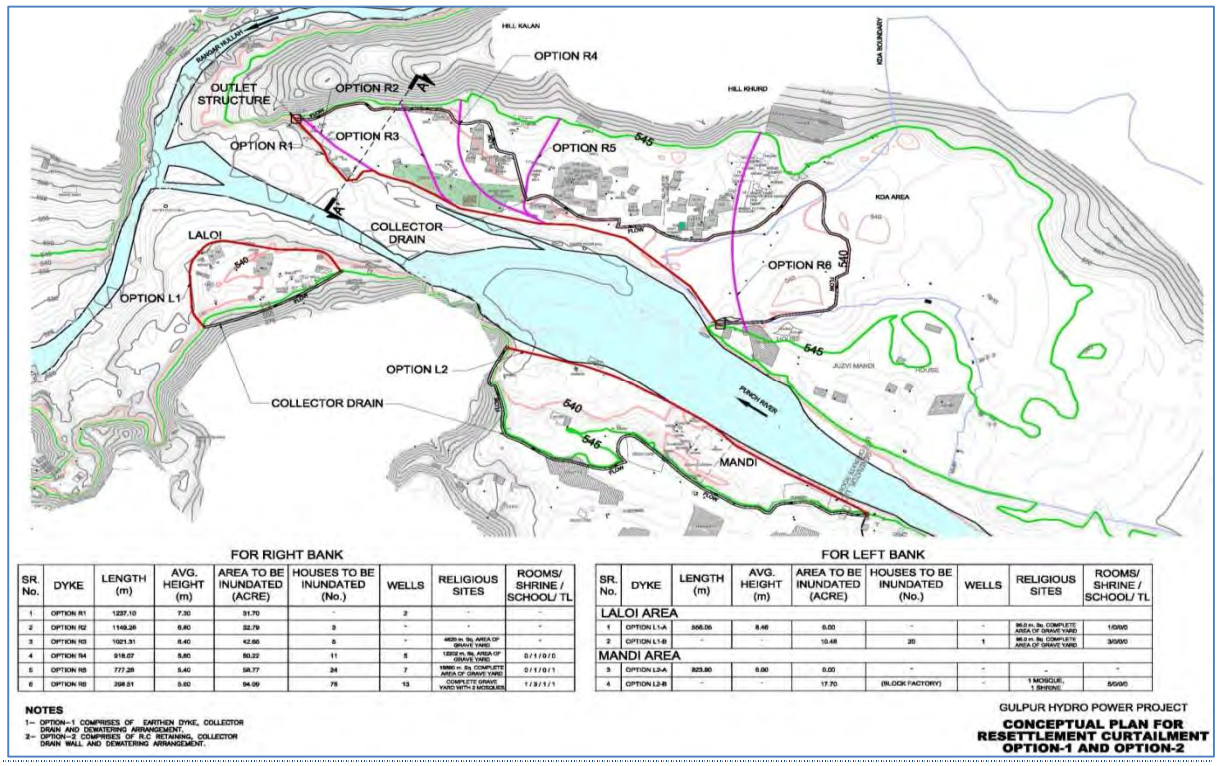


Figure 3.12: Different Options for Dykes

3.4 Construction Schedule

It is anticipated that the Project would take about 45 months for its completion and commissioning. The construction period for each project has been presented in **Table 3.2**.

Table 3.2: Summary of Construction Periods

Feature	*Time (Months)*
Weir	30
Intake	8
Power Tunnel	32
Powerhouse construction and installation	24
Switchyard installation	7
Surge Shaft	4
Penstock liners	12
Control Gates	12
Commissioning (Dry & Wet)	10

3.5 Construction Camp and Workforce

A large workforce, together with supervisory and support staff, will be required for the Project. It has been estimated that the Project will employ about 700 skilled, semi-skilled and unskilled workforce 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, the remaining will be accommodated in three camps located near construction sites at Weir, Intake and Power House.

Adequate temporary camps, offices and ancillary facilities at convenient locations near the site will be required. Owing to the hilly terrains, there is a limitation in the availability of ample areas at the sites near the Weir and Power House for establishing residences, workshops, batching plants and material storage areas separately. However, a sizeable nearly leveled terrace is available across the Ban Nullah at the Intake site where the contractor can establish residential colony as well as other facilities. Moreover, modern houses are also available in Kotli Town on rental basis. The contractor may hire these for establishing main office and hostels for the workforce.

3.6 Access Routes for Construction Sites

The Project falls in a terrain that is constituted of high hills having steep slopes with narrow valleys in between. Though the Weir and Power House sites lie close to the main road leading from Kotli to Mirpur, the sites are located down the hills having very steep slopes. On the other hand the Intake site is located about 2 km away from the main road devoid of any motor-able access. The contractor would need to develop access roads for all the sites.

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. The other route is from Lahore via GT Road to Dina and then to Mirpur and to Gulpur. During rainy season, traffic is susceptible to occasional disruptions due to landslides.

To carry out construction of Project components, there will be a need for temporary access roads connecting stockpile areas, work areas such as cofferdams, tunnel portal, batching plant(s) and site workshops for hauling labour and materials within the jobsite. Access roads required for construction of various Project components are planned and shown in **Figure 3.13**.

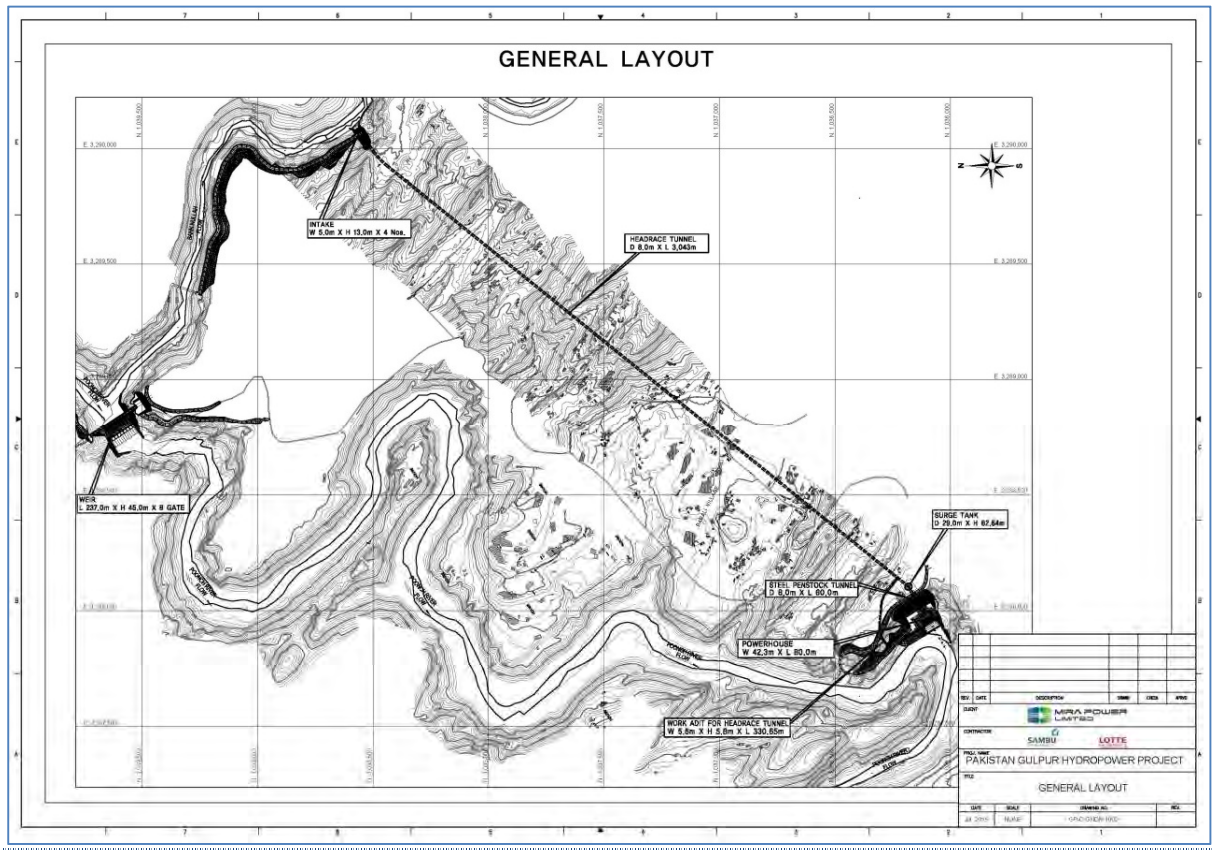


Figure 3.13: Project Area Access Roads

These roads are planned along the shortest and practicable route at reasonable grades, maximum allowed grade is 6%, nevertheless, ramps may be steeper. Details are given in **Table 3.3**.

Table 3.3: Project Construction Roads, Lengths & Gradients

Roads		*Length (km)*		*Elevation (m)*		*Gradient*
From	*To*	*From*	*To*	*From*	*To*	
ROADS TO INTAKE PORTAL AREA						
Main Kotli Road	Construction Camp	0+000	0+500	570	575	1.00
Main Kotli Road	Construction Camp	0+500	1+000	575	595	4.00
Main Kotli Road	Intake Portal	0+500	1+450	575	520	5.80
Rehman Bridge	Intake Portal	0+000	1+350	550	520	2.25
Alternate Camps	Intake Portal	0+000	1+050	565	520	4.30
ROADS TO WEIR						
Main Kotli Road Construction Camp	Weir Upstream	0+000	0+620	525	500	4.05
Main Kotli Road Construction Camp	Weir Downstream	0+000	1+300	560	500	4.65
ROADS TO POWERHOUSE						
Main Kotli Road	Powerhouse	0+000	2+200	600	475	5.70
Main Kotli Road	Concrete Mixing Plant & Powerhouse	0+000	2+300	600	475	5.45
Concrete Mixing Plant	Main Kotli Road for going to weir & Intake Portal	0+000	1+1000	575	630	5.50

3.7 Construction Material

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. Tentative quantities of various materials along with the source are depicted in **Table 3.4**:

Table 3.4: Quantities AND Sources OF Construction Material

Sr. No.	*Item*	*Quantity*	*Source*
1	Coarse Aggregate	300,000 cu m	The material will be borrowed from the following sources: • River Bed boulders, gravels, cobles. Crushers are already in operation near Kotli and Gulpur Towns. • Sandstone from excavation of weir, tunnel and power house areas • Quarrying limestone from Sawar (22 km from Kotli on Kotli-Tatapani Road), Dandli (16 km from Kotli on Dandli-Ghoi Road), Jhanjora (34 km from Kotli on Tatapani-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	Sand is though available in the river bed, its quality is not suitable for the Project construction. Moreover its quantities are small. Therefore, it has to be either transported from Lawrencepur and Qibla Bandi located in Attock District about 200 km from Kotli or manufactured locally from limestone sources.
3	Rock Material for Stone pitching and Riprap	5,000 cu m	Rock material will generally be available from the excavation for the construction of weir, power house and tunnel.
4	Cement (including Portland (60,000 tonnes and Slag 30,000 tonnes)	90,000 tonnes	There is no cement factory in AJK. The Portland cement will be transported from Islamabad, Nowshera and Attock on the average located at a distance of 200 to 300 km from Kotli. Slag Cement will be transported from Karachi (about 1500 km from Kotli) through rail and road transportation. The road network is available from the factories up to construction sites. However, its transportation on large truck-trailers will be difficult as about 100 km of the road passes through hilly terrains, encountering very sharp turns and having rather steep gradients at places. Therefore, a caravan of about 30 trucks would be required to meet daily requirement of cement of about 300 tonnes.
5	Reinforcement Steel	15,000 tons	The steel of the desired specification will be transported from re-rolling mills located at Lahore and Rawalpindi.
6	Water (including concreting, water sprinkling, compaction of earth/rock fill for cofferdams)	100,000 cu m	The project area is almost devoid of groundwater source. Therefore, the Poonch River and Ban Nullah are the only sources for water. The water from the river and nullah would however need some sort of treatment to make it silt and sulphate free for its use in concreting.

3.8 Construction Machinery

The Project will deploy various types of machineries for construction purposes. These will include bulldozers, excavators, shovels, tunneling machine, dumpers, batching plant, tankers, trucks, etc.

3.9 Excavated Material

The Project will generate about 1.0 M cum of rock material (mostly constituted of sandstone and siltstone) from excavation for the Project components. Excavation for Weir will generate a quantity of about 0.56 M cu m, Power Tunnel 0.211 M cu m and Power House 0.20 M cu m. Depending upon the quality of the excavated stone material, some quantity will be used to meet the requirement of aggregate, rock fill at cofferdams, stone pitching, etc. However, bulk of the excavated material will need to be disposed off. The configuration of the land mass in vicinity of the project structures and in the surroundings is such that limited appropriate area would be available for disposal of the waste material. 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 gorges. None of these really contain suitable areas for dumping the waste material. Through a reconnaissance of the areas it has been inferred that the well stabilized gullies in the forest areas and open wasteland benches along the river may be used for the purpose. In this respect, the matter was discussed with the officials of the Forest Department. They have given consent that under special case the Department would allow using these gullies provided a written request is forwarded in advance so that the plantation from the dumping area may be removed. It will also be required that these areas are re-vegetated with the trees after appropriately dumping and leveling of the material. Some gullies are also available in civil area near the power house that can be used for the purpose. Many of the drainage channels from the hills are having very steep slopes. These may also be used for dumping purposes off course with a plan that their slopes become milder without impeding their drainage characteristic. Details of excavated rock material are given in **Table 3.5**.

Table 3.5: Rock Excavation Quantities and Periods

Feature	*Estimated Quantity (m^3)*	*Time (months)*	*Peak Quantity m^3/day*
Weir	475,000	14	1600
Tunnel	268,000	21	600
Intake	13,715	2	600
Powerhouse	95,000	4	1200
Surge Shaft	3,000	1.5	100
Penstock	40,000	2.5	750
Switchyard	90,000	4	1100

3.10 Project Cost

The Project cost will be approximately US$ 340.00 million.

4 DESCRIPTION OF THE PHYSICAL ENVIRONMENT

4.1 General

This chapter summarizes the available baseline data on physical environment within the principal area of interest i.e. the area of project influence. Reconnaissance visits and physical field surveys were carried out in August 2013. Validation of this information was done through the data from secondary sources, satellite imagery study and published literature. The identification of physical characteristics of the region and assessing their existing conditions is imperative to predict the possible environmental impacts of the proposed hydropower project.

The baseline environmental data has been compiled to cover the following areas:

- Land;
- Climate and Meteorology;
- Water (water resources, water quality, source of pollution and hydrology);
- Air Quality and Noise (noise levels);

4.2 Area of Study

Gulpur Hydropower Project site is located on Poonch River, which is a left bank tributary of Jhelum River. Four hydropower projects are planned along the Poonch River; Sehra, Kotali, Gulpur and Rajdhani[13] . In the vicinity of the project site, Poonch River flows through a deep gorge at a slope of about 1V:200H. Mountains on both sides are more than 100 meter high; valley is narrow and banks are steep. Width of the river varies from 60 to 90 m. Kotli-Gulpur road runs along the left bank at about 60 to 80 m above the riverbed. Ranger Nullah on the right bank and Bann Nullah on the left bank are two main perennial tributaries, which join the river downstream of Kotli Town. Several villages are located on both banks of the river and along both nullahs. Majority of the settlements is above El 540 m.

The site of Gulpur Hydropower Project is located downstream of Kotli and upstream of the proposed Rajdhani Hydropower Project. Minimum tail water level of Kotli Hydropower Project is fixed at El 550 m. Whereas, maximum reservoir level of Rajdhani Hydropower Project is fixed at El 473.5 m. Location and reservoir levels of these projects are shown in **Figure 4.1**.

[13] P&D-AJK's Year Book 2011.

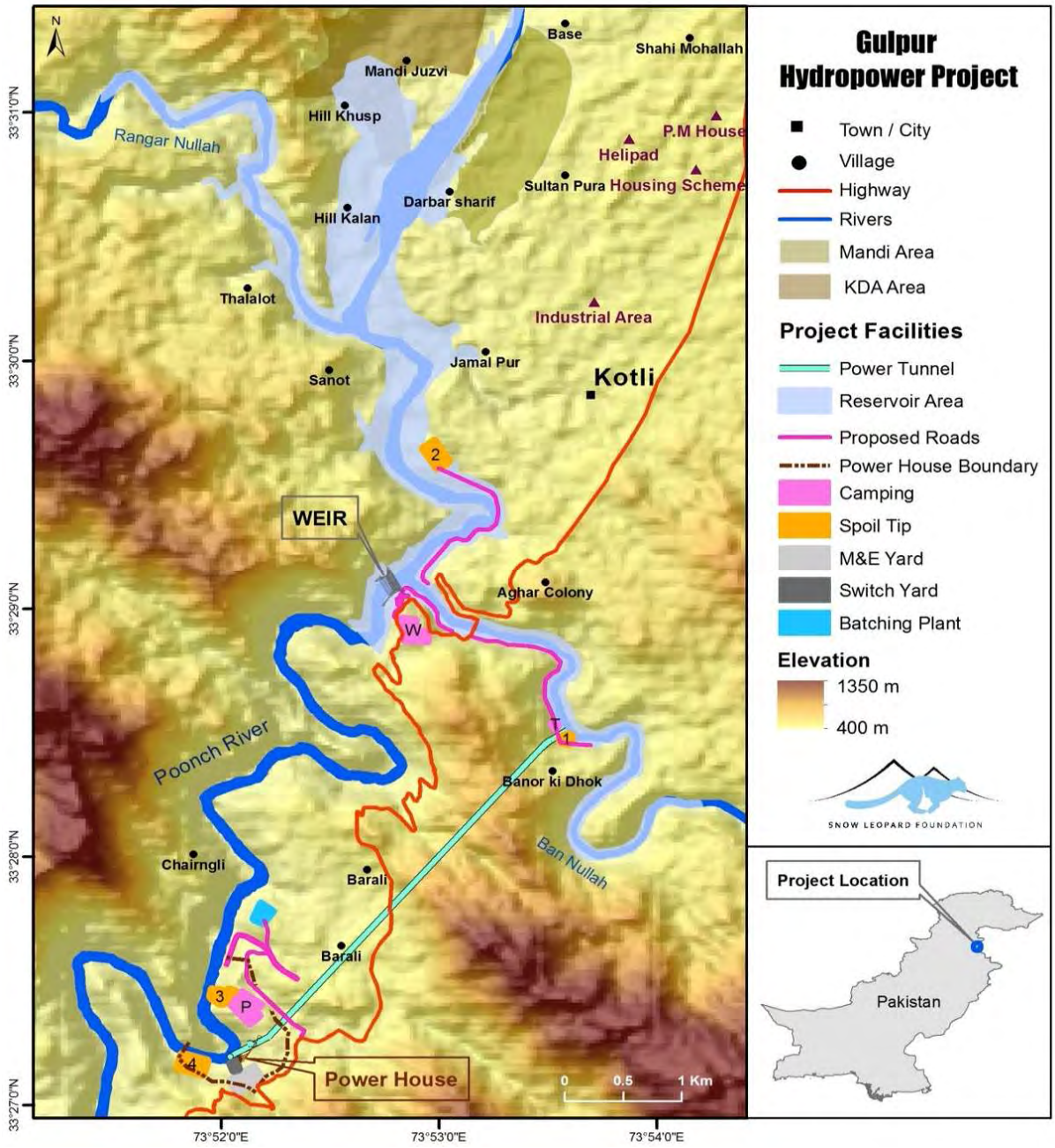


Figure 4.1: Project Location and Components

4.2.1 Delineation of the Study Area

From environmental view the study area is defined as the areas of project influence. Some of these areas are directly affected while others may be influenced indirectly. For this Project the areas of most concerns are as follows:

- Areas falling in the vicinity of the structures, viz., Weir, Power House, and upstream and downstream portals of the Power Tunnel,
- Areas to be used for establishing construction camps and colony,
- Areas likely to be submerged by water impoundment,

- Areas likely to be used for dumping of spoil material from excavation of tunnel, weir and power house,
- Areas to be used for developing haul tracks,
- Quarry areas,
- About 6.5 km stretch of the river reach from Weir up to the Power House that is going to be deprived from the river flows during low-flow season for its diversion into the Power Tunnel for power generation,
- Areas located on high-benches through which the Power Tunnel is going to be excavated. These areas are not going to be directly affected, but it is likely that the settlements on these benches may be disrupted due to vibrations from blasting and drilling at the Power Tunnel.
- Kotli Town is not going to be directly affected by the project; however, the area is likely to have indirect effects of mixed type. Primarily, the induction of heavy machinery and vehicles, particularly when transporting construction material from quarries falling on other side of the town, will cause traffic congestions and hazards, while on the other hand the induction of outside workforce will be beneficial in boosting the local business.
- The population residing on the right side of the Poonch River is dependent on Kotli for business, service, shopping, etc is going to be affected due to break in the communication by the creation of the reservoir.

Most of the potentially affected areas, except the ones related with the quarries, would fall within a strip of about 4 km wide (on the average 2 km on either side of the Poonch River) and about 10 km in length covering the river stretch from Kotli up to the Power House site. As such, the study area comes to about 50 sq. km. The quarry sites have presently been excluded from the study area as the sites indicated for quarrying are tentative and would be finalized when the contractor is mobilized (**Figure 4.2**).

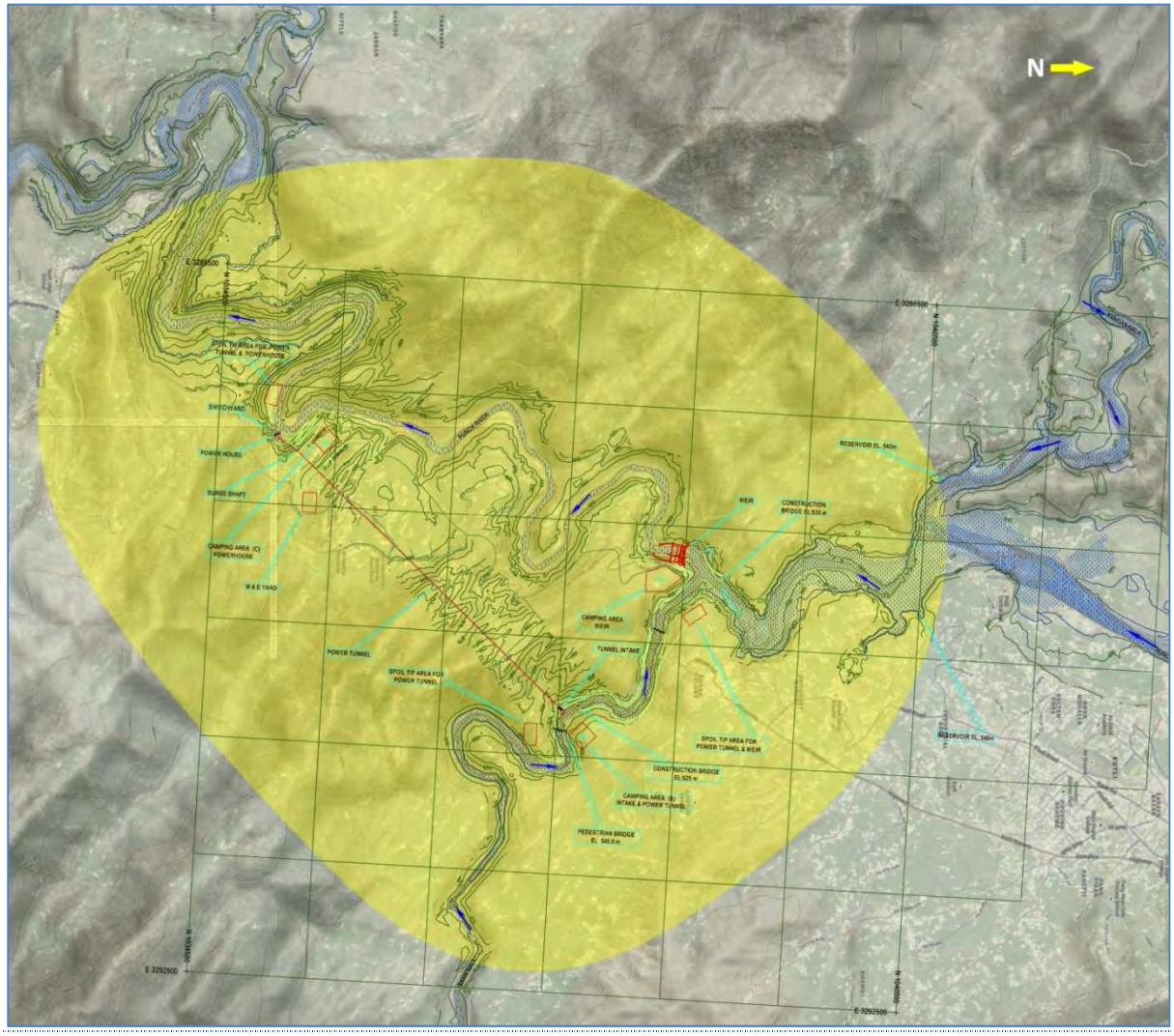


Figure 4.2: Area of Influence for the Propose Project

4.3 Land Environment

The different geological and physiographic features of the project area were analyzed using GIS tools and interpretation of the spatial databases were completed through secondary data like Survey of Pakistan toposheets, satellite imagery and other available data sources.

4.3.1 Geology

The study area is a part of land formations developed at the foothills of Himalayan Ranges through tectonic events subsequent to those that caused building of Himalaya. The Project area contains middle Siwalik formations developed from the sedimentary deposits 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 here and there which are being used for settlements and agricultural activities. The typical examples in the project area are Kotli and Gulpur towns. Similarly, some open and relative flat areas are also

encountered on the raised benches/terraces on the mountains. Invariably these areas are also used for settlement and agricultural activities. The typical examples of the raised benches are the Barali Village in the vicinity of the Power House and Dheri and Banor Ki Dhok near the Intake of the Power Tunnel.

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 are met with. Such areas include Mandi, Mandi Juzvi, Hill Kalan, and Laloi areas of Kotli Town and a small bench near Jamalpur Village, part of which are used for agricultural purposes.

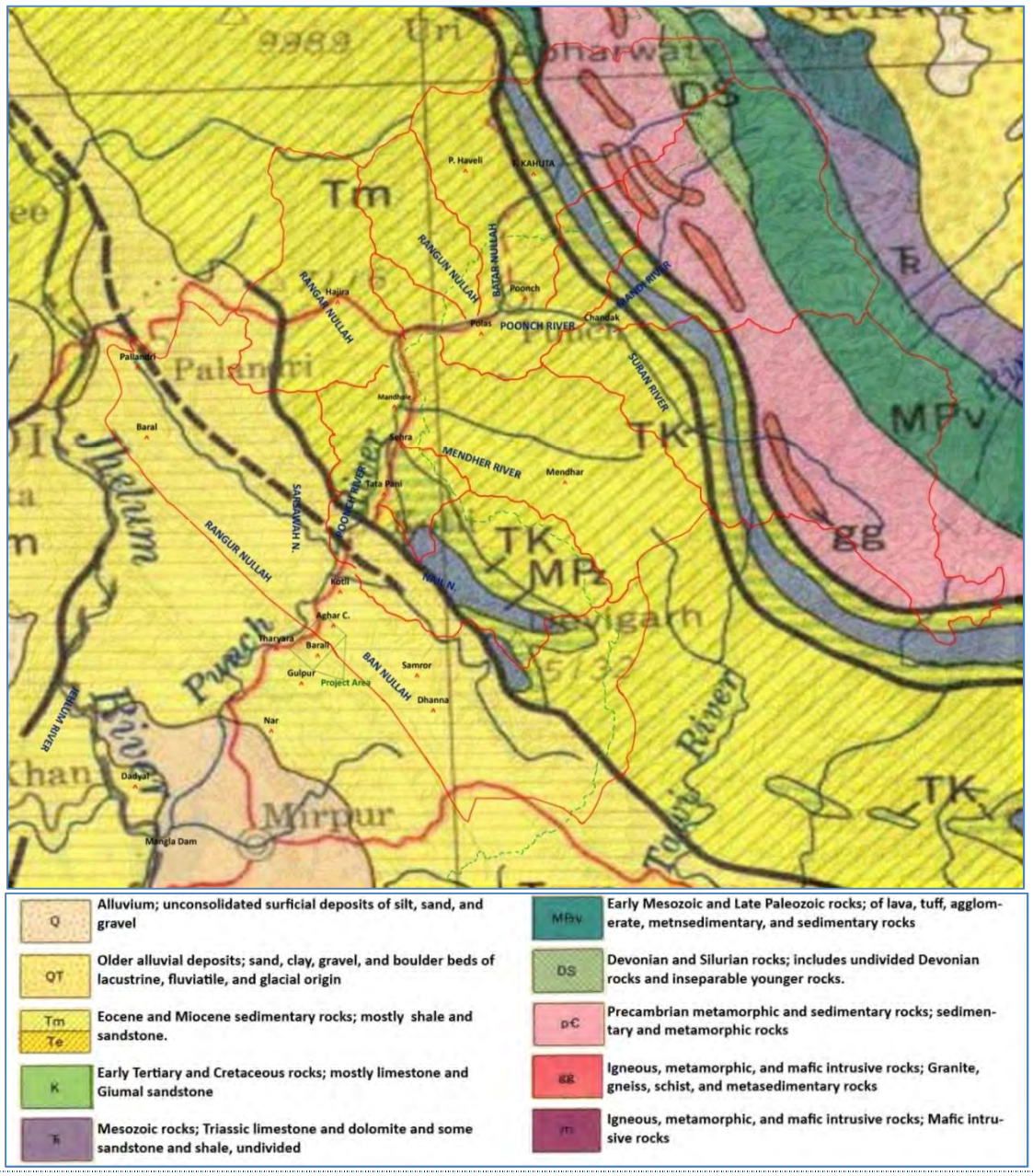


Figure 4.3: Regional Geological Map of the Area.

Major geological formations in the project area are;

4.3.1.1 Pliestocene and Recent Deposits Overburden

The overburden present in the area is river alluvial material and overburden on the terraces. River alluvial material is present in 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, generally of igneous and metamorphic origin, 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.

4.3.1.2 Secree, Talus and Vegetation

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 WAPDA Watershed Management and Forest Department.

4.3.1.3 Classification of Rocks

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

a. Sandstones of various strength and cementation
b. Claystones
c. Siltstones

4.3.1.4 Sandstone

Sandstones of this part of Nagri (middle Siwaliks) have also been classified into three categories:

1. Sandstone-1 (Sst-1). This type of sandstone is always present in the form of ribs and lenses in the main beds of sandstone-2.
2. Sandstone-2 (Sst-2). Moderately strong to strong, dirty greenish grey to light brownish grey, medium to coarse grained, moderately to well cemented and cross bedded.
3. Sandstone-3 (Sst-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.

4.3.1.5 Claystone/Siltstone

Alternate beds of Cst/Mst 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 jointed and moderate fractured.

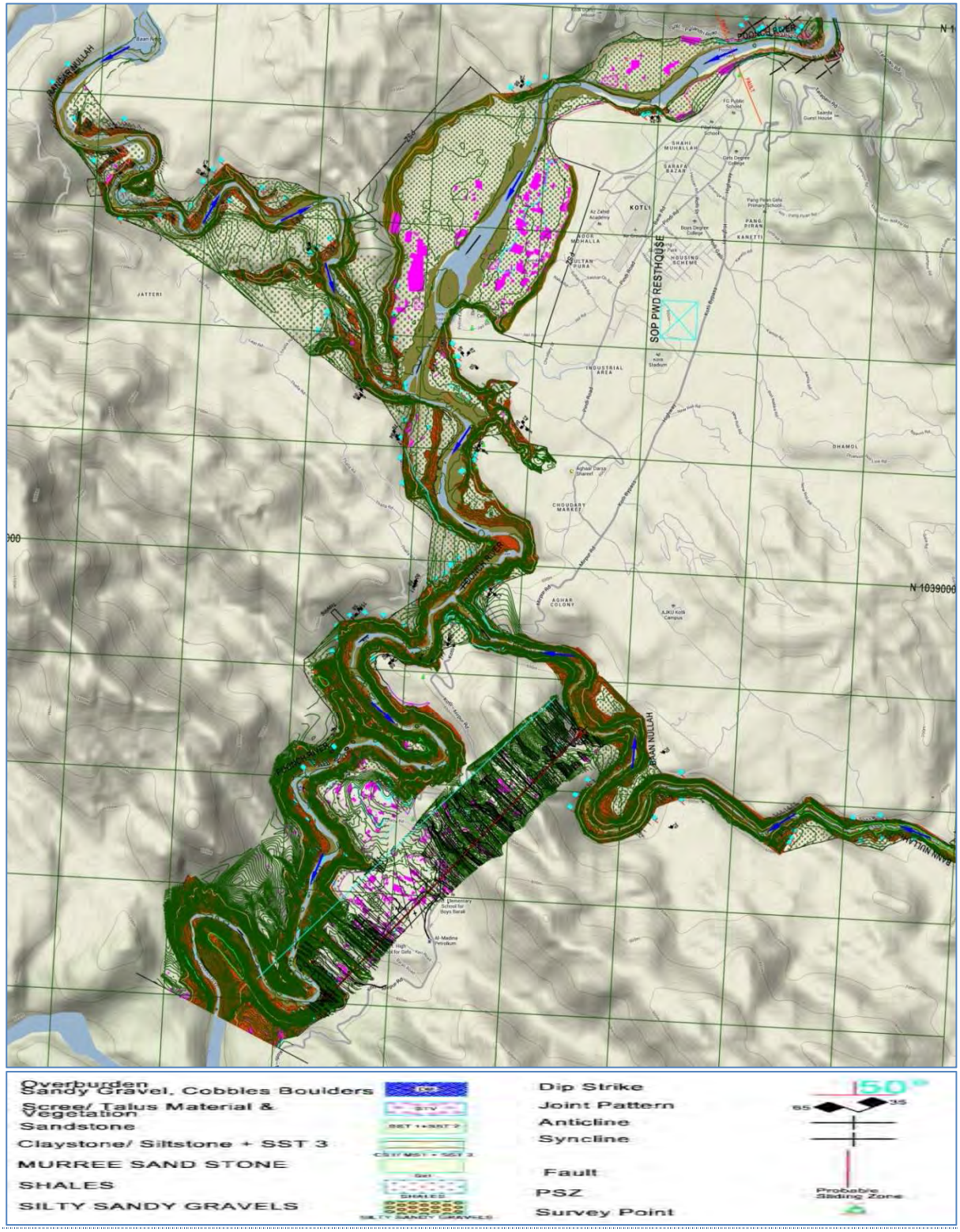


Figure 4.4: Geological Map of the Project Area

4.3.2 Seismicity

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 (**Figure 4.5**). These are believed to be associated with MBT in Himalayan range. A detailed study of seismic hazard is provided in **Annexure 1**.

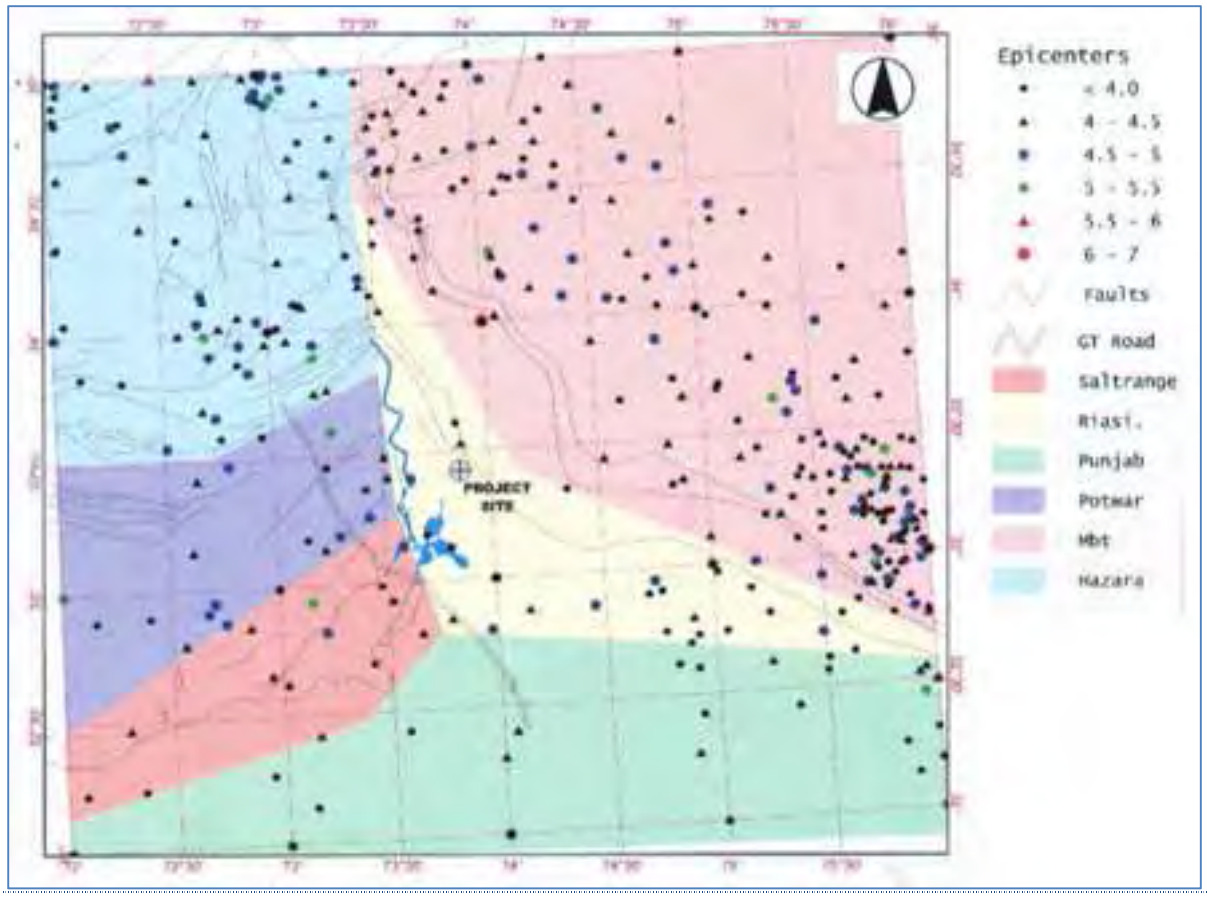


Figure 4.5: Seismotectonic Map of the Area

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. Two earthquakes of magnitude greater than 6 have also been recorded in this area.

Figure 4.6 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.

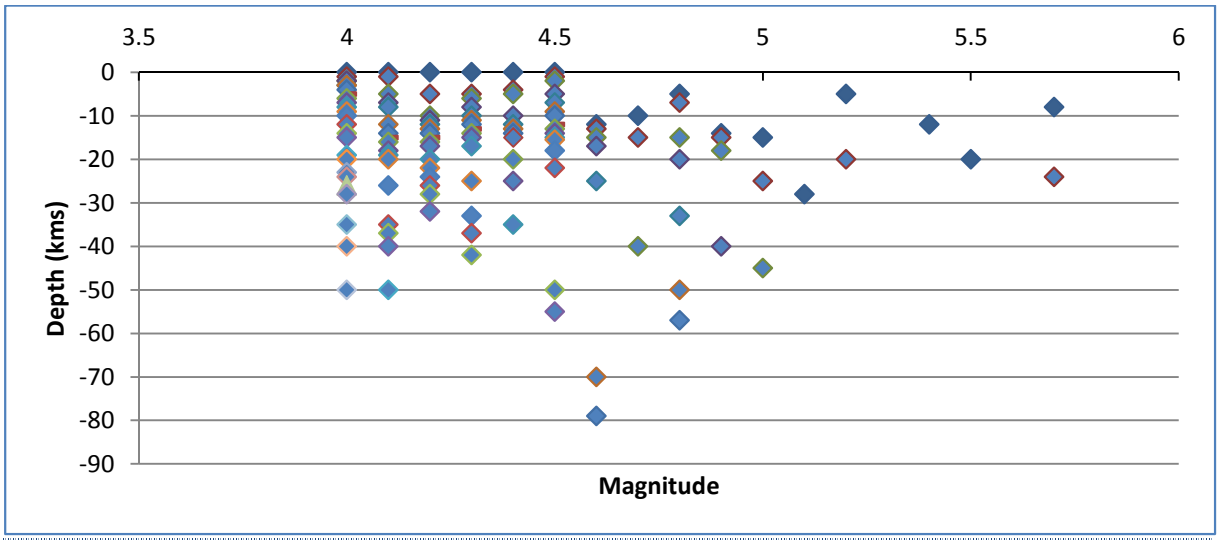


Figure 4.6: Micro-seismicity of the Project Area

4.3.3 Drainage

Situated in the Jammu and Kashmir region, catchment of the Poonch River down to the proposed weir is about 3800 km^2, with many snow fed and rain fed rivulets/streams with dendritic drainage pattern. It originates in the western foothills of Pir Panjal range, in the areas of Neel-Kanth Gali and Jamian Gali. It is called 'Siran' in this area. It flows to the north west. At first flowing southwards it enters Mangla Lake near Chomukh. The towns of Poonch, Sehra, Tatta Pani and Kotli are situated on the banks of this river. It has two major tributaries in Pakistan, Batar and Mendher. The Poonch River originates at an elevation of more than 3500 m and traverses about 110 km from east to west up to the proposed weir site and fed by many big and small streams on both the banks. Most of the tributaries join the river on its right bank (**Figure 4.7**).

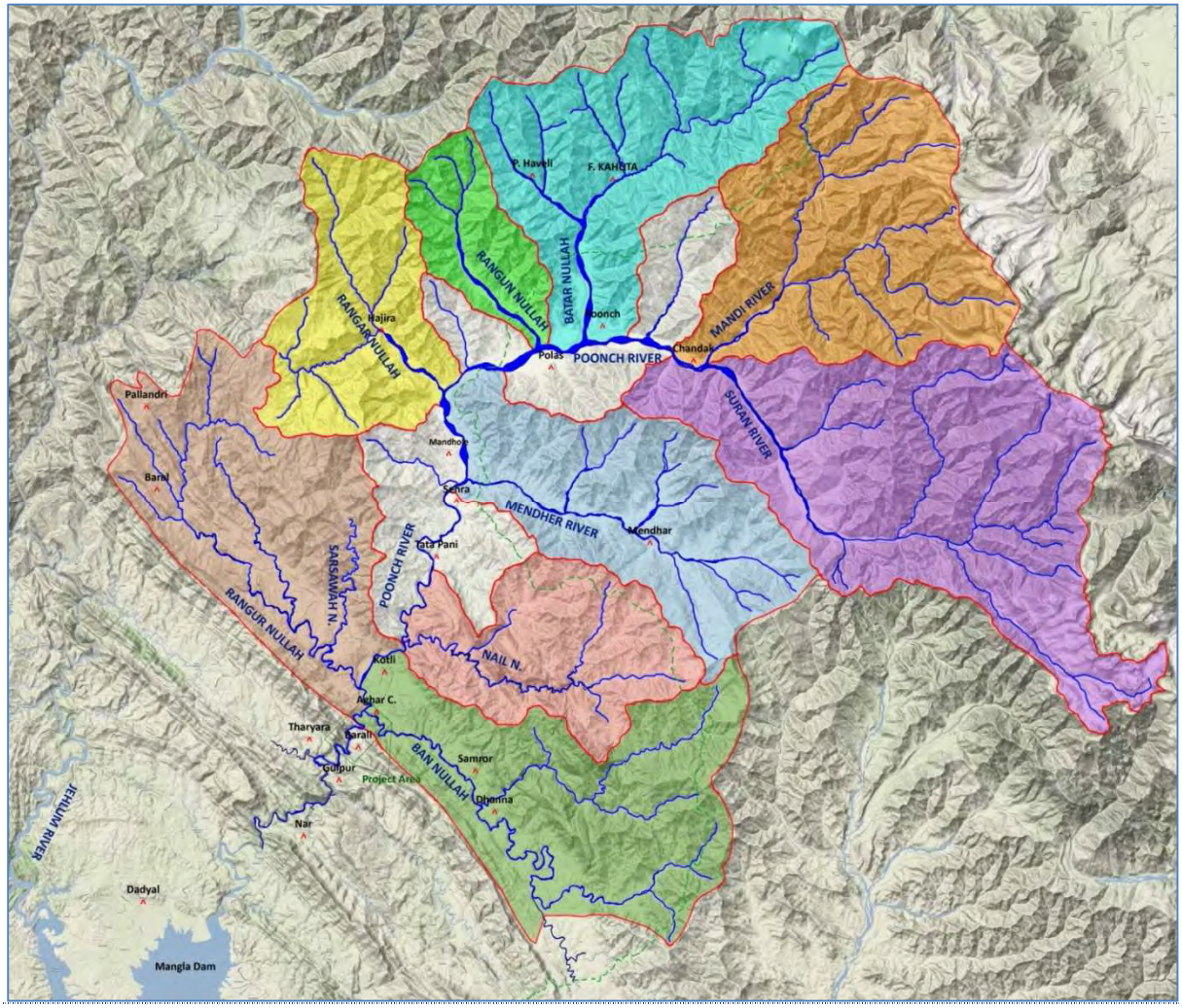


Figure 4.7: Poonch River Catchment Area with Highlighted Catchments of Tributaries

Bann Nullah: A left bank tributary has a relatively steep gradient. It joins the Poonch River at the proposed weir site. Catchment area of the nullah is about 423 km^2 and mean annual runoff is about 450 Million Cubic Meters (MCM).

Rangur Nullah: About 3 km upstream form the proposed weir site, this ephemeral tributary joins Poonch River at right bank near Kotli. With a catchment area of about 400 km^2 it is also joined by smaller tributaries like Sarsawah Nullah.

Mendher River: It is a snow fed perennial right bank tributary of Poonch. It joins Poonch River near Sehra about 33 km upstream from proposed wear site.

Rangar Nullah: It runs about 18 km from its point of origin, before joining Poonch River on right bank, about 42 km upstream of the proposed project site, near Sehr Kakota. This is the last major tributary of Poonch in Azad Kashmir. The settlement of Hajira is also located on this tributary.

Rangun Nullah: It is about 19 km ephemeral tributary. It originates in AJK, near the villages of Bandi and Jhaniwala and joins Poonch River, on right bank.

Batar Nullah: This is a perennial right bank tributary of Poonch River fed by many small nullahs. It joins the Poonch River about 56 km upstream from the proposed project site.

Mandi River/Suran River: About 10 km upstream from Poonch city, the river split into two perennial tributaries the northern tributary is Mandi River and the southern tributary is Suran River. The major tributary Suran River is the source of Poonch River, having its source, 39.5 km upstream from the junction point, in the Pir Panjal range. The total catchment area of these rivers is about 1260 km^2.

4.3.4 Elevation Bands (Relief)

The relief in the catchment area of Poonch River varies from 200 m to 4500 m. This elevation range was divided into 9 elevation bands with 500 m interval (**Figure 4.9**). The area of catchment area (in terms of sq. kms and percentage) which comes under these 9 elevation bands is given in **Table 4.1** and depicted in **Figure 4.8**. It is clear from the graph that most of the catchment area of proposed project (approximately 67%) has an elevation in the range of 500-2500m. The proposed location of project site has an elevation of 500 m ±50 m.

Table 4.1: Area and Percentage of Different Elevation Bands of Catchment Area

Elevation Band	*Catchment Area*	
	Area (Sq. Kms)	*Percentage (%)*
0-500	22.72	0.59
501-1000	719.57	18.69
1001-1500	832.76	21.63
1501-2000	590.98	15.35
2001-2500	433.51	11.26
2501-3000	372.68	9.68
3001-3500	321.48	8.35
3501-4000	291.06	7.56
4001-4500	265.27	6.89

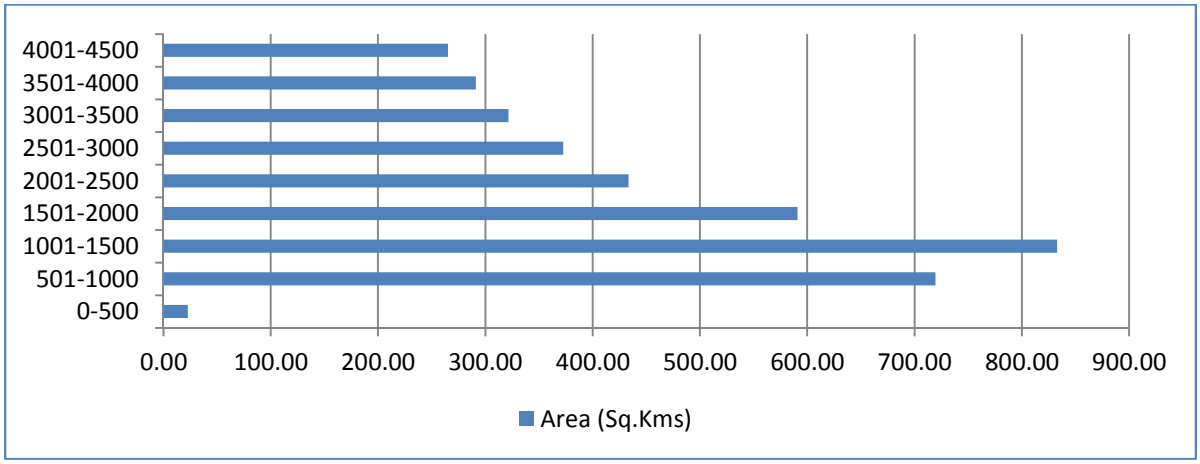


Figure 4.8: Area Profile under Different Elevation Bands

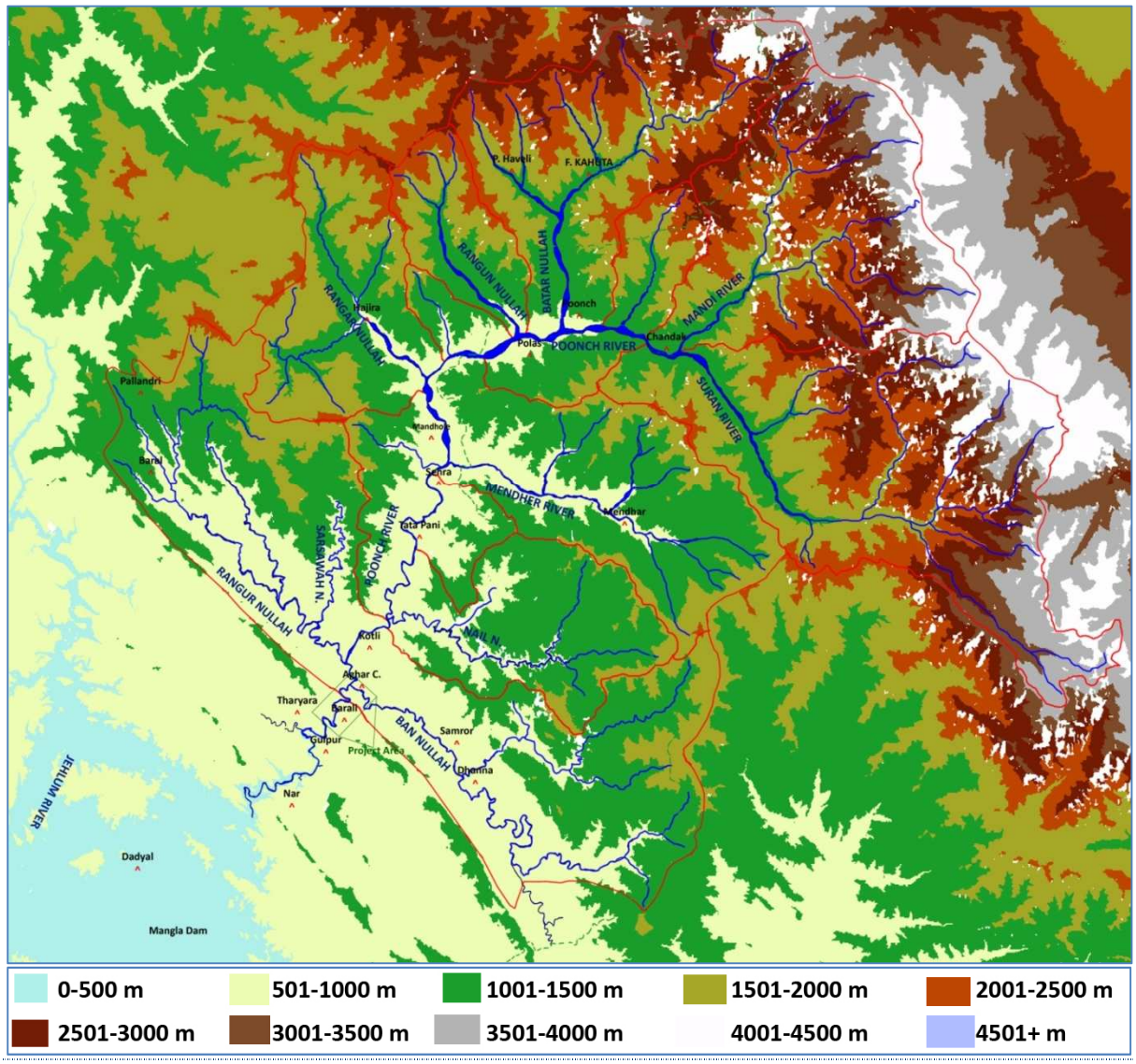


Figure 4.9: Elevation Band Map of Catchment Area of Poonch River

4.3.5 Land Use and Land Cover

The lands on the hills generally belong to the Forestry Department and bear forests of pine trees. The lands on the high benches within hilly areas, however proprietary, are used for cultivation and settlements. The river and nullah beds along with the adjacent slopes are again the government property. As such, the proposed project components, viz., Weir, Intake structure including intake portal of the Power Tunnel and Power House including penstocks, will be located on the government land. Though some proprietary land exists in the area of Intake structure, it lies on a quite high bench and will not be affected by the construction activities. Similarly, the Power Tunnel will pass underneath the lands belonging either to the Forestry Department or to individual owners of the Barali Village. Either of these lands would not be affected by the Project as the tunnel will be many tens of meters below the natural surface. 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.

On the other hand, the reservoir will consume both government and proprietary lands. Of this, however, the major chunk is the government land. Majority of the terrace land falling in the floodplain of the Poonch River in the Kotli Valley belongs to Auqaf Department attached with a shrine that was inundated and demolished by 1992 flood. Thus the proprietary land likely to be submerged by the reservoir will be a small fraction of the total reservoir area.

4.3.6 Soil

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.

During site visit conducted in August 2013, soil samples were collected from the following 5 locations:

1. Barali village;
2. Gulhar;
3. Mandi Juzvi;
4. Jamal Pur;
5. Weir Site;

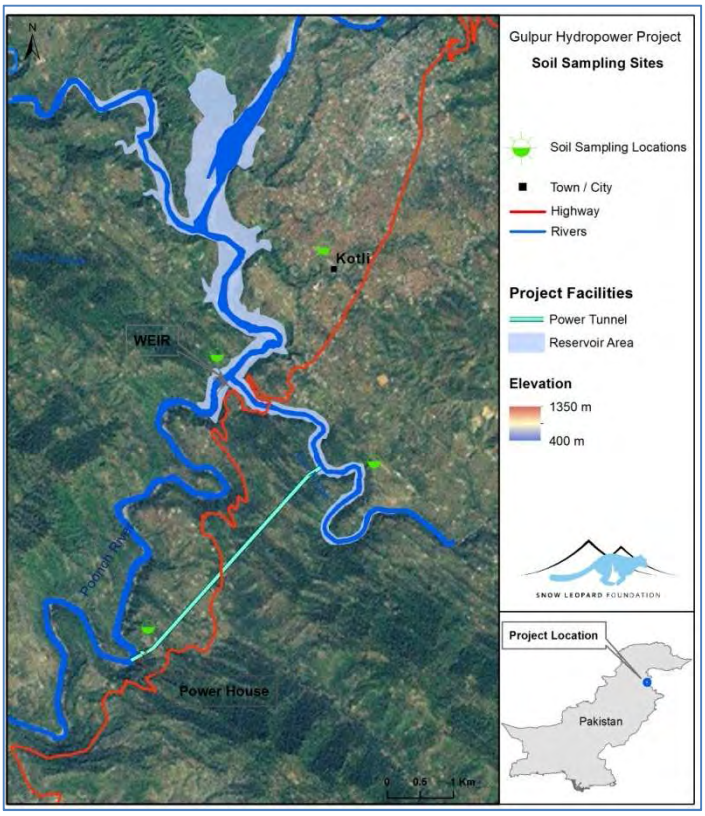


Figure 4.10: Soil Sampling Locations

The sample locations were well distributed to represent the project area; **Figure 4.10** shows the sampling locations. Test results of these samples have been presented in **Table 4.2**. TKN (Nitrogen) and Phosphorous contents of the samples indicate moderate fertility of soil. Though the metallic content of the soil samples is higher than average, these concentrations pose no threat to human health.

Table 4.2: Soil Analysis Results

Sr. #	*Parameters*	*Method*	*Unit*	*LDL*	*Test Results*				
					Barali	*Gulhar*	*Mandi Juzvi*	*Jamal Pur*	*Weir Site*
1	Nitrogen (TKN)	Based on APHA-4500 N_{org} B	mg/kg	0.1	1.53	3.02	1.86	1.38	1.8
2	Phosphorous	Based on APHA-4500 P C	mg/kg	0.05	2	1.72	2.6	2.6	2.36
3	Cadmium $(Cd)^{+2}$	USEPA 3050 B	mg/kg	0.5	3.55	<0.50	<0.50	<0.50	<0.50
4	Chromium	USEPA 3050	mg/kg	0.5	19.32	15.76	25.27	28.65	26.11

Sr. #	Parameters	Method	Unit	LDL	Test Results				
					Barali	Gulhar	Mandi Juzvi	Jamal Pur	Weir Site
	(Cr)	B							
5	Lead $(Pb)^{+2}$	USEPA 3050 B	mg/kg	0.5	75.16	95.19	77.76	100.9	76.69
6	Iron as $(Fe)^{+3/+2}$	USEPA 3050 B	mg/kg	0.02	27153.91	21934.86	25545.5	26119.6	25842.05
7	Aluminium $(Al)^{+2}$	USEPA 3050 B	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
8	Sulfate $(SO_4)^{-2}$	In-House /Gravimetric	mg/kg	5	299.18	213.73	311.39	201.15	102.07
9	Total Dissolved Solids (TDS)	In-House /Gravimetric	mg/kg	5	989.70	1193.51	796.81	688.10	994.91

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

4.4 Climate and Meteorology

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. This part of the report will provide a baseline of climate and meteorology of the area, for a detailed study refer to **Annexure 2**.

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. Consequently the weather is pleasant in the months of March to May and August to October.

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

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 period is of intense phonological activity at the higher elevations and can be termed as spring.

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.

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. In these months the diurnal range of temperature is quite marked.

4.4.1 Rainfall and Humidity

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 4.3**). **Figure 4.11** presents the yearly precipitation and evaporation trend in project area.

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.

Table 4.3: 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[14] (data not available from 1997 to 2002)

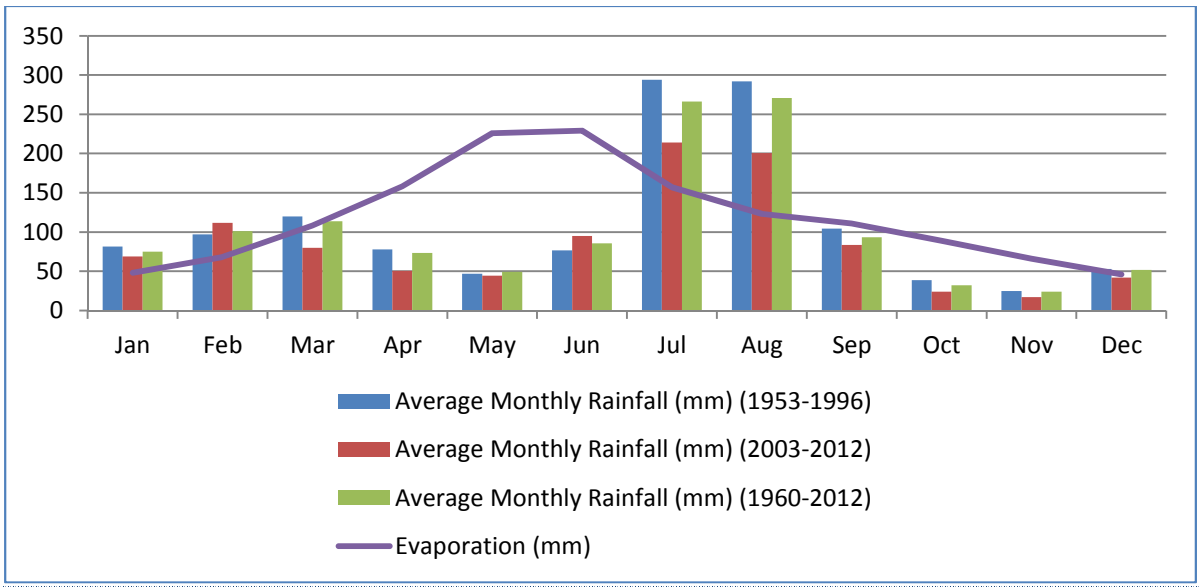


Figure 4.11: Average Monthly Rainfall and Evaporation

4.4.2 Temperature

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 warmest month. The temperature remains

[14] Annual Report on River and Climatology Data of Pakistan (WAPDA)

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. The data shows that the 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. (**Table 4.4** and **Figure 4.12**)

Table 4.4: 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 (^{o}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 (^{o}C)	4.8	7.37	11.9	16.9	21.46	24.94	24.2	23.44	21.4	16.35	9.9	5.5	15.6

* Source Pakistan Water and Power Development Authority

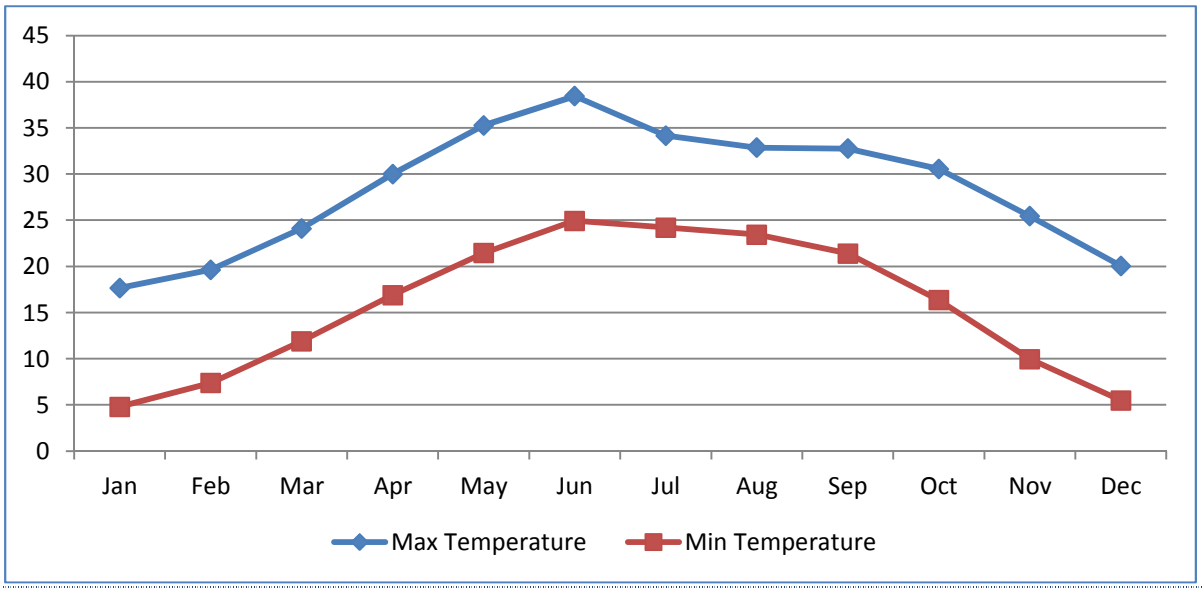


Figure 4.12: Average Monthly Temperatures in ^{o}C

4.4.3 Wind

Winds decide the dispersion of air pollutants and are an important aspect in any environmental impact assessment study. Movement of air pollutant is dependent on the wind speed and wind direction, the temperature and humidity also affects the dispersion of pollution. 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.

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. The detailed wind speed, direction, humidity and temperature data are provided in **Table 4.5**.

Table 4.5: Wind Data at the Proposed Project Site

Time	Proposed Power House Site			Proposed Camp Area			Proposed Weir Site			Proposed Batching Plant		
	Direction	Wind Speed	Humidity	Direction	Wind Speed	Humidity	Direction	Wind Speed	Humidity	Direction	Wind Speed	Humidity
		m/s	%		m/s	%		m/s	%		m/s	%
15:00	W	5.4	63	W	2.7	52	N	5.3	40	E	2.8	42
16:00	W	4.3	60	W	2.8	55	N	4.6	45	E	2.4	43
17:00	W	4.7	58	W	4.5	54	N	5.5	48	E	4.5	45
18:00	WE	5.9	68	WE	4.9	57	NW	4	52	E	4.3	46
19:00	WE	5	70	E	5.2	58	N	3.8	52	E	4	48
20:00	WE	3.8	72	E	5	58	N	1	53	E	5.2	53
21:00	W	3	78	W	4.6	59	N	3.2	55	NE	5.4	56
22:00	W	4.7	79	E	3.8	63	N	1.8	57	NE	4.8	58
23:00	W	5.8	80	E	2	64	N	1.4	60	NE	3.1	59
24:00	W	5.3	84	E	1.8	66	NW	2.4	61	E	2	60
1:00	W	4.8	80	WE	1.8	67	NW	2.2	63	E	1.9	62
2:00	W	4.6	78	E	1.3	69	NW	2	64	E	1.4	63
3:00	W	4.2	65	E	1	75	N	1.7	68	E	0.9	65
4:00	WE	4	63	E	0.8	74	N	2.8	67	E	1.8	68
5:00	WE	4.8	62	WE	2.4	78	N	2.2	65	E	1.2	69
6:00	WE	5.3	60	W	2.8	78	N	5	64	NE	1.1	66
7:00	WE	4.9	58	W	3.7	82	N	4.2	63	NE	2.6	64
8:00	W	4.5	57	W	2.2	80	N	3.9	61	NE	2.8	63
9:00	W	3	55	WE	4	64	NE	3.5	59	NE	3.5	60
10:00	W	3.8	53	WE	4.3	62	NE	3	58	E	4.8	57
11:00	WE	3.1	52	WE	5.3	60	N	4.6	57	E	4.6	56
12:00	WE	3	50	W	5	55	N	5.1	55	E	4	55
13:00	W	2.9	48	W	5.1	52	NE	5.4	53	E	4.4	54
14:00	W	3.8	45	W	4.7	50	NE	4.8	52	E	4.1	52

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

4.5 Hydrology and Water Resources

4.5.1 Hydrology

A stream gauging station on Poonch River has been maintained at Rehman Bridge by SWHP of WAPDA since 1960. Measurements include stream flows and suspended sediment concentrations. Complete water availability study is provided in **Annexure 3**. Rehman Bridge Gauging Station is located just downstream of Bann Nullah about 5 Km south east of Kotli Town. Between Rehman Bridge gauge site and proposed weir 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 has been used to present inflow time series. Mean monthly discharges computed from the mean daily flows are given in **Table 4.6**, which shows a minimum value of 12 cumecs observed in January 1966 and maximum value of 830 cumecs in September 1992. Mean monthly flows (in cumecs) and monthly runoff (in MCM) are graphically shown in **Figure 4.13** and **Figure 4.14**. This figure depicts that mean monthly flows vary between 41 cumecs (106 MCM) in November to 279 cumecs (746 MCM) in August. Additionally Punch River drains south side of Pir Panjal range and flows through Azad Kashmir in deep canyons with young easily erodible rocks and carries large amount of sediment load.

Table 4.6: Summary of Mean Monthly Flows of Punch River at Rehman Bridge (1960-2011)

Year	Mean Monthly Flow (Cumecs)												Annual Flow		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cumecs	MCM	(MAF)
Maximum	156	293	402	396	221	263	633	665	830	220	162	187	260	8215	6.66
Minimum	12	21	27	53	53	56	80	90	45	19	15	15	66	2086	1.69
Runoff	144	272	375	343	168	207	553	575	785	201	147	172	194	6129	4.97
Mean	53	100	177	165	119	116	225	264	141	57	41	47	126	3966	3.22

* Source Pakistan Water and Power Development Authority (Cumecs: Cubic Meters per Second MCM: Million Cubic Meters MAF:Million Acre-Foot)

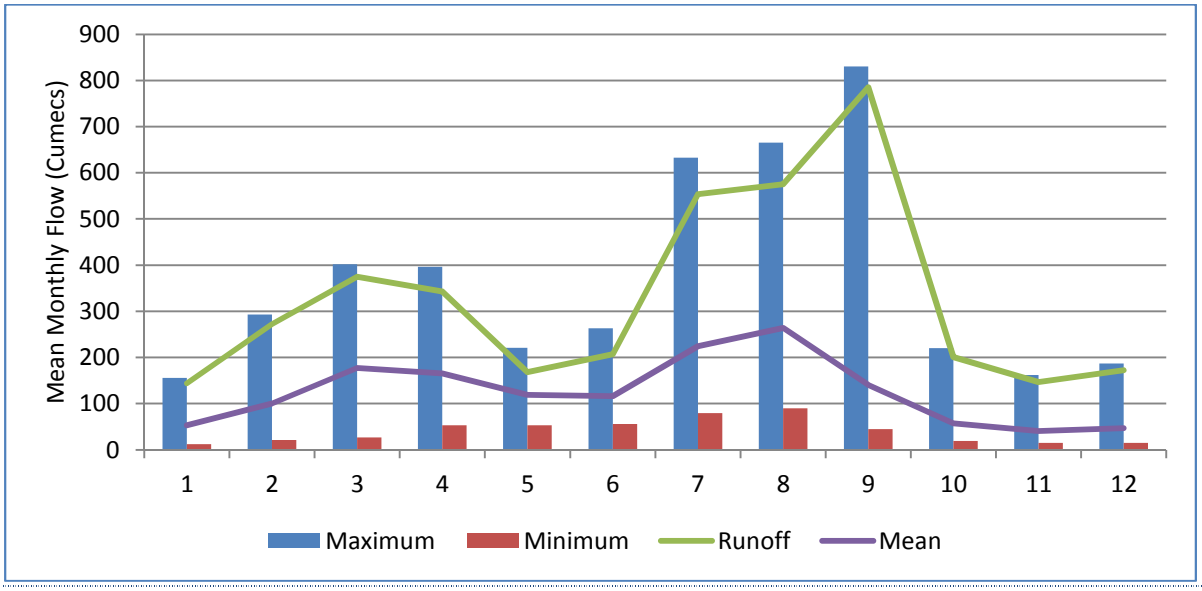


Figure 4.13: Monthly Flows and Runoff of Punch River

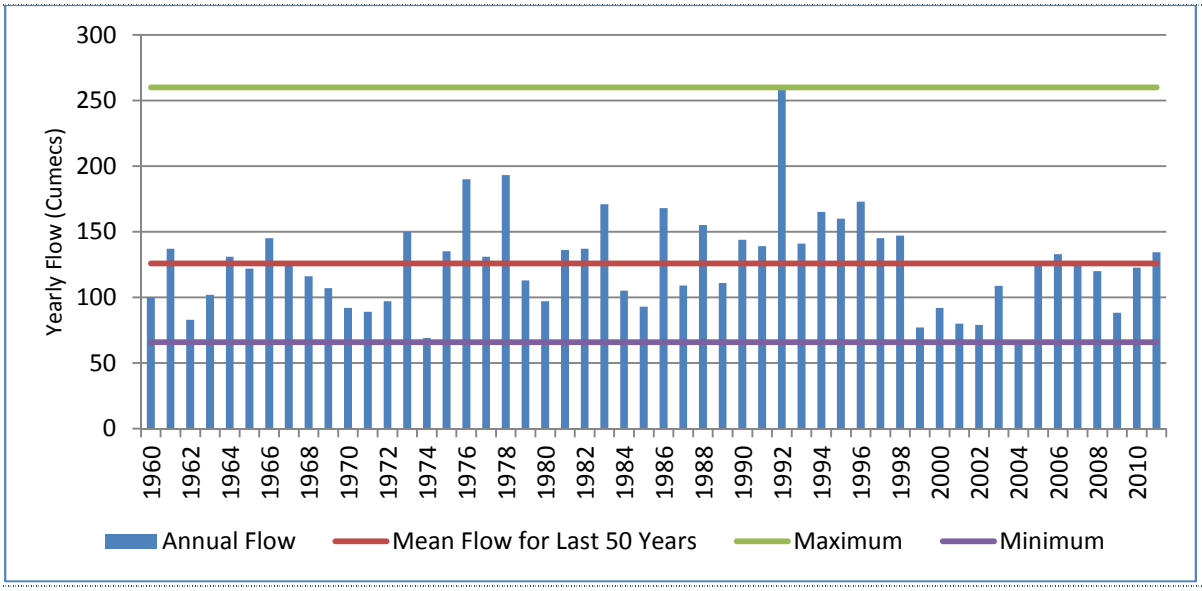


Figure 4.14: Mean Annual Flows of Punch River

4.5.2 Water Resources

4.5.2.1 Surface Water

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 Held Kashmir

draining south side of Pir Panjal Range. The total catchment area of the river at the Project weir 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 Weir 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 Rangur Nullah that has its confluence with river at about 2 km upstream of Weir site.

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 weir 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 cumecs (cubic meter per second) 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 or 3.28 MAF.

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 weir site during the reference period from 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 weirs are enough to efficiently pass more than the design discharge (about 15,000 cumecs).

The water quality of the 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.

4.5.2.2 Ground Water

The project area in Kotli District is devoid any true aquifer. This is because of the stony formation of the area and steep slopes of the mountains. The rain water 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. It has been observed that the settlements are located where spring water is available in addition to the availability of level ground for housing and cultivation.

4.5.3 Water Quality

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. The sampling and analysis was conducted for ESIA. Water quality can be expressed in terms of physical, chemical and biological characteristics. Essential characteristics like pH, color, odor and total suspended solid are covered under physical analysis; dissolved solids, total hardness, Calcium, Magnesium, Sulphates, Nitrates, Chloride, Fluoride and heavy metals under chemical analysis and Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Coliforms under biological/ bacteriological analysis.

To generate baseline data for existing quality of water in the project area, 25 water samples (composite) were collected (**Figure 4.15**) 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. Almost all the important physico-chemical attributes as well as microbiological parameters were analyzed for all the 25 samples collected. The results of the analysis carried out for the sampling undertaken are summarized in **Table 4.7** and **Table 4.8.** Some of the important results are also discussed below.

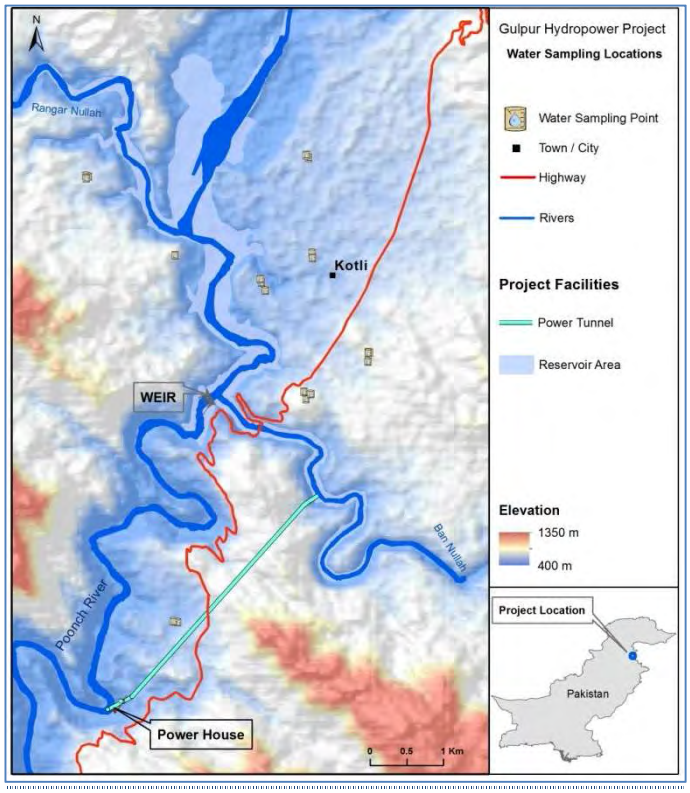


Figure 4.15: Drinking Water Sampling Locations

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. Especially the drinking water in Jamal Pur and Aghar Colony has highest microbial count.

Table 4.7: Microbiological Contaminant 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
Dharang Spring	$2.8x10^4$	79	2	16
Mandi Juzvi (Spring Water)	$1.1x10^4$	45	Absent	11

Parameter	Total Colony Count	Total Coli Forms	Faecal coli Forms (E. coli)	Faecal Streptococci/ Enterococci
Mandi Juzvi (Spring Water)	$9.9x10^4$	52	Absent	24
Mandi Juzvi (Spring Water)	$9.1x10^4$	48	Absent	48
Hill Kalan (Spring Water)	$1.1x10^5$	70	12	48
Hill Kalan (Spring Water)	$6.2x10^4$	74	Absent	18
Hill Kalan (Spring Water)	$1.4x10^5$	65	6	12
Hill Khurd (Spring Water)	$1.1x10^5$	55	4	14
Hill Khurd (Spring Water)	$9.5x10^4$	57	Absent	40
Hill Khurd (Spring Water)	$8.3x10^4$	63	18	22
M. Asif S/O M. Sadiq (Gulhar Colony)	$2.9x10^5$	8	Absent	4
Mr. Abdullah S/O M. Hussain (Gulhar Colony)	$1.6x10^3$	2	Absent	Absent
Mr. Waseem S/O Abdul Karim (Gulhar Colony)	$2.1x10^4$	6	Absent	2
Mr. Irshad S/O M. Nazir (Gulhar Colony)	$1.7x10^5$	7	Absent	1
Mr. Afaq S/O Mr. Haider (Gulhar Colony)	$3.9x10^4$	58	Absent	Absent
M. Shafiq S/O M. Usman (Dharang)	$7.3x10^4$	64	Absent	12
Mr. Haider S/O M. Abdullah (Dharang)	$1.5x10^4$	37	Absent	8
Jamal Pur	$3.9x10^4$	TNTC	Absent	16
Jamal Pur	$4.3x10^4$	14	Absent	62
Jamal Pur	$4.9x10^4$	TNTC	24	50
Aghar Colony	$6.5x10^4$	TNTC	40	68
Aghar Colony	$4.2x10^4$	TNTC	34	44
Aghar Colony	$4.3x10^4$	TNTC	58	30

* Source, physical baseline survey, sampling, testing and analysis conducted in August 2013, (cfu: colony forming unit TNTC: Too Numerous to Count)

Table 4.8: 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	0.1	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	405.9	486	19.56	41.57	0.027	< 0.005	0.033	83.76	3.869
Barali (Spring Neeara)	7.7	618	425.7	507.6	19.56	47.33	<0.01	< 0.005	0.041	83.6	3.805
Dharang Spring	7.68	832	356.4	378	127.19	171.63	0.021	0.034	0.7	191.85	7.026
Mandi Juzvi (Spring Water)	7.69	595	455.4	351	44.02	48.56	0.04	< 0.005	0.075	47.74	4.912
Mandi Juzvi (Spring Water)	7.16	590	455.4	356.4	39.13	59.68	<0.01	< 0.005	0.038	48	4.778
Mandi Juzvi (Spring Water)	7.17	600	455.4	351	44.02	59.68	<0.01	< 0.005	0.021	48.06	4.775
Hill Kalan (Spring Water)	7.72	601	485.1	351	44.02	56.38	0.041	< 0.005	0.033	48.2	4.798
Hill Kalan (Spring Water)	7.8	580	435.6	340.2	44.02	52.27	<0.01	< 0.005	0.546	47.84	4.753
Hill Kalan (Spring Water)	7.8	590	504.9	334.8	39.13	51.45	<0.01	< 0.005	0.026	47.66	4.763
Hill Khurd (Spring Water)	7.45	589	485.1	351	44.02	46.51	0.08	< 0.005	0.024	48.46	4.784
Hill Khurd (Spring Water)	7.62	866	346.5	361.8	132.08	171.22	0.023	0.018	0.333	190.95	6.358
Hill Khurd (Spring Water)	7.67	602	485.1	351	44.02	51.45	0.04	< 0.005	0.028	47.5	4.774
M. Asif S/O M. Sadiq	7.57	427	346.5	324	29.35	27.16	<0.01	<	0.022	31.1	2.52

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 $(K)^{+1}$*
(Gulhar Colony)								0.005			
Mr. Abdullah S/O M. Hussain (Gulhar Colony)	7.61	410	356.4	313.2	24.46	23.87	0.037	< 0.005	0.02	31.94	2.515
Mr. Waseem S/O Abdul Karim (Gulhar Colony)	7.64	424	366.3	324	29.35	27.16	0.061	< 0.005	0.033	32.76	2.619
Mr. Irshad S/O M. Nazir (Gulhar Colony)	7.58	726	514.8	486	53.81	53.5	0.061	< 0.005	<0.02	82.12	9.282
Mr. Afaq S/O Mr. Haider (Gulhar Colony)	7.55	701	475.2	464.4	48.92	61.17	<0.01	< 0.005	0.052	81.28	8.716
M. Shafiq S/O M. Usman (Dharang)	7.79	716	504.9	399.6	58.7	49.39	0.052	< 0.005	0.038	56.64	4.995
Mr. Haider S/O M. Abdullah (Dharang)	7.81	698	495	378	53.81	51.45	0.025	< 0.005	0.029	57.06	5
Jamal Pur	7.83	498	386.1	324	24.46	25.51	0.021	< 0.005	0.027	31.1	2.71
Jamal Pur	7.52	494	405.9	329.4	24.46	22.63	0.101	< 0.005	0.03	32.28	2.71
Jamal Pur	7.67	508	366.3	313.2	29.35	24.28	0.021	< 0.005	0.039	32.2	2.708
Aghar Colony	7.63	508	396	324	19.56	23.87	0.041	< 0.005	0.038	33.92	2.69
Aghar Colony	7.8	506	386.1	334.8	29.35	20.58	0.041	< 0.005	0.029	31.24	2.67
Aghar Colony	7.81	494	386.1	334.8	24.46	23.46	<0.01	< 0.005	0.046	31.5	2.69

* Source, physical baseline survey, sampling, testing and analysis conducted in August 2013 (LDL: Lowest Detection Limit NS: Not Specified)

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 (**Figure 4.16**).

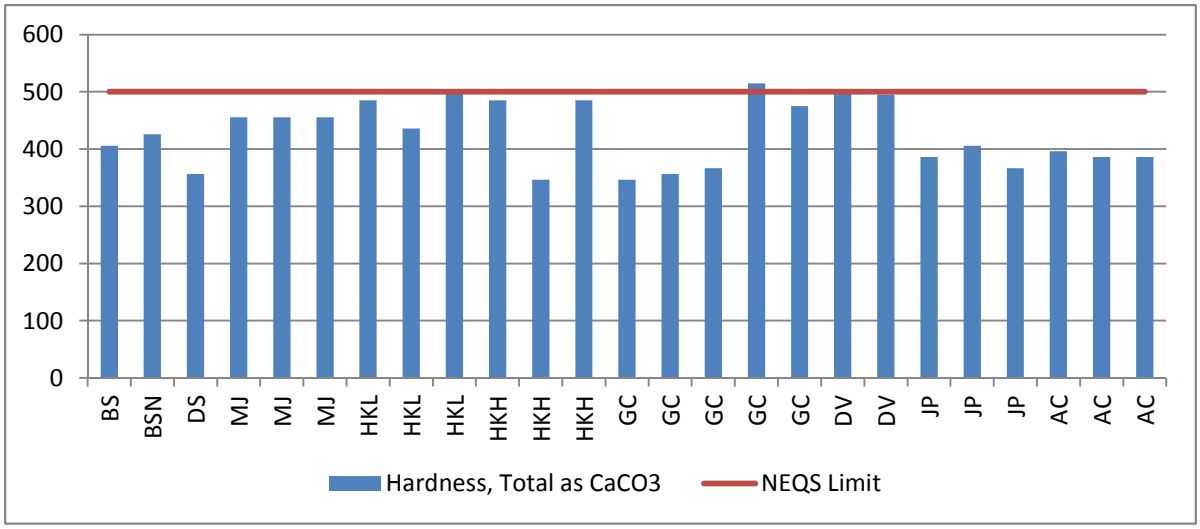


Figure 4.16: Water Hardness in the Various Sampling Sites Area

Chloride $(Cl)^{-1}$ and Sulfate $(SO4)^{-2}$ ranged from 19.56 to 132.08 mg/l and 20.58 to 171.63 mg/l respectively. The values are well within the permissible NEQS Limits (**Figure 4.17**).

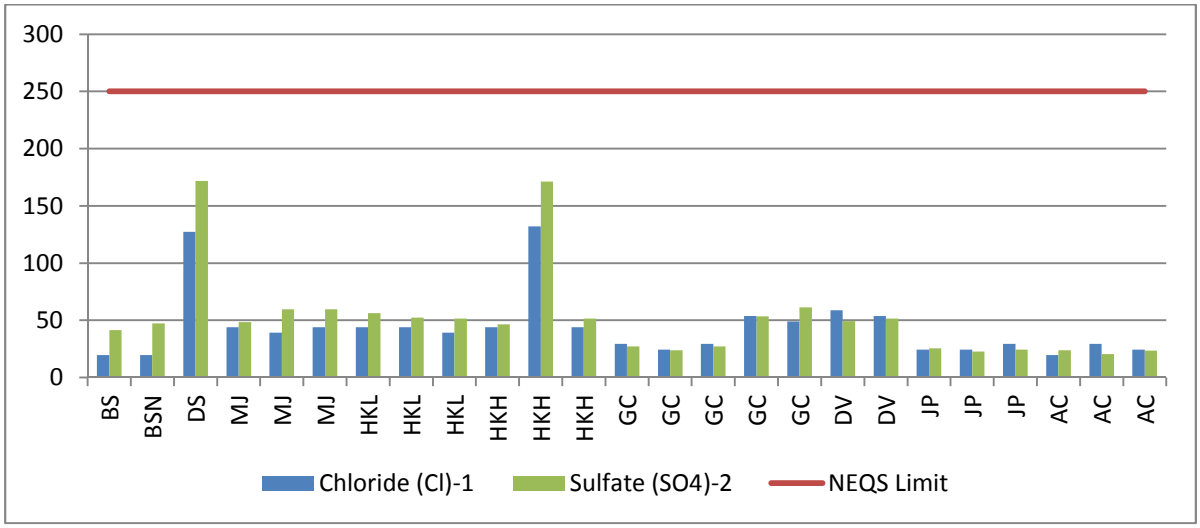


Figure 4.17: Chloride and Sulfate Concentration in the Drinking Water

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 (**Figure 4.18**). There are 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. Therefore, this points to poor quality of water.

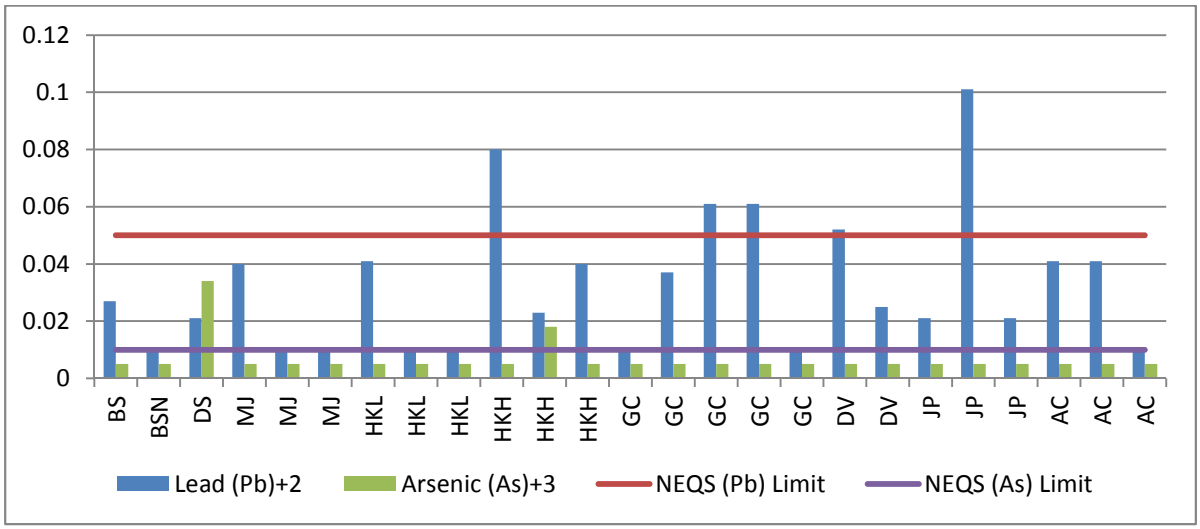


Figure 4.18: Lead and Arsenic Concentration in the Drinking Water

4.6 Air, Noise and Light

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. 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.

4.6.1 Air Quality

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

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

The average concentration of carbon monoxide (CO) for 08 hrs according to the National Environmental Quality Standards (NEQS) for Ambient Air should not exceed from 5.0 mg/m3. The values obtained are in compliance with National Environmental Quality Standards (NEQS).

Table 4.9: 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	80	120	150
Average Obtained Concentration	Proposed Power House Site	0.85	<5.0	<5.0	97.14
	Proposed Camp Area	0.82	<5.0	<5.0	87.9
	Proposed Weir Site	0.72	<5.0	<5.0	75.19
	Proposed Batching Plant	0.93	<5.0	<5.0	66.77

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

Average 24 hrs concentrations in Environmental Quality Standards (NEQS) for Ambient Air for Nitrogen Dioxide (NO_2) is 80 ug/m^3 and average concentrations of Nitrogen Dioxide (NO_2) measured during monitoring were found in compliance with National Environmental Quality Standards. According to standard the 24 hrs concentration of Sulphur Dioxide (SO_2) in ambient air should not exceed from 120 ug/m^3, while concentration obtained was found within limit of National Environmental Quality Standards (NEQS).

The ambient particulate matter PM10 was found 97.14 ug/m^3 at proposed power house site, 87.90ug/m3 at proposed camp area, 75.19 ug/m^3 at proposed weir site and 66.77ug/m3 at proposed batching plant are within standard value of 150 ug/m^3.

4.6.2 Noise

Noise level monitoring was conducted at the same location where the ambient air quality was monitored. The noise level was found in range of 59.7 to 68.1 (dBA) at proposed power house site, 37.0 to 57.0 (dBA) at proposed camp site, 37.3 to 54.8 (dBA) at proposed weir site and 35.9 to 48.9 (dBA) at proposed batching plant. **Figure 4.19** to **Figure 4.22** shows the values obtained during noise level monitoring at project sites respectively.

Table 4.10: WHO Guideline Values for Community Noise in Specific Environments

Specific Environment	*Leq (dB)*	*LAmax fast (dB)*
Outdoor living area	55	-
School class rooms and pre-schools (indoors)	35	-
School, playground (outdoors)	55	-
Hospital, ward rooms (indoors)	30	40
Hospital, treatment rooms (indoors)	1	-
Industrial, commercial, shopping and traffic areas (indoors and outdoors)	70	110

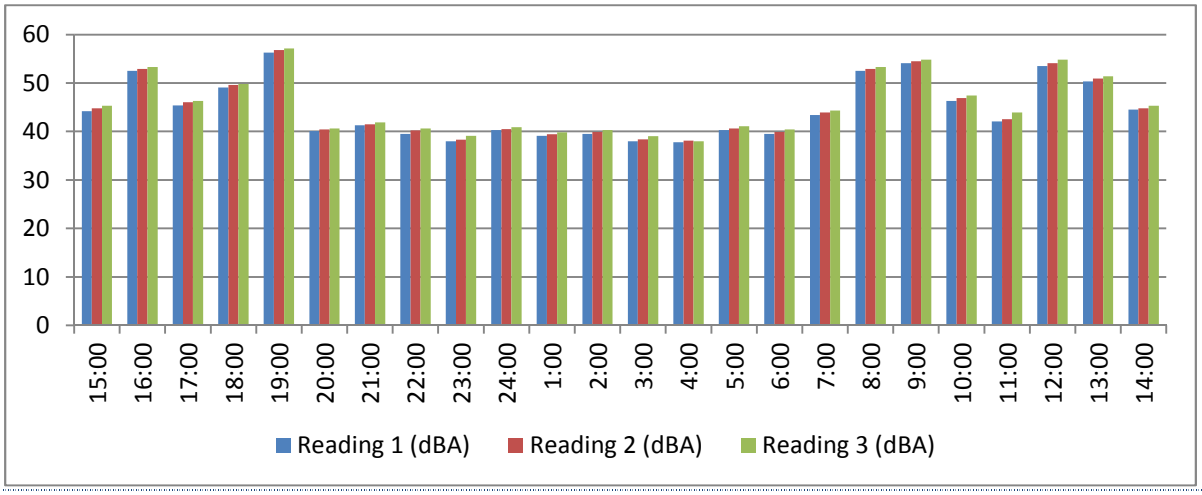


Figure 4.19: Noise Level at Proposed Powerhouse Site

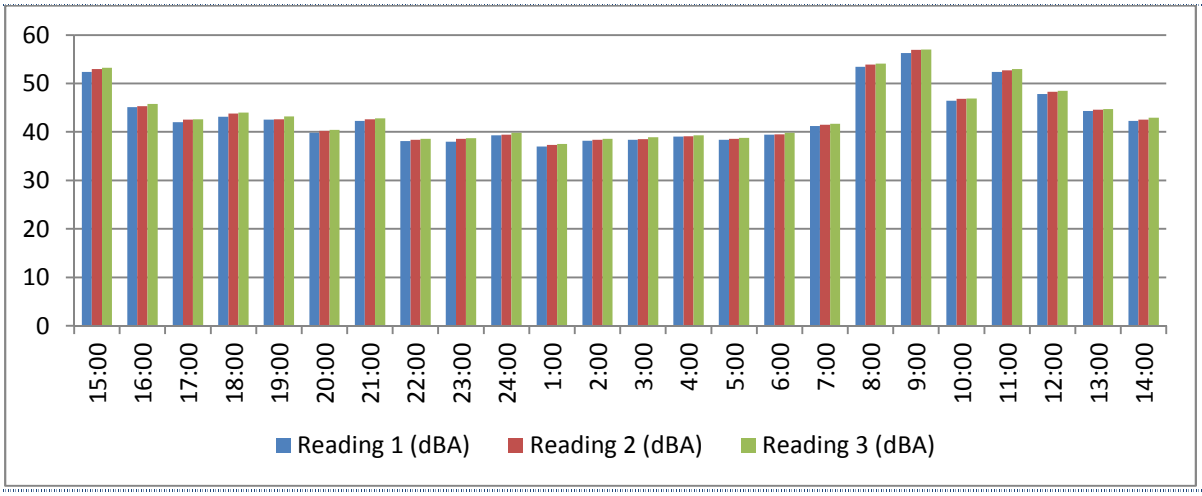


Figure 4.20: Noise Level at Proposed Camp Area

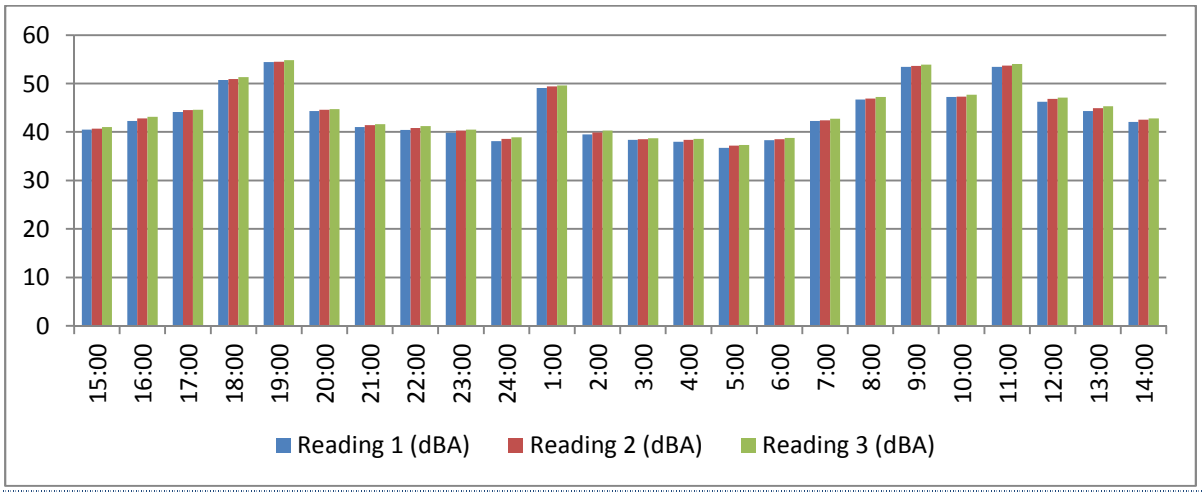


Figure 4.21: Noise Level at Proposed Weir Site

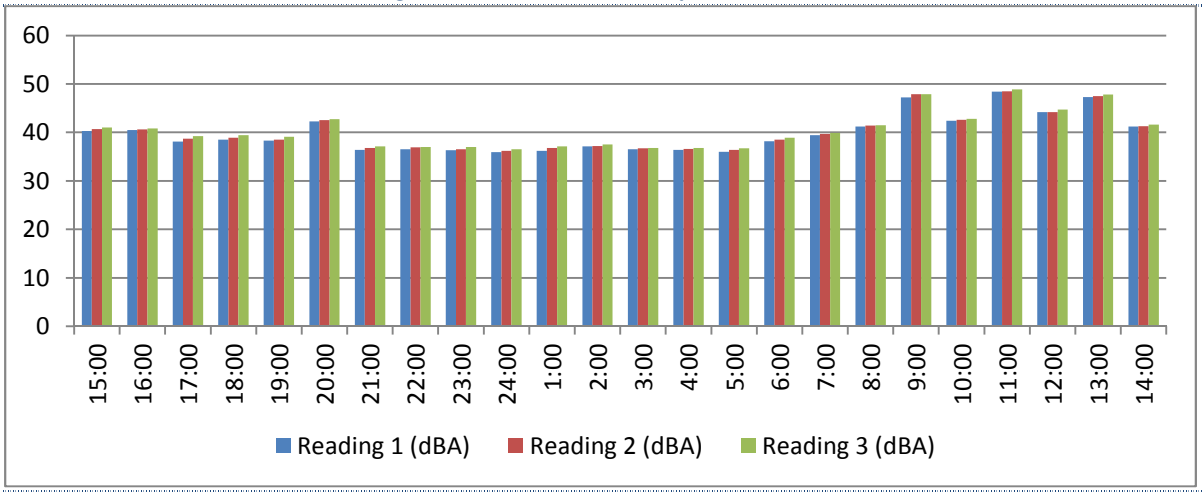


Figure 4.22: Noise Level at Proposed Batching Plant

4.6.3 Light

Lux monitoring was also monitored at a location near the community area. The monitoring results are provided in the **Table 4.11**.

Table 4.11: Instant Lux Monitoring

Sr. #	Sampling Point	Method / Technique	Unit	Results
01.	Near Community Area	Illuminance Meter	LUX	1165

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

5 DESCRIPTION OF BIOLOGICAL ENVIRONMENT

This section describes the ecological conditions in the study area (defined below, and shown in **Figure 5.1**), focusing on the aquatic ecology, flora, mammals, birds, and reptiles and amphibians. The diversity in these groups has been described along with the population and conservation status of the species. The habitat of the study area has been characterized on the basis of biological and physical factors and its spatial delineation is provided. **Annexure 5A** provides checklists of recorded flora and fauna, along with other auxiliary data. **Annexure 5B** provides description of species of concern.

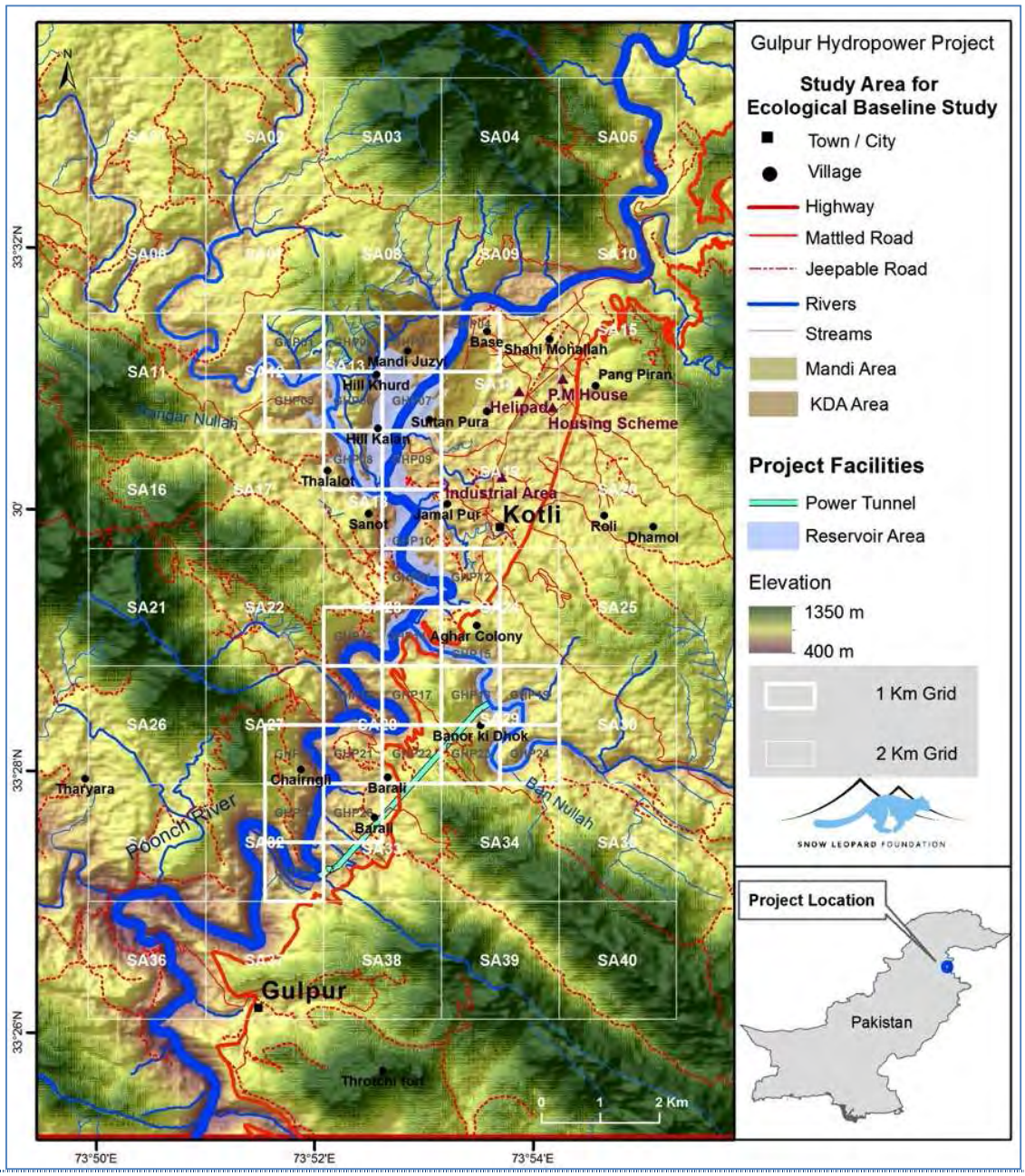


Figure 5.1: Study Area for the Ecological Baseline Study

5.1 Approach of the Ecological Study

The ecological baseline study focused on the following components:

- Assessment of vegetation and land cover classification
- A thorough investigation of aquatic ecology particularly fish and invertebrates
- Assessment of wildlife, on each of the following components;
    - Large mammals (carnivores/ungulates)
    - Small mammals
    - Birds
    - Reptiles and Amphibians

The field survey was carried around the project facilities, and a five-kilometer buffer was added to explore status of ecological receptors on a broader area of about 228 km^2 (**Figure 5.1**). In order to systematically cover the area, 1-km grid around the project facilities and 2-km grid in rest of the area was placed. At least one sample was taken in each grid, however fish and macro-invertebrate sampling was limited to aquatic the habitat.

Specific methodology was adapted for each component of the study, which will appear in the following sections.

5.2 Floral Diversity of the Area

The forests of the area are characterized by the presence of subtropical broad leaved vegetation (Shaheen et al., 2011a) and is fundamentally Chirpine forest type (Malik & Malik, 2004). These forests are mainly dominated by *Pinus roxburghii* in an altitudinal range of 700-1800m Ahmad et al., 2012. Several environmental and anthropogenic factors regulate the composition and community structure Doležal & Šrůtek, 2002. Malik & Malik, 2004 have reported seven plant communities in the area viz, *Adiantum olea, Acacia modesta, Dodonaea-Acacia- Themeda, Pinus-Themeda, Imperata-Pinus, Pinus roxburghii* and *Pinus-Carissa-Themeda* recognized in Kotli Hills during monsoon, 2000. Nazir et al., 2012 have classified the vegetation of the area into tree layer consisting *Ficus palmata, Dalbergia sissoo*, *Acacia nilotica, Pinus roxburghii* and *Flacourtia indica*; a shrub layer of *Adhatoda vasica, Dodonaea viscosa, Carissa opaca, Maytenus royleanus, Otostegia limbata, Punica granatum*; and herb layer dominated by *Themeda anathera* and *Poa annua*.

The sub-tropical forests of the area were mainly dominated by *Pinus roxburghii* Champion et al., 1965. But present figures show that *Pinus-Themeda* community is becoming sparse which would eventually transform the area into a degraded scrub-land. Now, the area is characterized by the dominance of herb and shrub layer, comprising *Themeda anathera, Poa annua, Carissa opaca* and *Adhatoda vasica* over *Pinus roxburghii* (Nazir et al., 2012). Radically, *Pinus* has a broad ecological amplitude and specialized niche in the subtropical zone and therefore cannot be out-competed by associated species. However the depletion of forest crown canopy over time as a consequence of factors like deforestation, overgrazing and forest fires have resulted in the shift from *Pinus* to ground and shrub flora (Ahmad, et al., 2012). Environmental factors such as low fertility (P and K) and soil moisture have also contributed to the situation (Dasti & Malik, 2000).

There are a number of studies focusing indigenous knowledge of flora. The study conducted by Ahmad, et al. (2012) of ethno botanical inventory about plants paves way to assess their usage and impacts associated thereof. A total of 66 plant species are reported to be used as folk medicine for curing different diseases in the village of Barali Kass and adjacent areas of District Kotli, AJK (Ur-Rehman, 2006). Most of the population of the area dwells in remote areas that are not easily accessible and thus left with no other option but to rely on medicinal plants for general treatment. Notable among these floras are *Justicia adhatoda*, *Acacia nilotica*, *Calotropis procera*, *Ricinus communis, Morus nigra, Dodonaea viscosa, Achyranthes aspera, Ipomoea carnea, Taraxacum officinale, Eriobotrya japonica, Cissus carnosa, Melia azedarach, Eucalyptus citriodora* and *Ficus carica* (Ahmad, et al., 2012). *Pinus roxburghii* is used as antiseptic, diaphoretic, diuretic, rubefacient, tonic and vermifuge. It is also used as charcoal, pigment, herbicide, resin and wood (Muhammad et al., 2012).

The data shows that these forests are faced with the problems of overgrazing and deforestation (Malik & Malik, 2004). The factors like poverty, over population, lack of access to remote areas, unavailability of alternates of energy sources are major causes for severe depletion of Himalayan forests. The local communities use forest species as their main source of fuel wood, timber and fodder. The simultaneous increase in the demand of forest products and population has not only deteriorated the condition of these subtropical forests but also affected the species diversity and community structure.

5.2.1 Methodology

Different vegetation types identified on the physiognomic basis were sampled using circular quadrats of 100 m^2 for trees, 25 m^2 for shrubs and 1 m^2 for herbaceous layer (**Figure 5.2**). The data recorded within each quadrat included a complete inventory of vascular plants as well as visual estimation of ground area covered by each species. Due to prevailing weather situation, only a modest effort to sample each landcover type could be performed, mainly emphasizing project components such as spoil tip areas, camping sites, and proposed new roads etc. as well as, submersion zone of the reservoir.

The plant specimens were collected for identification and voucher numbers were added to facilitate their identification as well as their geographic location was noted down using handheld GPS device.

The identification of flora was carried out with the help of published literature and identification keys. The main sources of information included Flora of West Pakistan fascicles (Nasir et al., 1970), online edition of the Flora of Pakistan (www.efloras.org). In addition, Jstor Plant Science archive was also consulted (http://plants.jstor.org/).

5.2.1.1 Species diversity

The notes on distribution of plants were documented during transect walks at suitable locations identified on the basis of change in habitat reflected by occurrence of new species. The association of different species with a particular habitat type was tabulated and species diversity was calculated for each of the habitat types using Shannon-Weaver diversity index (H´) or simply Shannon index, (Shannon & Weaver, 1948). It is calculated as:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

Where: H´ = Shannon-Wiener diversity index, s = number of species, pi = the proportion of individuals or the abundance of the i^{th} species expressed as proportion of total cover, ln = log basen

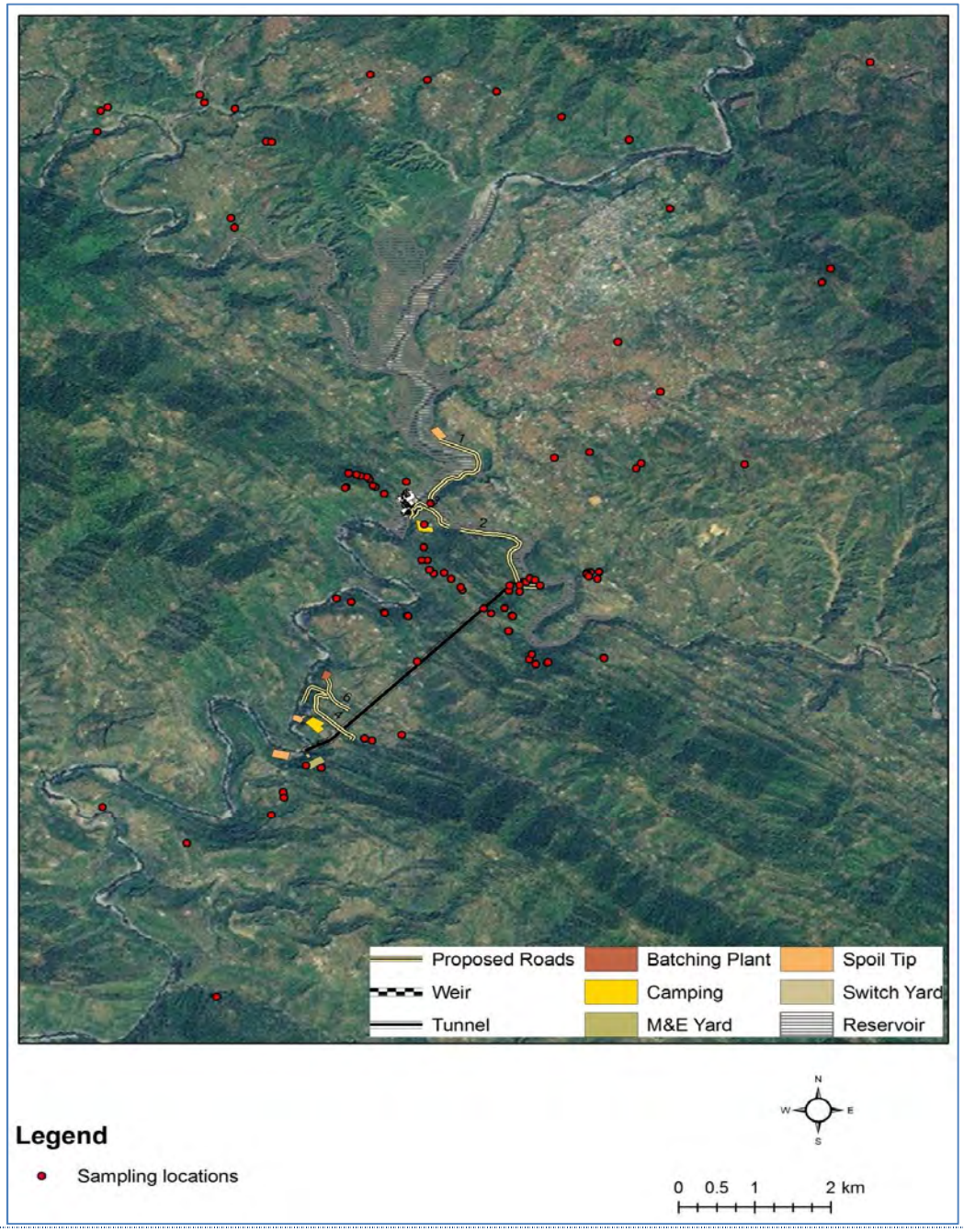


Figure 5.2: Vegetation Sampling Sites

5.2.1.2 Biogeography

The plant species recorded from the study area were assigned to respective chorotypes based upon their distribution (**Annexure 5A, Exhibit 5A.1**). Most important literature consulted includes:

Dickoré, 1991; Dickore & Miehe, 2002; Dickoré & Nüsser, 2000; Hara, 1966; Meusel, 1972; Nasir, et al., 1970; Nasir et al., 1972; Ohashi, 1975; Polunin et al., 1987; Rafiq, 1996.

5.2.1.3 Landcover Mapping

The landcover map was prepared using Landsat satellite image (path 150 row 037 dated June 15, 2011) and ancillary data, subset to the extent of project area and its immediate vicinities (30 m resolution). The map was prepared using statistical modeling approach by including ancillary data such as elevation, aspect and slope coupled with satellite derived indices. The quantitative analysis of remotely sensed data in mountainous regions is often affected by topographic effects, thus land surface reflectance in the image was corrected through Pixel-based Minnaert correction method (Lu et al., 2008).

The statistical models were developed for each of the landcover classes subjectively defined during the fieldwork. These classes were used as response variable in a statistical model against a predictor dataset and the classes included: Agriculture (AGR), Riverine (RIV), Open areas (OPA), Settlements (SET), Broadleaved and Conifer forests with Sparse (<30%), Medium (30-75%) and Dense (>75%) crown cover. Notes on major floral associates of these landcover classes were also prepared.

The ground control points (GCP) for the areas representing particular landcover class were marked during the field visits using handheld GPS receiver. Some additional locations were inferred by visual interpretation of high resolution satellite imagery (Google Earth) supplemented with GPS labeled photographic documentation and field sketches. The number of GCPs utilized to map the respective landcover class has been provided in **Annexure 5A**.

The explanatory variable data including extracted from digital elevation model of the study area (elevation, slope, aspect and topographic wetness index) and satellite image (normalized difference vegetation index (NDVI), Tasseled cap greenness, and Soil brightness (Crist & Cicone, 1984)) corresponding to these locations were extracted in GIS and used to develop statistical model for each of the landcover class. The satellite data that was used consisted of Landsat 5 scene (L1T processed - radiometrically and geometrically correct) dated: 15th June 2010 (WRS II path 150, row 037) having <1% cloud cover for GHPP area. The image was obtained from Land Processes Distributed Active Archive Center (LPDAAC) of National Aeronautics and Space Administration's (NASA) Earth Observing System (EOS) Data and Information System (EOSDIS). The necessary image processing was done using ERDAS IMAGINE ® ver. 9.2 and elevation data in ArcGIS ver. 9.2.

The generalized additive models (GAM) were fitted for each of landcover using GRASP (Generalized Regression Analysis and Spatial Prediction) package (Lehmann et al., 2002) in software S-PLUS ver. 8 and their accuracy was statistically tested using the area under the curve (AUC) of the Receiver Operating Characteristic ROC (Fielding & Bell, 1997).

The fitted landcover models for each of the classes were exported as a 'lookup tables' from S-Plus software and processed in ArcView GIS software ver. 3.1 (ESRI, 1992) with an Avenue script program (GRASPIT - available with GRASP package) to produce landcover maps for individual categories. These individual maps were then combined in a GIS to produce final landcover map based on probability of occurrence of landcover classes.

5.2.2 Floral Diversity and Biogeography

A total of 186 vascular plant species were identified from the area including 3 species of pteridophytes (**Figure 5.3; Annexure 5B**). The Leguminosae and Asteraceae were the largest families of dicotyledons, whereas, Poaceae was largest of the monocotyledons.

Biogeographically the area of the Project falls into Irano-Turanian region Floristic region (Ali, 1978). It was found that the majority of the species were of the tropical origin or introduced/cultivated category. This signifies that the flora of the area is much disturbed. The Himalayan endemics included 19 species viz., *Ajuga bracteosa* var. *densiflora* Wall., *Asparagus filicinus* var. *brevipes* Buch.-Ham. Ex, *Dalbergia sissoo* Roxb. ex DC., *Duchesnea indica* var. *microphylla* (Andr.) Focke, *Erigeron bellidioides* (Buch.-Ham. ex D. Don) Benth., *Galium acutum* Edgew., *Geranium wallichianum* D. Don ex Sweet, *Grewia optiva* J. R. Drumm. ex *Burret, Juglans regia* var. *kamaonia L.*, *Kickxia ramosissima* (Wall.) Janchen, *Mentha royleana* var. *royleana* Benth. *Mimosa himalayana* Gamble, *Morus serrata* Roxb., *Olea ferruginea* Royle, *Otostegia limbata* (Benth.) Boiss. *Pinus roxburghii* Sarg., *Rubia wallichiana* Decne., and *Sauromatum venosum* (Aiton) Kunth. However, none of them is narrow endemic and have relatively wider distribution.

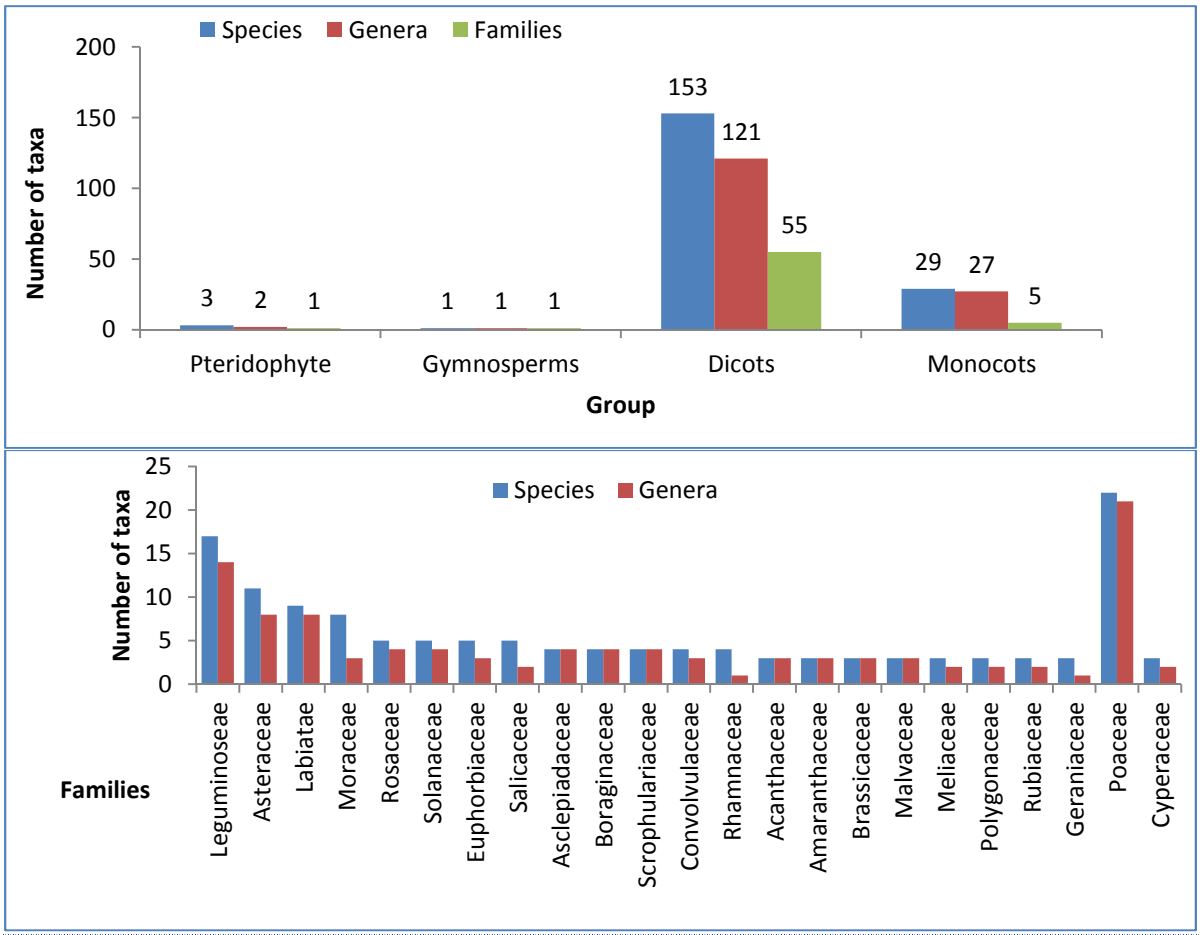


Figure 5.3: A Summary of Plants Identified from GHPP Study Area

5.2.2.1 Rare Species

Fraxinus raiboearpa was the plant that is confined to few localities in north Pakistan and E Afghanistan.

5.2.2.2 Threatened Species

World Conservation and Monitoring Centre (WCMC) and Species Survival Commission (SSC) of IUCN has prepared a list of species with different categories of threats in their wild habitats. None of the species found in GHPP study area is listed in the WCMC list in endangered categories.

There are several taxa for which sufficient information is not available but they are threatened or vulnerable in other countries in their distribution range.

5.2.3 Vegetation Types

The project area lies in the humid subtropical zone influenced by monsoon Mediterranean disturbances as well. The forests can be grouped into and Subtropical Broadleaved Forest, and Subtropical Pine Forests.

5.2.3.1 Subtropical Broadleaved Forest

This is a scrub type forest with *Olea ferruginea, Acacia modesta* and *Dalbergia sissoo* as key species. It occupies altitude ranging from 450 to c. El. 1000 m. Acacia dominates dry slopes whereas Olea finds its space in moist depressions. Both species admix with each other in varying proportions, depending upon site conditions. The principal associates include *Adhatoda vasica, Mallotus philippinensis, Dalbergia sissoo, Cassia fistula, Punica granatum, Ficus spp* and *Nerium odorum*. Such a kind of vegetation may transform into a *Dodonaea viscosa* type Scrub on the base of forest or disturbed localities due to heavy cutting and grazing. The depressions and cool moist slopes may dominate with *Dalbergia sissoo*. The broadleaved forest terminate into Chir pine forest above.

5.2.3.2 Subtropical Chir Pine Forest

The *Pinus roxburghii* stands occur singly or in groups with an irregular deciduous lower storey, often best developed in depressions and on sheltered aspects. The main species associated with the pine include *Mallotus philippinensis, Pyrus sp, Ficus sp., Flacourtia sp., Berberis sp., Gymnosporia sp.* and *Rubus*.

The main habitat types zones that can be delimited in the study area may include:

- **b : Broad leaved forest**
  - Fbl liana (woody climber)
  - Fbo open space/forest clearing
  - Fbr rock inside forest
  - Fbs shady floor
- **Fc : Coniferous forest**
  - Fcs shady floor
  - Fco open space/forest clearing
  - Fcl liana (woody climber)
- **Fm : Mixed broad-leaved/coniferous**
  - Fms shady floor

  - Fmo open space/forest clearing
- **S : Shrubland or Shrubberies**
  - Sl climber
  - So open shrubland
  - Sp parasite
- **: Open land**
  - Os slope/ pasture/ meadow/ridge
  - Ot terrace/flatland
  - Or rock/rocky/ landslide area/slope
- **C : Cultivated land**
  - Ck Irrigated land
  - Cb Non irrigated land
  - Cc cultivated crop
  - Cp planted for fodder, shade, medicine etc.
- **U : Urban/Settlement area**
  - Ug garden/avenue/pot
  - Ut wall, etc.
  - Uw waste-land
- **R : Riverine (River belt, flood plain etc)**
  - Rs river/streamside
  - Rss shady river/stream side, ravine
  - Rc irrigation canal/running water
  - Rsr river/streamside rocky area

The land cover map of the study area, developed from landsat data, and map showing above described vegetation types, is provided in **Figure 5.4**. The associated species of each habitat type have been documented in **Exhibit 5A.4** (**Annexure 5A**).

With respect to diversity, the habitat agricultural and open areas were found to be most diverse with H' 4.19 and 4.25 respectively (**Figure 5.5**). The broadleaved forests also had value close to 4. The conifer forest and shrubs habitat types were having lowest values for diversity. There can be two reasons for this difference. The first being the fact that most of the sampling efforts and ecological observations were made in the broad leaved forest type vegetation for the reason that the dam components were located within these habitat types. Secondly there is a great diversity of habitats in this zone and due to edge effect there could be higher species diversity.

The representative photo of each vegetation type is given in **Figure 5.6**.

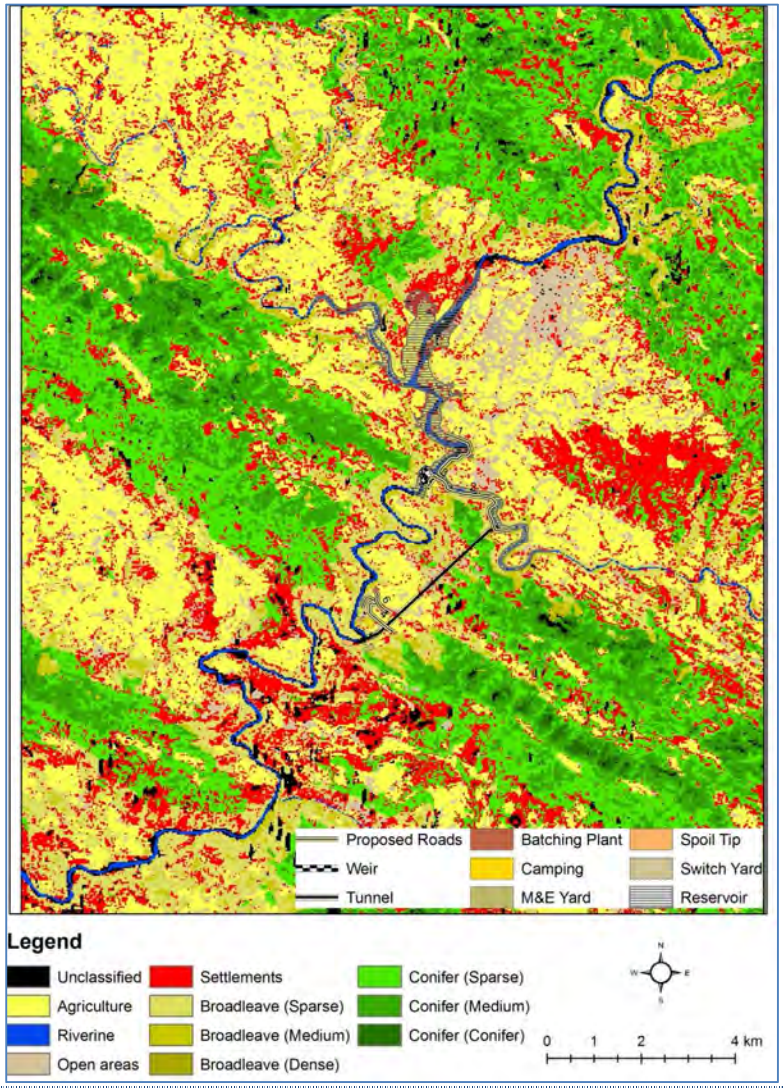


Figure 5.4: Landcover Map of the Study Area

Habitat	Category	Shannon Diversity
	Fb	3.99
	FB	2.77
	FBL	1.10
	FBO	3.53
	FBR	0.00
Fb	FBS	3.00
	Fc	2.64
	FCS	2.08
	FCO	1.61
Fc	FCL	0.00
	Fm	1.33
	FMS	1.39
Fm	FMO	0.69
	S	2.93
S	SI	0.69
	SO	2.89
	SP	1.10
	O	4.25
	OS	4.01
	OT	3.14
O	OR	3.43
	C	4.19
	CK	2.94
	CB	3.91
	CC	1.95
C	CP	2.77
	U	3.43
	UG	2.08
	UT	1.95
U	UW	3.04
	R	3.55
	RS	3.40
	RSS	0.00
R	RSR	1.61

Figure 5.5: Habitat Wise Comparison of Species Diversity

Forest clearing has given way to broadleaves

Conifer forest

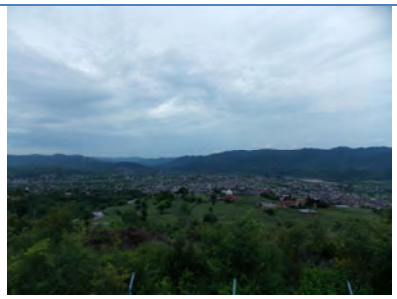
Mix forest


The vanishing forest closer to the settlements


Broadleaved forest


Open Areas


Broadleaved sparse


Agriculture/settlements


Riverine

Figure 5.6: Representative Photos of Vegetation Types in the Study Area

5.2.4 Vegetation at Project Facilities

The existing land cover of at proposed project facilities is summarized in **Table 5.1** (and facility wise detail of land use is provided in **Annexure 5A**). The dominant land use at the project facilities was agriculture/settlements. Areas devoid of forest make about 25% of the land cover. Overall forest cover is only 18 % that can be treated to be closest to primary; otherwise, the forest cover is not so dense. Similarly for the direct impact areas (project facilities) the forest cover is around 35% with only about 5% being dense.

Table 5.1: Land Cover for Each Project Area

S.No	*Landcover/Landuse*	*Code*	*Total Area (ha)*	*Area (ha) Project components*
1	Agriculture	AGR	5562.344	59.368
2	Riverine	RIV	303.515	54.947
3	Open areas	OPA	1269.516	9.413
4	Settlements	SET	4294.065	43.570
5	Broadleaved (Sparse)	BLS	3484.192	94.043
6	Broadleaved (Medium)	BLM	800.600	16.588
7	Broadleaved (Dense)	BLD	28.612	0.101
8	Conifer (Sparse)	CNS	5292.298	-
9	Conifer (Medium)	CNM	3500.617	-
10	Conifer (Dense)	CND	372.395	-

Generally, the landcover class representing sparse broadleaves will be the most affected landcover due by all components except camping sites (of Power house, and Weir) and Spoil tip2 that will mainly affect agriculture and medium cover broadleaves. The overall impact by the project components in ascending order is Broadleaved (Dense) < Open areas < Broadleaved (Medium) <

Settlements < Riverine < Agriculture < Broadleaved (Sparse). The breakup of area that will be impacted by each component of the project is summarized in **Exhibit 5A.5** (**Annexure 5A**).

5.3 Fish Fauna

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 Main River. The valley also opens up and Poonch River begins to flow in a leisurely manner 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 is the warm water river and the water temperature approaches to 30^{o} C during the summer months. Water in the Jhelum River has the intermediate temperature and the reaching up to 25^{o} C during the summer months. Due to this temperature and topographical differences between two rivers, fish fauna of the Poonch River is more representative of Mangla Reservoir than that of Jhelum River. A reasonable number of riverine fish species found in the reservoir move upstream on the onset of summer season for breeding and feeding and in the reservoir for wintering.

5.3.1 Methodology

5.3.1.1 Selection of Sampling Stations

A general survey of the study area was conducted to identify sampling sites. The sampling sites were selected keeping in mind the major activity areas of the Gulpur Hydropower Project. Special concentration was paid on the sites where the Weir is going to be constructed, the downstream areas of the Weir up to Gulpur and various nullahs (tributaries) meeting the river as they are major breeding grounds of the fish of the Poonch River (**Figure 5.7**, shows locations of fish sampling sites).

5.3.1.2 Fish Sampling Strategy

Recognized techniques for fish surveys include bank-side counts, trapping, cast netting, seine netting, gill netting, and electro-fishing. Bank–side counts are preferred on the banks of clear shallow streams, and would not suitable given the torrential nature and turbidity of the water in the Poonch River. Trapping is suitable for specific species using specific baits. Gill netting and seine netting is mainly done in lakes, slow moving rivers or side pools along the river side. Electro–fishing is suitable for shallow streams with limited width. Keeping in mind the constraints regarding different sampling strategies, cast netting technique was used as it requires a minimum amount of time with good results.

5.3.1.3 Cast Netting

The fish fauna in running waters was collected using cast with mesh sizes 2 x 2 cm, having a circumference of 4m. The cast net had the lead weight so that it could not float with the fast flowing

water. The net was not immediately dragged after cast but was delayed so that maximum fish could be trapped in the pockets. One cast of net was made at about 10 meter apart from the first one. In this way 10 casts of net were made along a length of 100 m, starting from downstream to upstream to minimize the impact of adjacent netting. The cast nets which were entangled in the rocks or were not cast in a proper way were not counted but the alternate net was cast at a distance of 10m upstream as the net once cast, disturb the area and fish moves from that spot.

5.3.1.4 Specimens Handling

The specimens collected from each sampling point were collected in a bucket, and were photographed and identified in the field. Number of specimens of each species was counted and then released. The voucher specimens were preserved in 10% formaldehyde solution in the field. Large specimens were given an incision in the belly to ensure proper preservation. All the specimen data and the relevant auxiliary information were recorded in the data sheet specially designed for these studies.

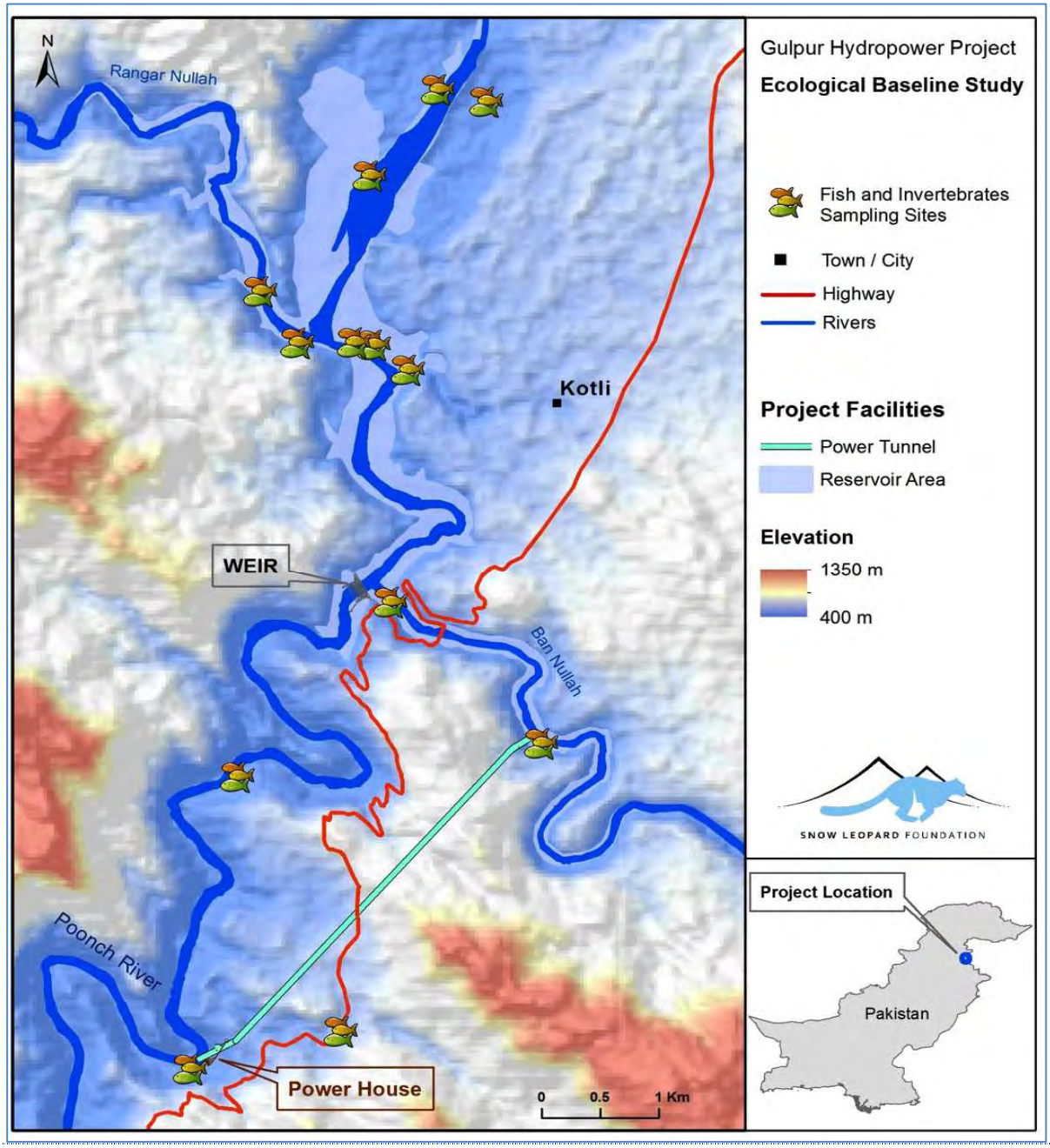


Figure 5.7: Fish Sampling Locations

5.3.2 Fish Diversity of the Project Area

River Poonch is generally rich in fish diversity and even 21 fish species have been recorded from a stretch of about 10 km (**Figure 5.2**). This diversity is quite high for this small river stretch. The reason is generally prevailing 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 riverbed of the river Poonch not only helps for high river productivity but also enhance the breeding capacity of aquatic organisms and their subsequent survival.

Among the recorded species, majority of fish fauna belongs to the family Cyprinidae which is comprised of 13 species. Other 8 species are divided among seven families in such a way that five families are represented only by one species and the rest two each by two species. Among the fish fauna of the project area, two species are endemic in Pakistan including AJK, one is endangered, two are Vulnerable, and one is Near Threatened. Quite a good number of species are commercially important. The species *Tor putitora* and *Clupisoma garua* are considered among the esteemed fishes and have very high commercial value. The fishes *Labeo dyocheilus, Cyprinus carpio, Cirrhinus reba, Labeo dero, Ompok bimaculatus* and *Mastacembelus armatus* are also quality food fishes. In addition to the above documented 21 species, the field team collected another specimen, for which identification is not clear at this stage. Additional field surveys and lab work will be required to confirm identification of this species.

A detail description of species of concern is provided in **Annexure 5B**, whereas **Figure 5.8** provides photographs of important species and spatial pattern of their occurrence in the study area. **Figure 5.9** shows spatial pattern of abundance of selective species in the study area. Species abundance is expressed as netting success, defined as chance (%) of capturing a species per netting effort. This statistics was calculated from a data of ten netting efforts at each sampling location. Species captured at ≥5 locations are selected for spatial analysis of abundance. Inverse Distance Weighting interpolation technique in Arc GIS 10 was used to generate maps of spatial abundance. A 250 m buffer was added to river to improve visibility of the pattern.

Table 5.2: Fish Fauna recorded from the Gulpur Hydropower Project Area

	Scientific Name	*Family*	*Common Name*	*English Name*	*Distributional status*	*IUCN Status*	*Commercial value*
1	*Securicula gora*	Cyprinidae	Bidda	Gora Chela	Wide	Least concerned (LC)	Low
2	*Salmophasia bacaila*	Cyprinidae	Chal	Large razorbelly minnow	Wide	LC	Low
3	*Aspidoparia morar*	Cyprinidae	Chilwa	Aspidoparia	Wide	LC	Low
4	*Barilius pakistanicus*	Cyprinidae	Chal	Pakistani baril	Endemic	Not determined (ND)	Low
5	*Cirrhinus reba*	Cyprinidae	Sunni	Reba carp	Wide	LC	Fairly good
6	*Cyprinion watsoni*	Cyprinidae	Sabzal	Cyprinion	Wide	ND	Low
7	*Labeo dero*	Cyprinidae	Chali	Kalbans	Wide	LC	Fairly good
8	*Labeo dyocheilus*	Cyprinidae	Torki	Pakistani Labeo	Wide	LC	High
9	*Osteobrama cotio*	Cyprinidae	Palero	Cotio	Wide	LC	Low
10	*Tor putitora*	Cyprinidae	Mahasheer	Mahaseer	Wide	Endangered	Very high
11	*Crossocheilus latius*	Cyprinidae	Chilwa	Gangetic latia	Wide	LC	Low
12	*Garra gotyla*	Cyprinidae	Pathar Chat	Sucker head	Wide	LC	Low
13	*Cyprinus carpio*	Cyprinidae	Carp	Common carp	Exotic	Vulnerable	High
14	*Acanthocobitis botia*	Noemacheilidae	Kangi	Mottled Loach	Wide	LC	Low
15	*Schistura punjabensis*	Noemacheilidae	Loach	Hillstream loach	Endemic	ND	Low

	Scientific Name	*Family*	*Common Name*	*English Name*	*Distributional status*	*IUCN Status*	*Commercial value*
16	*Botia rostrata*	Cobitidae	Loach	Twin-banded Loach	Wide	Vulnerable	Low
17	*Clupisoma garua*	Schilbeidae	Jhalli	Garua bachwaa	Wide	LC	Very high
18	*Ompok bimaculatus*	Siluridae	Palu	Butter catfish	Wide	Near threatened	Low
19	*Glyptothorax pectinopterus*	Sisoridae	Sangi	Flat head catfish	Wide	LC	Low
20	*Mastacembelus armatus*	Mastacembelidae	Groje	Tire-track spiny eel	Wide	LC	High
21	*Channa gachua*	Channidae	Dola	Dwarf Snakehead	Wide	LC	Low

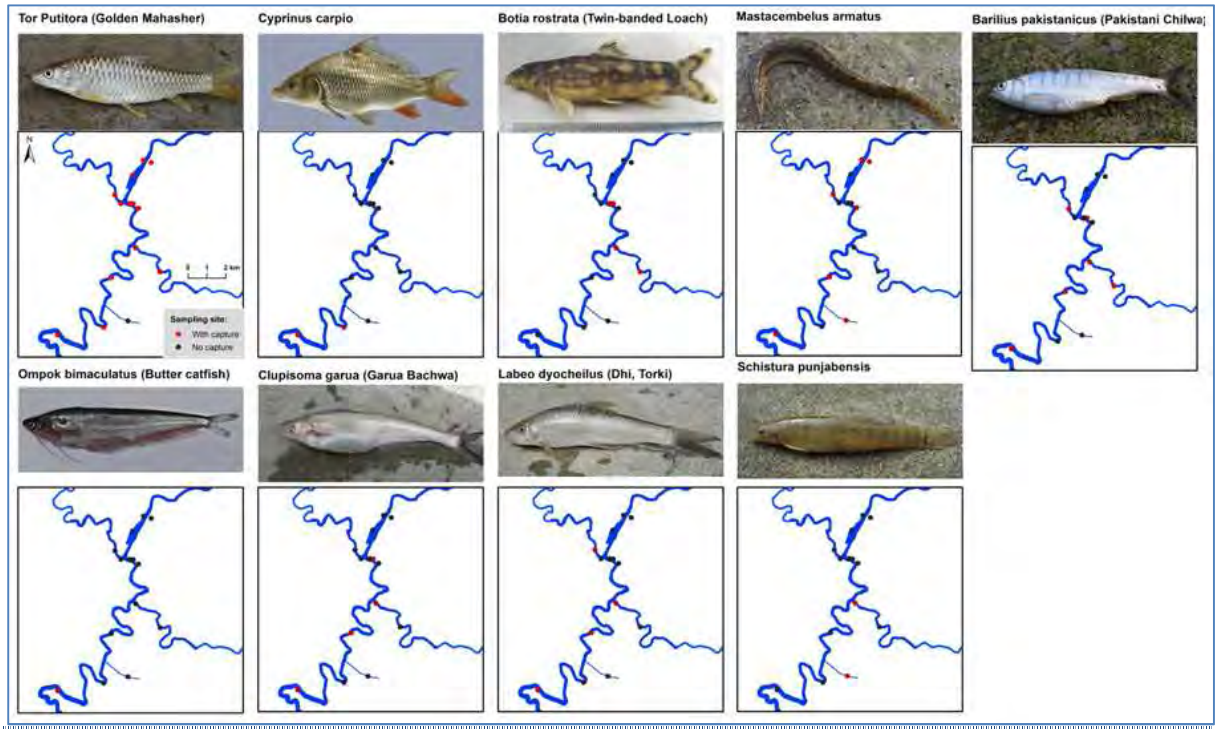


Figure 5.8: Spatial Pattern of Occurrence of Species of Concern in the Study Area.

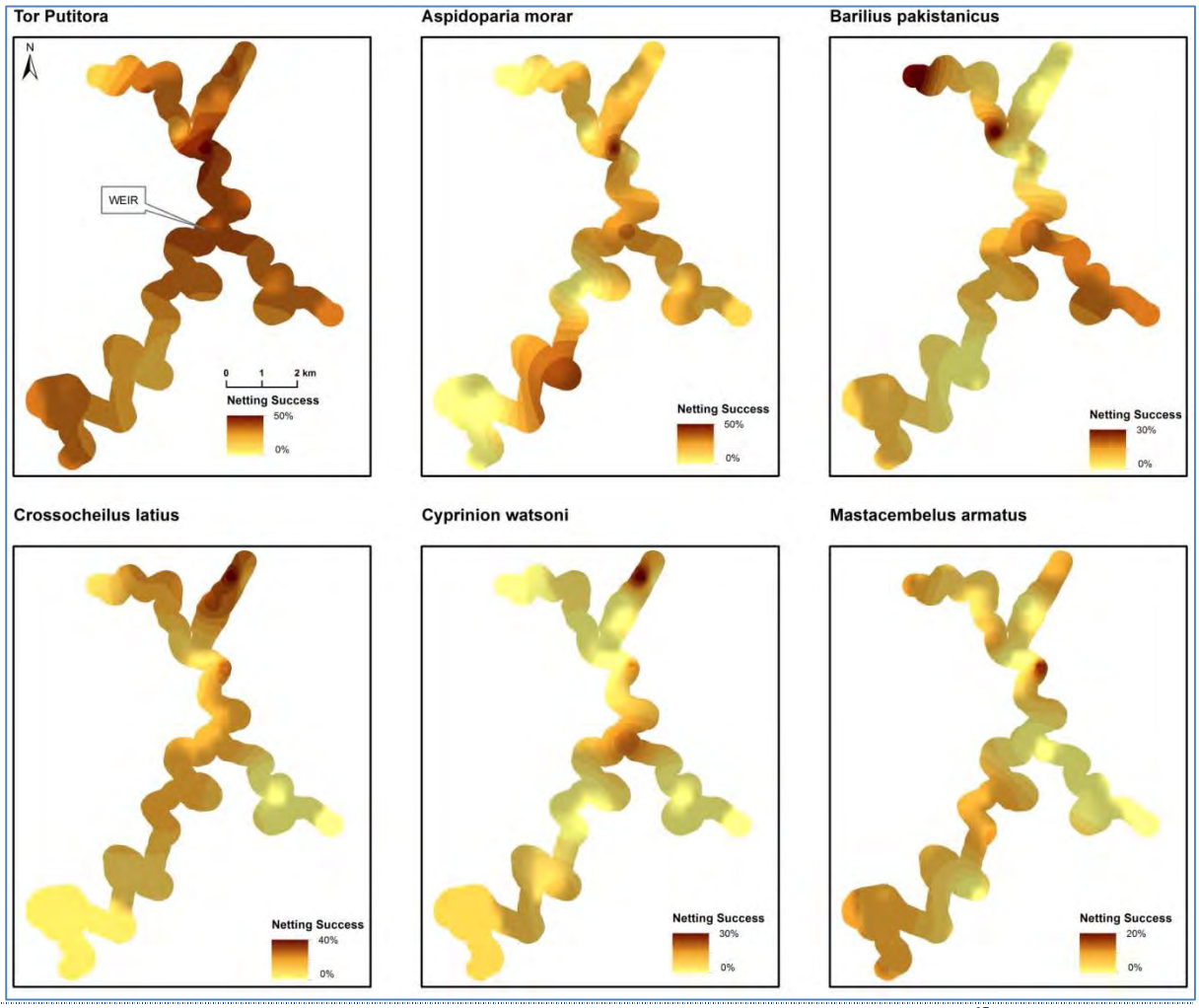


Figure 5.9: Spatial Pattern of Abundance of Selected Species in the Study Area.[15]

Notes: Species abundance is expressed as netting success, defined as chance (%) of capturing a species per netting effort. Species captured at ≥5 locations are selected for spatial analysis of abundance.

5.4 Benthic Invertebrate Fauna

Benthic macro invertebrates are an important part of the food chain, especially for fish. Many invertebrates feed on algae and bacteria, which are on the lower end of the food chain. Some shred and eat leaves and other organic matter that enters the water. Because of their abundance and position as 'middlemen, in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients (Williams & Feltmate, 1992). Ali (1971) reported five orders of benthic invertebrates including Oligocheats, Ephemeroptera, Trichoptera, Chironomidae and Tabanidae from Poonch River. But it provided very limited information about assemblage benthic macro invertebrates and organisms were identified up to order level. Present study provides first comprehensive account on benthic macro invertebrate fauna of the area.

[15] Species abundance is expressed as netting success, defined as chance (%) of capturing a species per netting effort. Species captured at ≥5 locations are selected for spatial analysis of abundance.

5.4.1 Methodology

Sampling was conducted during the flood season. Locations of the sampling sites are shown in **Figure 5.7**. The location of individual sampling sites was influenced by accessibility to the rivers, as certain segments of the both rivers have steep banks, or are located at a distance from the access road.

The sampling sites are representative for the river-segment (Frissell et al., 1986) and the purpose of the study. Sampling was started at the downstream end of the stretch and progressed upstream. The river section to be sampled was disturbed by physical contact. The sampling area of each sampling unit was covered by a quadratic area in the front of the opening of the surber net (32.5 □ 30.5 cm). When kick-sampling was necessary (e.g. in deep sections), the D frame dip net were held vertically with the frame at a right angle to the current, downstream from sample collector boots (991.25 cm2 sampling area), and the river/stream bed was disturbed vigorously by kicking or rotating the heel of your boot to dislodge the substratum and the fauna.

After at least every three sampling units (or more frequently if necessary) collected material was rinsed by running clean stream water through the surber of D frame dip net two to three times. Sampling material was transferred into a large (white) tray or a bucket. The final multi-habitat sample was comprised of 20 pooled sampling units. The samples were combined to obtain a single, homogeneous sample at each sampling station. The sample was then transferred to white enamel tray and thoroughly checked to remove large debris. The sample was then transferred to a container and covered with 10% formalin.

In the laboratory, each sample was passed through a sieve of 500 □m mesh size and rinsed with running water (to remove traces of formalin). Macro-invertebrates were sorted out from the samples and identified to family level using a Kyowa Stereozoom Microscope and the identification keys given in (Edmondson 1959; Ali 1967, 1970, and 1971; Hartmann 2007; Khatoon & Ali 1975, 1976, and 1977; Bouchard 2004). The benthic macroinvertebrate data was presented in the form of number of individuals per square meter. Organism's pollution tolerance was taken from HKHbios scoring list (Hindukush Himalayan Score Bioassessment, Hartmann et al., Deliverable 10).

5.4.2 Macro-invertebrates Diversity

Table 5.3 show the overall picture of macro-invertebrates families collected from six sampling stations. Thirty one families of macro-invertebrates were identified from 546 benthic macro-invertebrate individuals collected during the whole study period. Ali (1971) reported five orders of benthic invertebrates including Oligocheats, Ephemeroptera, Trichoptera, Chironomidae and Tabanidae from Poonch River, however the present documents higher diversity.

There was high flood in Poonch on 13th August 2013 due to monsoon rains, which resulted in bank full flow in channel. Therefore no macroinvertebrate were recovered from samples collected on the same day (station S_1 & S_2, **Table 5.3**). The number of benthic macroinvertebrates was comparatively higher at S3 because of two reasons. First, sample was collected from standing water pool formed as a result of River seepage water. Secondly, it is mostly populated by lentic ecosystem loving pollution tolerant taxa including Culicidae, Chironomidae, Erpobdellidae and Ceratopogonidae etc. The samples S4, S5 and S6 were collected from running water (stream & river). The number individuals

were relatively lower at these stations because of recent flood in river. Floods usually dislodge the habitat available to benthic macroinvertebrates during ordinary flow conditions. Results also indicate that running water accommodate *Neoperla, Acentrella, Rhithrogena, Atherix, Elmidae* and *Scirtidae*.

Among the documented benthic macro-invertebrate fauna:

- Culicidae (14% of total count) was most dominant genus followed by Chironomidae (8.4 % of total count) and *Hydropsyche* sp. (7.9 % of total count) at Poonch River.
- Eight taxa including *Neoperla* (Plecoptera: Perlidae), *Acentrella* (Baetidae: Ephemeroptera), *Heptagenia*, *Rhithrogena* (Heptageniidae: Ephemeroptera), *Ephemera* (Ephemeridae: Ephemeroptera), *Atherix* (Athericidae: Diptera), *Scirtidae* (Coleoptera), *Elmide* (Coleoptera) were highly sensitive to pollution and represent small proportion of the benthic invertebrate population sampled at Poonch river. Highly pollution tolerant taxon was *Culicidae, Chironomidae, Planorbidae, Physidae* and *Ceratopogonidae* which represent approximately 34 percent of the total count.
- Major functional feeding group was predators which were 28.7% followed by unknown 22.4%, and collector gatherers 17.3% of entire sample collected.

Table 5.3: Data regarding Number of Benthic Macro-invertebrate[16]

S. No.	Taxa (Family)	Genus	S_1	S_2	S_3	S_4	S_5	S_6	Total no. of Individuals	Feeding Habit	HKH Bios pollution tolerance values
1	Perlidae	*Neoperla*	-	-	-	-	6 (6.7)	10 (15.1)	16 (2.9)	Predator	8
2	Baetidae	*Acentrella*	-	-	-	6 (11.1)	-	-	6 (1.1)	Collector gatherer	8
3		*Baetis*	-	-		10 (18.5)	8 (8.9)	12 (18.2)	30 (5.5)	Collector gatherer	-
4		*Centroptilum*	-	-	29 (8.6)	4 (7.4)	-	-	33 (6.0)	Collector gatherer	-
5	Caenidae	*Caenis*	-	-	-	2 (3.7)	-	-	2 (0.4)	Collector gatherer	7
6	Heptageniidae	*Heptagenia*	-	-	-	10 (18.5)	18 (20.2)	10 (15.1)	38 (6.9)	Scraper	8
7		*Rithrogena*	-	-	-	-	7 (7.8)	-	7 (1.3)	Scraper	9
8	Leptophebiidae	*Choroterpes*	-	-	-	8 (14.8)	5 (5.6)	-	13 (2.3)	Collector gatherer	7
9	Ephemeridae	*Ephemera*	-	-	-	6 (11.1)	-	-	6 (1.1)	Collector gatherer	8
10	Hydropsychidae	*Hydropsyche*	-	-	-	-	15 (16.8)	28 (42.4)	43 (7.9)	Collector filterer	7
11	Chironimidae	-	-	-	54 (16.1)	-	10 (11.2)	-	64 (8.4)	Unknown	1
12	Ceratopogonidae	-	-	-	42 (12.5)	-	-	-	42 (7.7)	Predator	2
13	Tipulidae	*Antocha*	-	-	-	5 (9.2)	-	-	5 (0.9)	Collector gatherer	7
14	Simulidae	-	-	-	23 (6.8)	-	-	-	23 (4.2)	Collector filterer	7
15	Athericidae	*Atherix*	-	-	-	-	9 (10.1)	-	9 (1.1)	Predator	9
16	Culicidae	-	-	-	76	-	-	-	76 (14.0)	Unknown	2

[16] Benthic Macro-invertebrate individuals per 991.25 cm2 of Poonch River from different sampling stations (data with in parenthesis indicate percent abundance).

S. No.	Taxa (Family)	Genus	S_1	S_2	S_3	S_4	S_5	S_6	Total no. of Individuals	Feeding Habit	HKH Bios pollution tolerance values
					(22.5)						
17	Elmidae	-	-	-	-	-	5 (5.6)	-	5 (0.9)	Scraper	8
18	Scirtidae	-	-	-	-	-	-	2 (3.0)	2 (0.4)	Unknown	8
19	Dytiscidae	-	-	-	23 (6.8)	-	-	-	23 (4.2)	Predator	5
20	Hydrophilidae	-	-	-	14 (4.2)	-	-	-	14 (2.5)	Predator	6
21	Aphelocheiridae	*Aphelocheirus*	-	-	-	-	6 (6.7)	-	6 (1.1)	Predator	7
22	Notonectidae	-	-	-	10 (3.0)	-	-	-	10 (1.8)	Predator	3
23	Naucoridae	-	-	-	3 (0.8)	-	-	-	3(0.5)	Predator	7
24	Gerridae	-	-	-	16 (4.7)	-	-	-	16 (2.9)	Predator	-
25	Pleidae	-	-	-	5 (1.5)	-	-	-	5 (0.9)	Predator	4
26	Corydalidae	*Corydalus*	-	-	-	-	-	2 (3.0)	2 (0.4)	Predator	7
27	Gomphidae	-	-	-	-	-	-	2 (3.0)	2 (0.4)	Predator	-
28	Libellulidae	*Pantala*	-	-	7 (2.1)	3 (5.6)	-	-	10 (1.8)	Predator	6
29	Physidae	-	-	-	12 (3.6)	-	-	-	12 (2..2)	Scraper	2
30	Planorbidae	-	-	-	20 (5.9)	-	-	-	20 (3.6)	Scraper	4
31	Erpobdellidae	-	-	-	3 (0.8)	-	-	-	3 (0.5)	Predator	-
Total no. of Individuals			**337**	**54**	**89**	**66**	**546**				
Number of taxa			**15**	**9**	**10**	**7**					

5.5 Large Mammals

Large mammals, especially carnivores, are hard to grasp directly in the field. Therefore it is challenging to study these animals particularly when their numbers are too small and populations are scattered. So, the best way is to go with some indirect approaches like sign surveys are interviews from local people to get maximum information about these species. A number of mammalian species including common leopard, black bear, barking deer, jackal, fox and rhesus monkey were reported from the Kotli district of Azad Jammu and Kashmir in past(Akbar and Anwar 2011; Roberts 2005). Status of most of these species is still unknown in the area due to lack of scientific studies in the area.

This study was conducted in Gulpur Hydropower Project area in the surroundings of Kotli city to assess the status and occupancy of different mammalian species in the area. Study covered the project area and its buffer zone. The main objectives of the present study were to collect information about their presence and absence in the area, human-wildlife conflicts, threats to different mammalian species and the proportion of the area occupied by each species. Two methods were used; a standardized questionnaire survey to collect information on status of species and its conflict with local people while site occupancy surveys were used to measure the proportion of the area occupied by different species.

The findings of the study will be helpful in future actions about different species and their conservation in the area. It will also be helpful in measuring the impact of hydropower project on existing wildlife of the area.

5.5.1 Methodology

5.5.1.1 Human-Carnivore Interaction Survey

Human-wildlife interaction surveys were conducted to measure the human conflict with large and medium sized mammals like black bear, common leopard, jackal, fox, otter, rhesus monkey and Indian wild boar. Whole area was considered as one unit. Thirty respondents, each representing a separate household, were interviewed from different villages/localities. People were asked about their previous record of sighting of different large mammals in five years, status of large mammals, their perception about different species of large mammals, and intensity of danger of large mammals according to them. Information on killings of livestock and poultry different by carnivores for last five years (2008-2013), was also collected. Attacks of any large mammal species on human and number of large mammals killed during past five years were also recorded. Respondents were also asked for a guestimate of population of different large mammal species in their areas according to their knowledge.

5.5.1.2 Site Occupancy Survey

Site occupancy surveys (MacKenzie and Nichols 2004) were conducted from August 12, 2013 to August 19, 2013 to assess the occupancy of different medium and large sized mammalian species in the surroundings of Kotli city. Global Information System (GIS) maps of the area were developed by dividing the area into 2×2 km grid cells while Gulpur Hydropower Project area was further divided into 1×1 km grid cells (**Figure 5.10**). Each grid was accessed by Global Positioning System (GPS) and points (repeat surveys) were selected on the basis of favorable routs of different species, habitats and topographic features. Different points were surveyed depending upon the accessibility, settlements and disturbance. Total 43 grids were accessed by excluding settlements, and 2-10 points were explored in different grids. Signs were searched along ridges, valleys, draws, cliff bases and river banks. Signs of different mammalian species were recorded on data forms along with the necessary information like species name, sign age (guessed by freshness of a sign), and substrate type. Sign were categories in three age groups; “fresh”= < 10 days, “old”= <30 days and “very old”= >30 days.

Detection or non-detection of species signs on each of the point was recorded as 1s and 0s in a matrix of sites vs. replicates (points) (McKenzie et al. (2002). Survey covariates like terrain brokenness (1-4), topography, habitat were also recorded during the survey while the Normalized Difference Vegetation Index (NDVI), slope, altitude, distance from roads and distance from settlements at site level, calculated from GIS, were used as site covariates .

After preparing data matrix for detection/non-detection and appropriate survey covariates and site covariates, it was analyzed using software PRESENCE (Hines, 2006). Different combinations survey and site covariates were compared to find the model that best explains the variation in probability of detection and markability, and occupancy of the different species at the site level. The best fitting model was determined using the Akaike Information Criteria (AIC). The model that has the best fit

(likelihood) and minimum number of parameters obtains the minimum value of AIC value (Akaike 1974; Burnham and Anderson 2002).

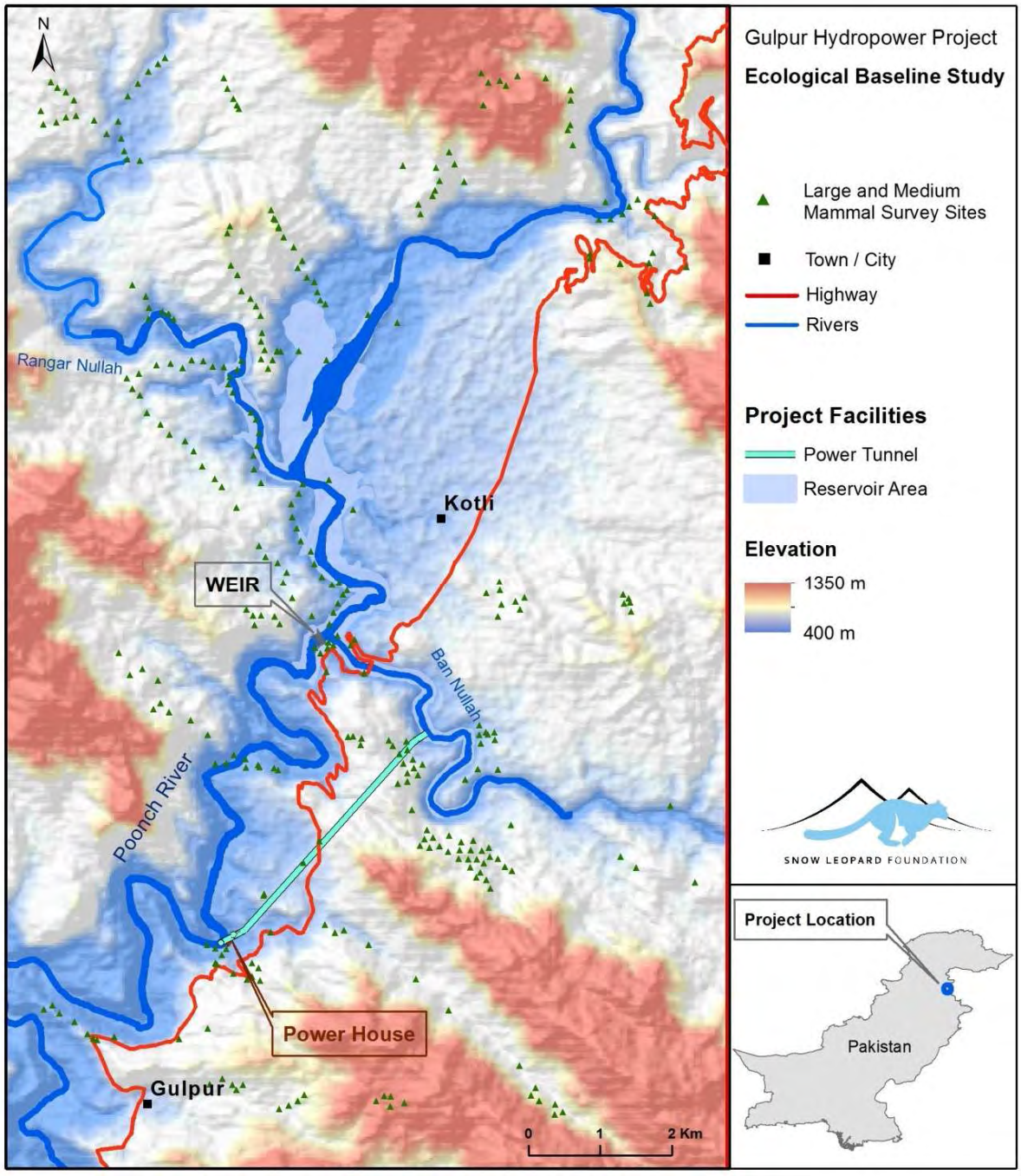


Figure 5.10: Map of the Study Area Showing Site Occupancy Survey Points.

5.5.2 Status of Large Mammals in the Area

5.5.2.1 Public Perception on Status of Large Mammals

Local people were asked about the sightings of different mammalian species in the area for past five years (2008-2013). Jackal has highest annual sighting rate at 25 animals per respondent per year

followed by fox; 4.7, and rhesus monkey; 2.8. Black bear, leopard cat and wild boar have negligible sighting rates (**Table 5.4**).

Table 5.4: Annual Sighting Rate of Different Mammalian Species in the Area.

Species	*Annual Sighting Rate*
Black bear	0.0
Common leopard	0.1
Leopard cat	0.0
Otter	0.2
Jackal	25.0
Fox	4.7
Rhesus monkey	2.8
Wild boar	0.0

Public perception about presence of mammals in the area is summarized in **Figure 5.11**. Among the species questioned, jackal was considered as most common species of the area while leopard cat was considered completely absent from the area. For the common leopard, people believe it is either extirpated or very rare in neighboring forest areas.

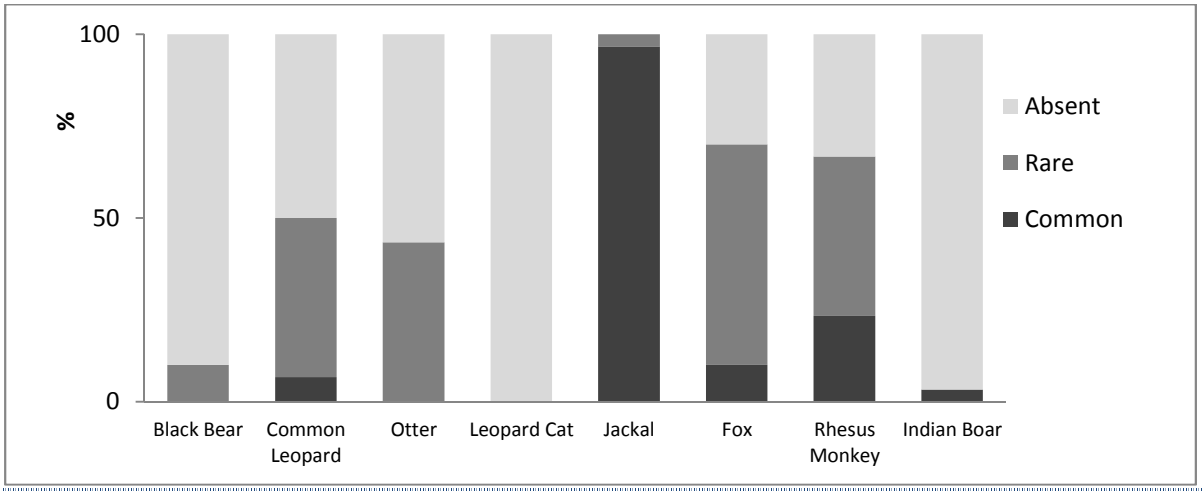


Figure 5.11: Status of Different Mammalian Species by Local People.

Local people were also asked to provide a guestimates of different mammalian species in the area. A range of figure was quoted by local people which is given in **Table 5.5**.

Table 5.5: Public Perception of Mammal's Population in the Area.

Species	*Reported Population*
Black bear	0
Common leopard	0
Leopard cat	0
Jackal	up to 1000
Fox	up to 500
Wild boar	0-25
Barking deer	0
Mongoose	up to 300

Species	*Reported Population*
Flying Squirrel	up to 200
Porcupine	up to 250

5.5.2.2 Relative abundance through Sigh Surveys

Different types of signs belonging to different mammalian species were detected in the area but signs frequencies were very low. Jackal was dominating in field signs, followed by fox. No reliable sign or sighting of common leopard, black bear, leopard cat, rhesus monkey and wild boar was recorded.

Occupancy analysis was done in Program PRESENCE (Hines, 2006) to find out the occupancy of different mammalian species in the study area. Due to low sign detection for majority of the species, estimates were possible for jackal and fox only. A summary of occupancy models tested for jackal and fox is given in **Exhibit 5A.8** and **Exhibit 5A.9** (**Annexure 5A**). **Figure 5.12** shows spatial pattern of jackal and fox occupancy in the study area.

Occupancy of Jackal in the area

Naïve estimate for jackal was 0.3256 which showed an overall low sign detection of the animal in area at that time. Among 43 surveyed sites 22 fresh signs of jackal were detected including feces and pugmarks while total signs detected were 25 which by including old and very old signs. Sites occupancy estimates (psi) were calculated by PRESENCE (Hines 2006) and found an estimate at an average 0.6 ± 0.2135SE for top model; psi (road-qd), p (terr), which means almost 60% area was occupied by the jackal at the time of survey. Various models were compared with different combination of survey and site covariates (**Exhibit 5A.8**). No single model supported adequately to estimate the occupancy of jackal therefore model averaging was used to get an averaged estimate of different models at site level. Distance from the road and terrain brokenness affected the occupancy and detection of signs. Terrain brokenness had a positive effect while distance from road had a negative effect.

Occupancy of fox in the area

Signs detection for fox was much lower than that of jackal. Only 9 (both old and fresh) signs of fox were detected in the study area among them 7 were fresh. Naive occupancy estimate was very low; 0.1163 due to low sign detections. Different models with different combinations of site and survey covariates were used but none of them have enough weightage (**Exhibit 5A.8**). Top model was; psi (.), p (terr) with constant occupancy (psi) and detection probability (p) was influenced by terrain brokenness. The model gave an occupancy estimate of 0.2278 ± 0.1213SE which means that almost 23% area was occupied by the fox at the time of survey. To estimate the site level occupancy estimate of fox, model averaging was used to get an average estimate of different models used.

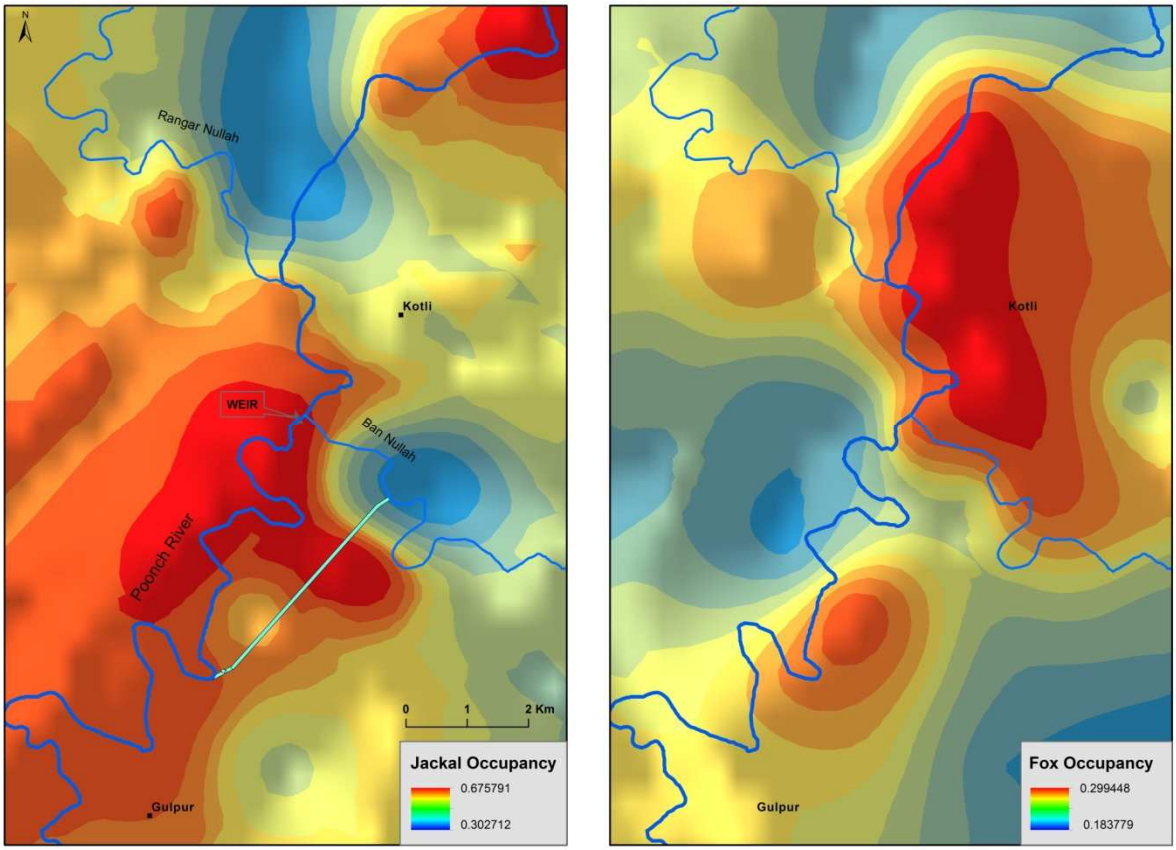


Figure 5.12: Spatial Pattern of Jackal and Fox Occupancy in the Study Area

5.5.3 Human wildlife conflict

Only 12 cases of predation on livestock and poultry were recorded. Jackal was the main predator responsible for almost 92% predations majority; 93%, of which was poultry while remaining were goats. Goats were killed while grazing and poultry was capture from cage most of the time. Only one case of common leopard depredation was reported in which predator attacked on a coral and killed 30 goats at a time.

5.5.3.1 Economic Loss by Mammals due to Crop Damage

Porcupine was mainly responsible for crop damages in the area. An estimated 2300 PKR were lost in past one year to each household by porcupine which attacks on maize crop in summer. In one case wild boar was also considered for crop damage.

5.5.3.2 Attacks on Humans

Local people were asked about the attacks of large mammals on humans which may be fatal or non-fatal. Three animals were found to be involved in attacks on humans. There were two attacked by common leopard and jackal each. All of these were non-fatal but a case from nearby area was died of common leopard attack. One non-fatal attack was also reported to wild boar.

5.5.3.3 Killings of Large Mammals by Local People

At least 95 jackals were killed by local people in past five years in different localities followed by 15 porcupines (**Table 5.6**). At least four common leopards were killed in the study area and two cubs of common leopard were killed in the adjacent area (**Annexure 5A**).

Table 5.6: Spatial Pattern of Jackal and Fox Occupancy in the Study Area

Mammalian Species	*Killed in past five years*
Black bear	0
Common leopard	04-07
Leopard cat	0
Jackal	95
Fox	09
Porcupine	15

5.5.4 Conclusion

Overall diversity of large mammals was much lower as compared to adjacent areas like Pir Lasura National Park where 45 barking deer are residing (Zulfiqar et al. 2011) and frequent sightings of yellow-throated marten, small Kashmiri flying squirrel and common leopard are reported (Manzoor et al. 2013).

Both questionnaire survey and sign based site occupancy survey revealed the rarity of the most of the species. Low sighting and sign detections were mainly because of small populations, and disturbances imposed numerous human settlements in the area. Signs were destroyed due to human and livestock movements, and weather conditions. Human-wildlife conflicts also make area hostile for carnivores. Killings of large mammals especially of predators explain absence of majority of large mammals.

Project area and its surroundings is dominated by adaptable species like fox and jack, while the species which either pose danger (eg, leopard) or have economic value (ungulates) seems to be locally extirpated. The species of large home ranges like common leopard gets killed if some individuals enter into to the area while dispersing from main populations (**Annexure 5A, Exhibit 5A.10**)

5.6 Small Mammals

Nestled in the famous Siwalik Range of the Pir Panjal Hills, the project area has good biodiversity with meager forests around. There is abundant aquatic vegetation mixed with agriculture fields on the sides of both sides of the Poonch River having perennial and deciduous scrub forest on the hillsides providing enough shelter and food to the terrestrial fauna.

As the area is thickly populated, the forest around the project area is over-exploited by livestock grazing, firewood cutting and encroachment etc. which results in the depletion of suitable habitat for wildlife, coupled with the indiscriminate killing of the animals. Most of the local people in vicinity of project area keep fighting and hunting dogs and hunt animals mainly predator species like foxes, rabbits and jackals just for fun.

There are several scattered reports on the study of small mammals of Pakistan (Ahmad and Ghalib, 1979; Akhtar, 1958-60; Anthony, 1950; Baig et al, 1986; Banerji, 1955; Beg, et al., 1975, 1986; Frantz, 1973; Fulk et al., 1981; Mehmood et al., 1986; Mian, 1986; Mirza, 1969; Parrack, 1966; Roberts, 1972, 1973; Siddiqui, 1970; Thomas, 1920a,b,1923; Wagle, 1927; Walton, 1973 and Wroughton, 1911,1920) but the most comprehensive and consolidate work is that of Roberts (1997). Roberts (1997) compiled all the information available on the mammalian fauna of Pakistan. After that Woods et al. (1997 a,b) gave a very detailed account on the small mammals of Pakistan but their work was restricted to the northern mountain region of Pakistan. None of these studies has specifically addressed the mammals of project area.

5.6.1 Methodology

Following method for the study of small mammals was adopted.

5.6.1.1 Trapping

Bait used: A mixture of different food grains mixed with fragrant seeds was used as bait in Sherman Traps for the attraction of the small mammals. Wheat and rice were used as food grains while peanut butter, coriander, oats and onion were used for fragrance. For Snap Traps mixture of peanut butter and oats was used as bait.

Traps and trapping procedure: Sherman traps and Snap traps (**Figure 5.13**) were used for the present studies to collect the live specimens. Fifty traps were set at each location (**Figure 5.14**) in a grid of 10X10 m. The snap traps were set in line transect of 100 m setting each trap 2 m apart. The traps were checked on the next day. The trapped animals were carefully transferred one after the other into an already weighed transparent polythene bag. Utmost care was done to avoid direct handling and harassing of the specimens. The sex, weight, breeding status, habitat and other necessary data of the specimen were noted. The voucher specimens collected were subsequently preserved in 10% formaldehyde.

Snap trap

Sherman trap

Figure 5.13: Traps Used in Small Mammal Surveys

5.6.1.2 Indirect Methods

The mammals' presence was also documented through indirect methods like burrows, footprints, droppings, and road kills. Some of the species were directly sighted in the field and whenever possible photographs were also taken

Whenever necessary the records of specimens were verified from the already published literature or distribution maps of different species.

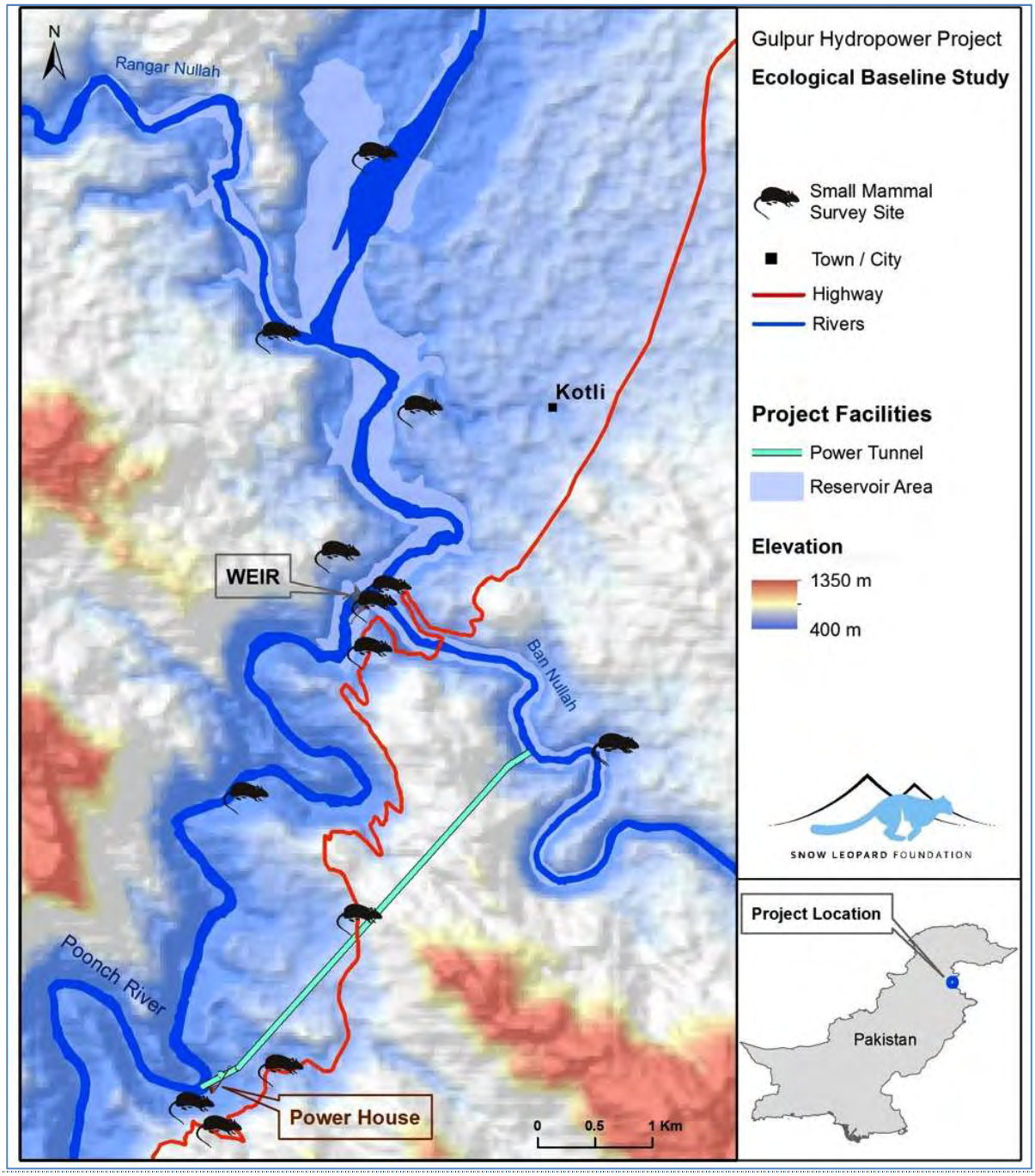


Figure 5.14: Small Mammal Survey Sites

5.6.2 Small Mammal Diversity

Seventeen species of small mammals have been collected from the study area belonging to eleven families and five orders (**Figure 5.15**). The species *Rattus rattus, Mus musculus* and *Suncus murinus* are the dominant rodent and insectivore species, *Pipistrellus kuhlii* and *Scotophilus heathii* are common chiroperan species and *Lutra lutra* represents the rare but widely distributed carnivore species in the study area. The species *Lutrogale perspicillata* (Otter) is Vulnerable species (IUCN 2010). This species is reported in good numbers in the study area due to easy availability of the food in the form of large sized fish and also due to availability of shelter for this species in the form of crevices in the hills found in and around the Poonch River. The species *Herpestes edwardsi* and *Herpestes javanicus* are included in the CITES APPENDIX III. These species have a trade pressure for their skins exported to different countries. These skins are used for manufacturing the purses and the decoration pieces. None of the other species of small mammals have any conservation status and are also common in the area. The species of fruit bats, viz., *Rousettus leschenaultii* (Fulvous Fruit Bat) is quite common in the area found hanging on the fig trees.

The area forms a transitional and overlapping zone between the fauna of plain areas in the south and that of the Himalayas in the North. This phenomenon is reflected from the distribution of many species in the project area. The small mammal species *Rattus pyctoris* (Turkistan Rat) is distributed in the Himalayas and the project area forms the southernmost distribution limit of this species. The area provides the first record of this species at this lower altitude of 700 m and the previous lowest altitude recoded for this species is 2300 m. The species *Suncus murinus* (House shrew), on the contrary, is distributed in the plain areas and the project area forms the North most limit for distribution of this species in AJK. Similarly the species *Mus booduga* (Little Indian field mouse) is distributed in the plain areas and the project area forms the North most limit for distribution of this species in AJK. The bat *Pipistrellus tenuis* (Least pipistrelle) is found in the plain areas and generally avoids hilly areas but was observed in the project area indicating its north most limit in Himalayan region. The Indian Fox, Vulpes bengalensis, is distributed in Southern parts of the country and has the last northward distribution limit in the project area. Smooth coated otter, *Lutrogale perspicillata*, is found in plain areas but has been reported in the project area forming its north most distribution limit. Two species of Mongoose, *Herpestes edwardsii* and *H. javanicus* are also found in plain areas and were recorded in the project area forming its north most distribution limit. The Jungle cat also has the north most distribution limit in the area.

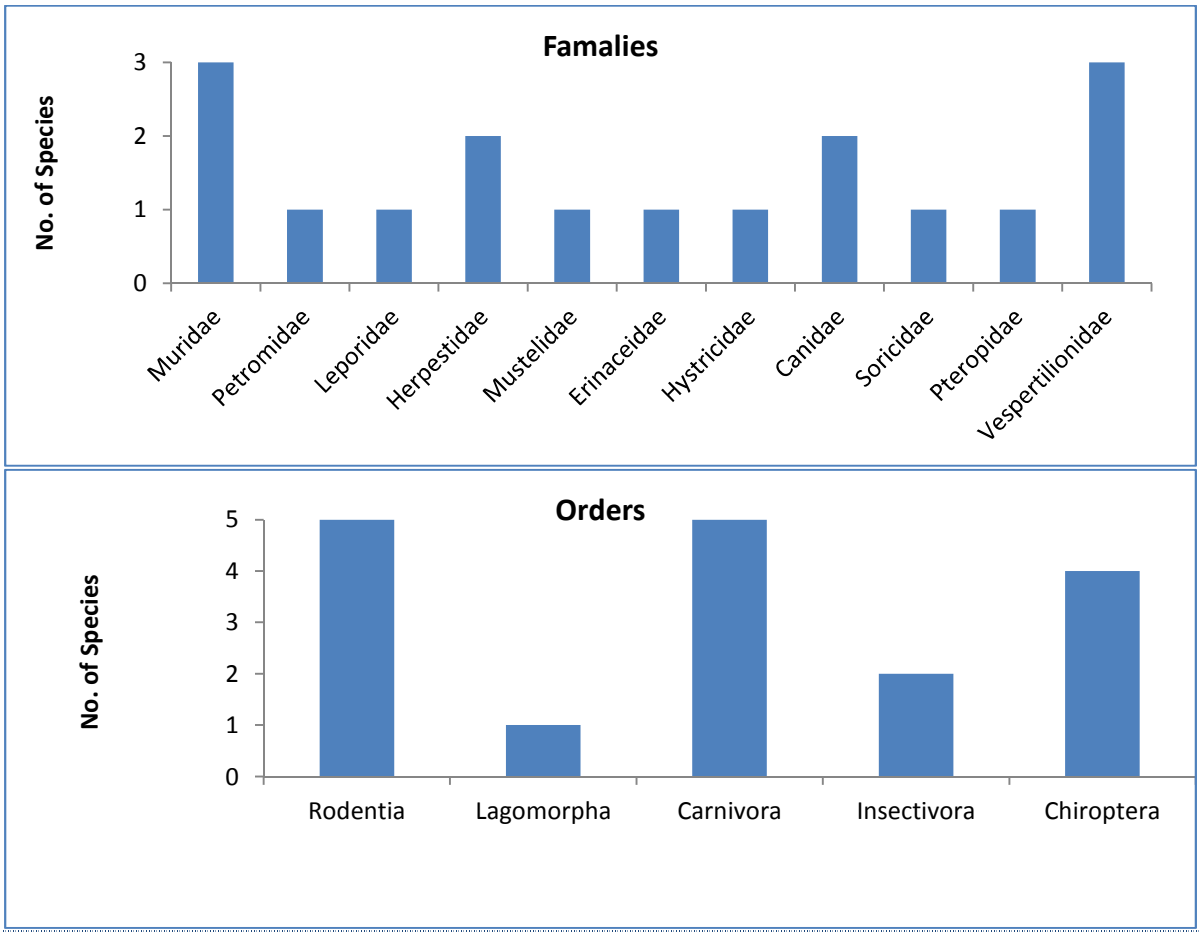


Figure 5.15: Family and Order Wise Distribution of Mammals Found in the Study Area

5.7 Reptiles and Amphibians

The available works on the herpetology of the proposed Gulpur Hydro-Power Project in District Kotli, AJK include those by Khan (1989, 1998, 1999, 2000), Khan (1996) and Manzoor et al. (2013). Khan and Khan (2000) described a new subspecies of *Coluber* snake *Coluber rhodorachis kashmirensis* from Kotli, Azad Kashmir. Khan (1999) described two new species and a subspecies of blind snakes of Genus Typhlops from Kotli, Azad Kashmir and Punjab. The new species included; *Typhlops madgemintonai* and the subspecies included; *Typhlops madgemintonai shermanai*. The Holotype of the other new species *Typhlops ahsanai* was also collected from Kotli, Azad Kashmir. Khan (1998) described a new subspecies of Diard's blind snake *Typhlops diardi platyventris* belonging to the Genus Typhlops from Kotli, Azad Kashmir. Khan and Khan (1996) described the Ophidian fauna of the State of Azad Jammu and Kashmir and recorded 25 ophidian species belonging to five families and 17 genera. Khan and Tasnim (1989) described a new species of frog of the Genus Rana, Subgenus Paa from Southwestern Azad Kashmir including the Gulpur Hydro-Power Project in District Kotli. Manzoor et al. (2013) while assessing the biodiversity of the Pir Lasura National Park in District Kotli, Azad Kashmir reported six amphibian and 24 reptilian species.

5.7.1 Methodology

The study area represents different types of habitats and terrains including cultivated lands, wild lands, wetlands and forests. Similarly, some of the herpetological elements are nocturnal in feeding habits whereas others are diurnal; therefore, different direct and indirect methods were applied to study various groups of the herps in the study area. Field visits were carried out between 9:00 am to 4:00 pm for diurnal species and for two hours after dusk for the nocturnal species. Detailed methodology applied for studying the herpetological diversity in the study area is given below. Survey locations of Reptiles and Amphibians are shown in **Figure 5.16**.

5.7.1.1 Secondary Data

To record every possible species in the study area, the available literature was collected and reviewed. The literature included published and unpublished reports and books of private and government conservation organizations, gazetteers, research articles, popular articles and newspapers. Based on the available literature, a checklist of different species was developed which was confirmed through observing different species during the survey.

5.7.1.2 Interviews with Local Residents

Interviews with local residents are valuable not only for identifying the potential sites in the study area but also a good source of primary data about the existing wildlife of an area. This method was used for locating different amphibian and reptilian species in the study area. The relevant people in the study area for the interviews included; field biologists, local hunters, local fishermen, fish farmers, agriculturists and officials from fisheries, wildlife, forest and irrigation departments in the study area. A questionnaire was also developed before interviewing different people for herpetological survey. However, despite the effectiveness of this method, minimal emphasis was placed on this source regarding the populations of different animals as it is assumed that the data regarding the population estimates could be biased.

5.7.1.3 Amphibians' Survey

Indirect Evidences

Since the survey was planned during the breeding season of amphibians (August), therefore different indirect evidences of existence of different species were available in the study area including amphibians' eggs, tadpoles and their mating calls. To locate different amphibian species and their identification at the project area, following indirect methods were be applied.

Amphibian Eggs: Amphibian eggs are the best indication of the presence of different species at a particular site. Medium sized eggs of *Fejervarya, Euphlyctis* and *Sphaeroteca* are found in jelly patches, normally floating at water surface. Large *Hoplobatrachus* eggs are mostly attached in 1-5s to the submerged marginal grass blades. Much smaller, greenish-brown eggs of *Uperodon* and *Microhyla* are about 1/4th of the size of that of other species, float in small patches of thick jelly at water surface. Toads' spawn of black eggs are strung in a double string of jelly, wound round submerged vegetation. During the present survey, amphibian eggs were actively searched along ponds, puddles and roadside water reservoirs in order to locate any amphibian species.

Amphibian Tadpoles: Temporal breeding sites of amphibians are the major source of bulk of tadpoles and the tadpoles can also be an indication of different species. For example, dark brown to

black *Bufo* and *Pseudepidalea* tadpoles are most common, usually fringe the marginal water. They move in deeper water as they grow older and lighter in color. Schools of transparent *Microhyla* and *Uperodon* tadpoles swim at mid-stream. While different species of Ranoid tadpoles occupy different niches in the pond. *Euphlyctis* are confined to the bottom, *Fejervarya* under submerged vegetation; *Hoplobatrachus* and *Sphaerotheca* keep to the marginal deep water. Of the mountain tadpoles; *Allopaa* develop in pools in the course of streams, taking refuge among crevices and holes along marginal stones, when the stream is in flood. *Chrysopaa* tadpoles remain in deep water pools confined under floating algal sheets. During the present survey, amphibian tadpoles were actively searched in ponds, puddles and roadside water reservoirs in order to locate any amphibian species. Tadpoles of *Euphlyctis cyanophlyctis, Hoplobatrachus tigerinus* and *Microhyla ornata* were observed at eight different locations in the study area.

Mating Calls: Amphibian species can also be identified through their mating calls during night and this method was also applied during night search at four out of the 18 study sites in the project area.

Active Search

It is an effective way to search amphibians during the daytime. This method is equally applicable for both nocturnal and diurnal species. The study area was actively searched for potential breeding areas of amphibians like small water pools, water channels, roadside ponds and puddles and suitable microhabitats for amphibians e.g. stones, pond bunds, crevices, leaf litter, debris, rotten log etc. These places are deliberately uncovered to search the amphibians hiding under such covers. Active searching was carried out at all the sites with focus on suitable microhabitats. Search for the nocturnal amphibians was carried out in exposed areas of their potential habitats on the ground, along the path or the pond or stream bank.

Amphibians were also observed during day time as well as at night around their feeding grounds i.e. under light posts etc. and around breeding sites like ponds, puddles and streams where they advertise their presence by their crocks. All the amphibian species found during the study, were identified at the spot and photographed to record the evidences of their existence.

Collection and Preservation of Amphibians

Monsoon rains are the best time for study amphibians as they breed usually during monsoon when water as a medium for their breeding is available easily. Amphibians are specialized vertebrates, occupying special habitat in ecosystem where they forage, follow their breeding rituals, lay eggs and where their tadpoles feed and develop. A few specimens were collected, preserved, tagged and deposited/donated to the Pakistan Museum of Natural History as reference material for future researchers.

To keep track of a preserved specimen and related field information, every collected specimen was allotted a specific number written on a tag tied to the specimen. Tags were prepared by using water / formalin resistant paper, strung on a strong silken cord. The number was written on the tag with a water / formalin resistant ink or with lead pencil. The prepared tag with number was then tied at knee joint or around waist of the specimen. Field notes were taken and data was entered in the notebook under each tag number. The field notes included; date of collection (day / month / year), time of collection, name of the collector, name of the locality from where the specimen was

collected including district, province and distance and direction from nearest town by using a standard map and the ecological data including habitat, vegetation, temperature, humidity, substratum and elevation from sea level.

Photography

A close up color photograph of the specimen in its natural habitat or a series of photographs or a short movie can contribute to understand morphology, breeding, spawning and feeding habits of the animal. Therefore, photographs of all the specimens were taken in their natural habitats not only for their identification purposes but also as an evidence of their existence.

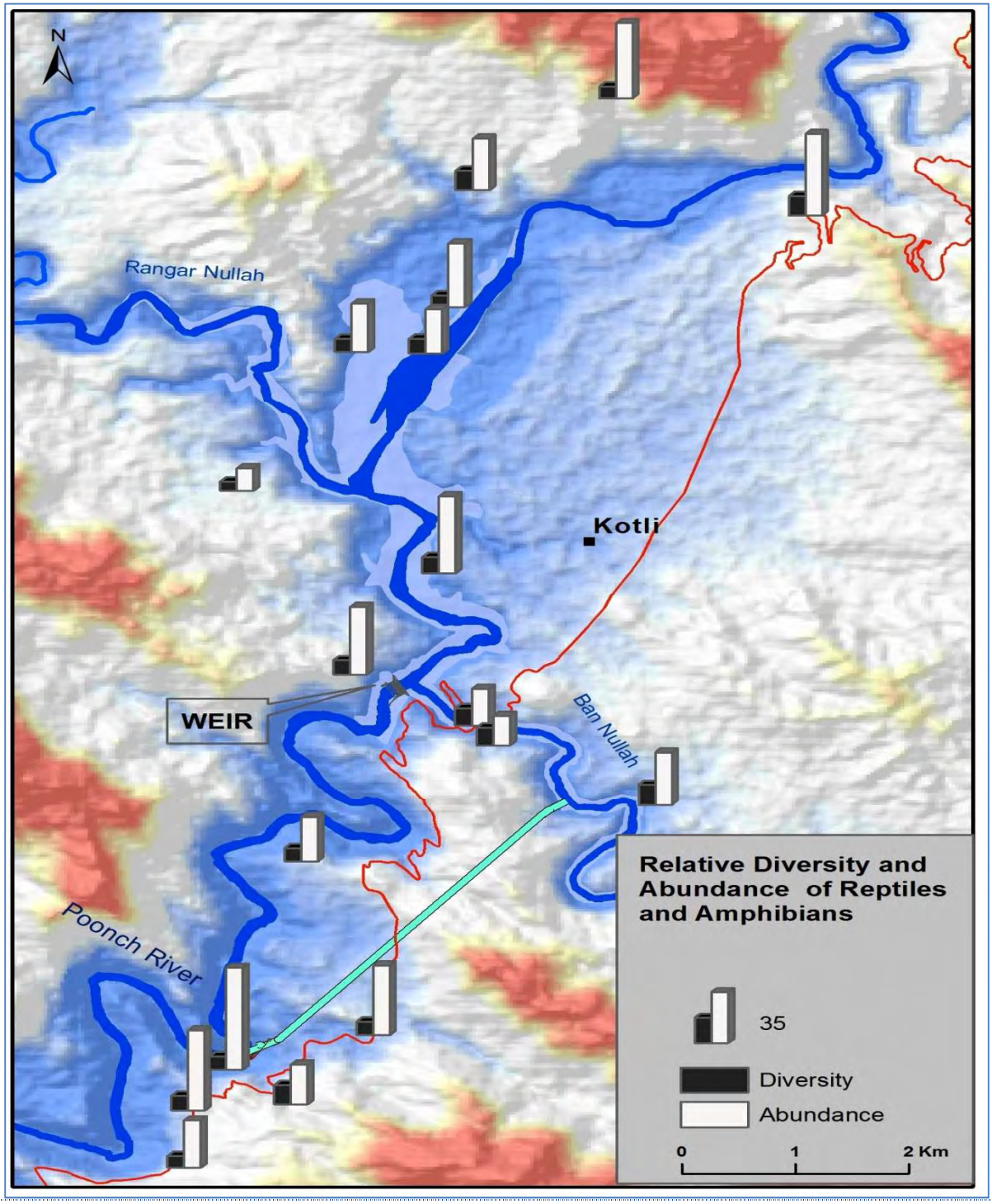


Figure 5.16: Survey Locations of Amphibians and Reptiles, with Species Diversity and Abundance

5.7.1.4 Reptiles' Survey Methodology

According to a preliminary review of literature, it was found that no crocodilians and tortoises are found in the study area; Kotli, AJK and the existing species in the study area include; freshwater turtles, lizards and snakes. Some of the reptilian species are nocturnal in their feeding habits like gekkonid lizards and elapide snakes whereas others are diurnal like agamid, lacertid, varanid and scincid lizards, freshwater turtles and colubrine snakes. Therefore, different direct and indirect

methods were applied to study various groups of the reptilian fauna at the study area. Field visits were carried out between 10:00 am to 3:00 pm for diurnal species and for 2-3 hours after dusk for the nocturnal species.

Field Identification of Reptiles

Different habitats in the study area were searched for any reptilian species both during day time and night. Stone turning, looking at and through bushes, searching basking agamas on stones and boulders and walking along microhabitats were the means to find out all possible reptiles in the study area. Freshwater turtles were observed from the banks of the water bodies. All the reptiles encountered during the survey were photographed and field notes for each specimen were recorded. However, the specimens that could not be identified on the spot or the specimens identified but require detailed study for their confirmation as a sub-species were collected and preserved for their identification in the lab. For the identification of different species, Amphibians and Reptiles of Pakistan, by Khan (2006) was used.

Collection Methods for Reptiles

Hand picking through bare hands or with the help of long forceps or snake clutch has always been the most efficient way of collecting different species of reptiles. The larger species like monitor lizard and rock-agama, noose traps were used. For handling snakes, especially poisonous ones, snake clutches / sticks were used. In addition to Hand picking, “Scoop nets” for shallow water and “cast nets” in large water bodies were also used for aquatic reptiles. Fast moving Agamid and Lacertid lizards were also collected by striking with stick. Some specimens were pulled out with the help of long forceps from crevices in stones while a few were collected by hand from under the bushes. Snakes were mostly collected using snake catcher and every snake being collected was considered as poisonous in order to avoid any mishap.

The collected lizards were killed by injecting concentrated formalin at the site of heart and then the formalin was injected in belly, neck, legs and tail for preservation. A tag number was allotted to each specimen and tied with the left hind limb for identification and later detailed studies. Preserved specimens were stored in 10% formalin in air-tight plastic jars.

5.7.2 Reptiles and Amphibians Diversity

A total 21 species of herps belonging to three orders, 13 families and 18 genera are found in the study area including six amphibians and 15 reptiles. Amphibians included two toads and four frogs whereas; reptiles included one turtle, nine lizard and five snake species (**Annexure 5A**). Two species out of the five recorded snakes are poisonous rests all the amphibian and reptiles are non-poisonous. According to a preliminary review of literature, no crocodilians and tortoises are found in the study area.

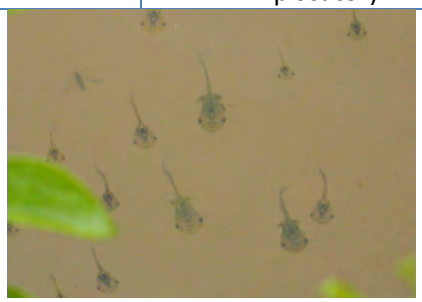
Most of the species were observed directly whereas some were detected through indirect evidences like tracks, burrows, molts and interviews with local residents. All the amphibians and lizards were observed directly. The existence of five species including one turtle (Lissemys punctata andersoni) and four snakes (Typhlops ductuliformes, Eryx johnii, Xenochrophis piscator and Naja oxiana) was confirmed after interviewing a number of local residents including farmers, hunters and teachers.

Common Krait (Bungarus caeruleus)

Brown Cobra (Naja oxiana)

Checkered Keeled back Snake (Xenochrophis piscator)

Himalayan Rock Agama (Laudakia himalayana)



Tadpoles of Microhyla ornata

Figure 5.17: Photographs of Reptile and Amphibian Species Recorded in the Area

5.7.2.1 Conservation Status of the Recorded Species

All the species recorded during the survey were commonly found at all the study sites, with mostly Not Evaluated species (52%) according to IUCN 2013 or having Least Concern status (42%) with stable population trend (**Table 5.7**). Only one species, Brown Cobra (Naja oxiana) was found Data Deficient with unknown population trend. None of the recorded species is protected under the AJK Wildlife Act 1975 or AJK Wildlife Ordinance 2013.

Six of the recorded 21 species are CITES Species with one (Varanus bengalensis) enlisted in Appendix I, four species (Hoplobatrachus tigerinus, Lissemys punctata, Eryx johnii, Naja oxiana) are enlisted in Appendix II while one species (Xenochrophis piscator) is enlisted in Appendix III of the CITES category 2013.

Table 5.7: Conservation status of the reptile and amphibian species

Sr. No.	*Zoological Name*	*Local Status*	*CITES Category*	*IUCN Status(2013)*	*Population Trend IUCN, 2013*
1	*Bufo stomaticus*	Abundant	-	Least Concern	Stable
2	*Bufo melanostictus*	Rare	-	Least Concern	Increasing
3	*Microhyla ornata*	Fair	-	Least Concern	Stable
4	*Euphlyctis cyanophlyctis*	Common	-	Least Concern	Stable
5	*Fejevarya limnocharis*	Rare	-	Not evaluated	Not evaluated
6	*Hoplobatrachus tigerinus*	Common	II	Least Concern	Stable
7	*Lissemys punctata*	Occasional	II	Least Concern	Unknown
8	*Laudakia agrorensis*	Common	-	Not evaluated	Not evaluated
9	*Laudakia himalayana*	Common	-	Not evaluated	Not evaluated
10	*Eublepharis macularius*	Occasional	-	Least Concern	Unknown

Sr. No.	Zoological Name	Local Status	CITES Category	IUCN Status(2013)	Population Trend IUCN, 2013
11	*Hemidactylus flaviviridis*	Abundant	-	Not evaluated	Not evaluated
12	*Hemidactylus brookii*	Abundant	-	Not evaluated	Not evaluated
13	*Indogekko rohtasfortai*	Common	-	Not evaluated	Not evaluated
14	*Ophisops jerdonii*	Common	-	Least Concern	Stable
15	*Eutropis dissimilis*	Fair	-	Not evaluated	Not evaluated
16	*Varanus bengalensis*	Common	I	Least Concern	Decreasing
17	*Typhlops ductuliformes*	Common	-	Not evaluated	Not evaluated
18	*Eryx johnii*	Fair	II	Not evaluated	Not evaluated
19	*Xenochrophis piscator*	Common	III	Not evaluated	Not evaluated
20	*Bungarus caeruleus*	Fair	-	Not evaluated	Not evaluated
21	*Naja oxiana*	Fair	II	Data Deficient	Unknown

5.7.2.2 Local Status of the Recorded Species

The local status of the recorded species in the project area was determined following five categories based on their appearance at different locations in the project area;

- Abundant: if the species appeared in almost all the study sites visited during the study
- Common: if the species appeared in almost 50 % study sites visited during the study
- Fair: if the species appeared in almost 25 % study sites visited during the study
- Rare: if the bird appeared in 5 to 10 % study sites visited during the study
- Occasional: if the species appeared at only one or two study sites during the study

Following the criteria given above, three species were evaluated as Abundant, nine species as Common, five species as Fair, two species as Rare and two species as Occasional (**Table 5.7**).

5.7.2.3 Endemic Species at the Project Site

Out of the recorded 21 species, three are endemic to Pakistan including two lizards; Agrore valley agama (*Laudakia agrorensis*) and Rohtas gecko (*Indogekko rohtasfortai*) and one snake; Slender blind snake (*Typhlops ductuliformes*). All the three endemic species were commonly found at the project site.

5.7.3 Conclusions

Total 21 species of herps including six amphibians and 15 reptiles were recorded during the present study. Out of the recorded 21 species, three are endemic to Pakistan including two lizards; Agrore valley agama (*Laudakia agrorensis*) and Rohtas gecko (*Indogekko rohtasfortai*) and one snake; Slender blind snake (*Typhlops ductuliformes*). The recorded three endemic species were not only found commonly at the project site but also these species occupy a vast distribution range in the country. *Laudakia agrorensis* is found in almost all the mountainous areas, *Indogekko rohtasfortai* occupies vast distribution range in the Salt Range whereas; *Typhlops ductuliformes* is a common species in plain areas.

None of the three recorded endemic species during the survey have yet been evaluated by IUCN or listed for evaluation of their conservation status in IUCN Red List of Threatened Species. None of these endemic species are protected under the AJK Wildlife Act 1975 or AJK Wildlife Ordinance

2013. The recorded endemic species are none CITES species i.e. none of these is enlisted in any Appendix of CITES category 2013.

5.8 Avifauna

Birds are considered as important health indicators of the ecological conditions and productivity of an ecosystem (Li and Mundkur, 2007). While addressing the environmental problems of an area, birds can be used as very appropriate bio-indicators suggesting the status of biodiversity in general (Bhatt and Joshi, 2011).

Of the total Pakistan's bird species, 30% visit the country for a significant period of the year as long distance migrants, 43% are either Palearctic species visiting Pakistan only for breeding and 28% are regular winter visitors, which breed mainly in trans-Himalayan northern regions (Roberts, 1992). The information about avian distribution across different habitats and Himalayan elevation zones across the region is scarce, fragmented and preliminary (Ali & Ripley, 1998). The study area is unexplored in terms of avifauna and old documentation of the bird diversity specific to the study area exist.

5.8.1 Methodology

The present study was carried out using 500 m transects, spread across the study area (**Figure 5.18**). Transects were rightfully separated (about 400 m) to shun the double counting of birds. The other most important aspect kept in consideration while surveying for the birds was the activity period of birds. The peak activity of birds lasts for 1 or 2 hours after sunrise or before sunset, so recording of birds were done either in early morning or late evening hours (Thakur et al., 2002). Survey was done between 0530–1100 hrs and 1530–1830 hrs during the dusk and dawn, respectively. It helped to note the movements and calls of the birds, which were noticed easily to draw data more accurately. All birds seen while walking along transects, including those flying, were recorded. All observations were made by using binocular and photographic documentation was done by using digital camera. In the field, the birds were identified using an authentic field guide (Grimmett, et al., 2008). By using Shannon's Diversity Index (H'), data was analyzed for species diversity and relative abundance.

Pi (Relative abundance) = n_i /N
H' (Shannon diversity index) = -Σ (pi*ln*pi)
E (Evenness) = H'/LnS
Whereas, Pi = relative abundance of species, i=1, ni = Number of individuals of species, N = total number of individuals of all species, H'= the Shannon Diversity Index, S = Total number of species, Ln = Log with base 'e' (Natural logarithm)

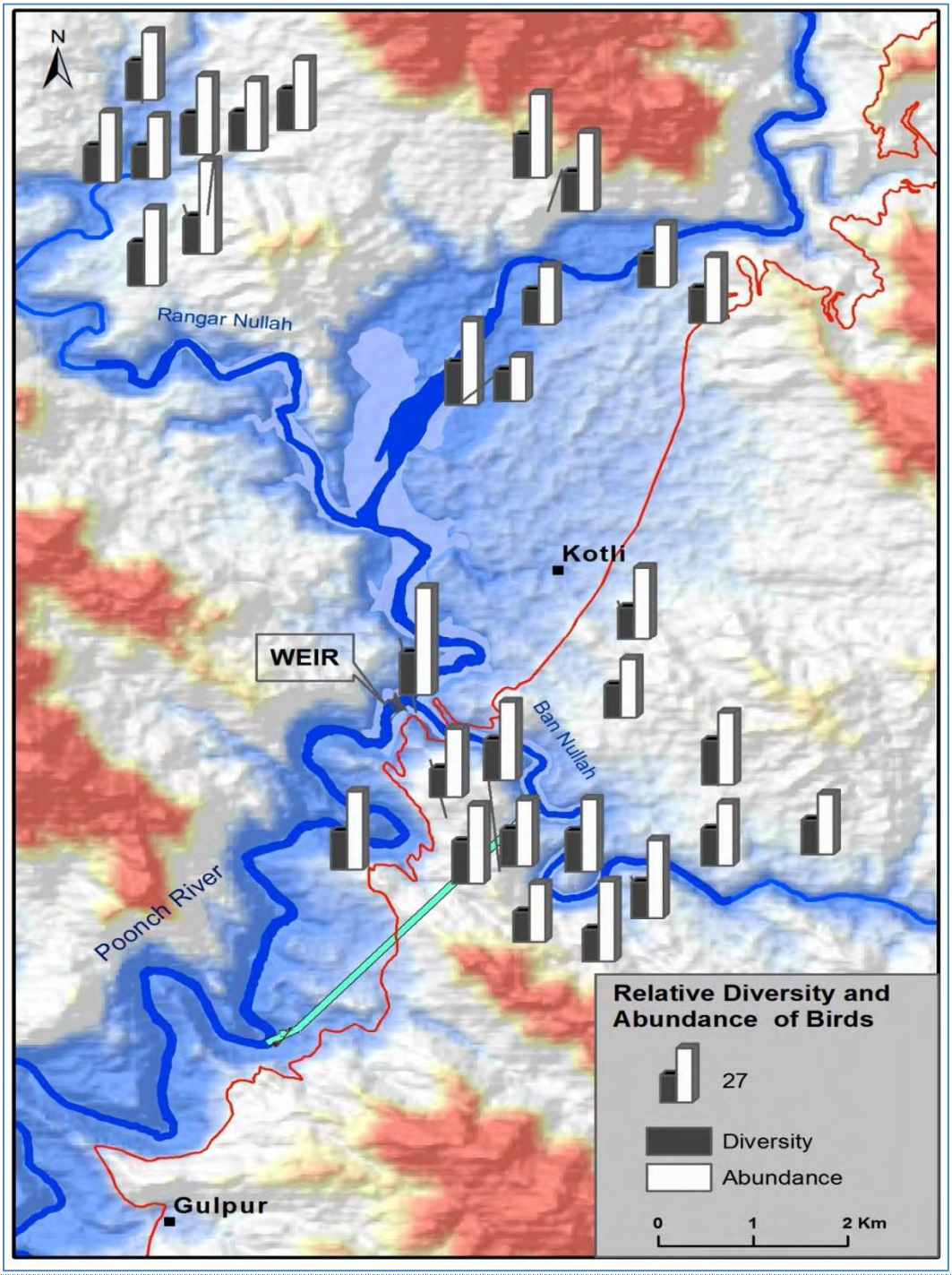


Figure 5.18: Bird Survey Locations, along with Species Diversity and relative Abundance

5.8.2 Bird Diversity

A total of 61 species belonging to 32 families were recorded during the present study (Annexure 5A). The area is a transitional zone between plains and foot hills of Himalayas. It provide the diverse habitat to the birds species such as winter migrant from higher altitude and summer migrant from lower altitudes. This renders higher bird diversity and species richness. Analysis of data on residential status revealed that out of 61 bird's species, 76% were year round resident, remaining were summer breeders, winter visitors and passage migrant. The order Passeriformes was the most

dominant order with highest value of relative abundance. The passerine birds dominated the diversity with 40 species as compared to non-passerines, which were 21 in number.

Passeriformes have highest relative abundance (pi) and encounter rate (ER) (pi= 74.8134: ER= 53.4667/km) followed by Falconiformes (pi= 7.8358: ER= 5.6/km) and Coraciiformes (pi= 6.1567: ER= 4.400/km) respectively. The family Accipitridae dominate the study area in terms of total bird counts, followed by Muscicapidae, Corvidae. The family Corvidae has highest relative abundance and encounter rate (pi=15.02: ER=10.73/km) followed by Muscicapidae (pi=12.22: ER=8.73/km) and Accipitridae (pi=7.74: ER=5.53/km) (**Figure 5.19**). The diversity of species in a particular area depends not only on the number of species found, but also on their individuals' counts.

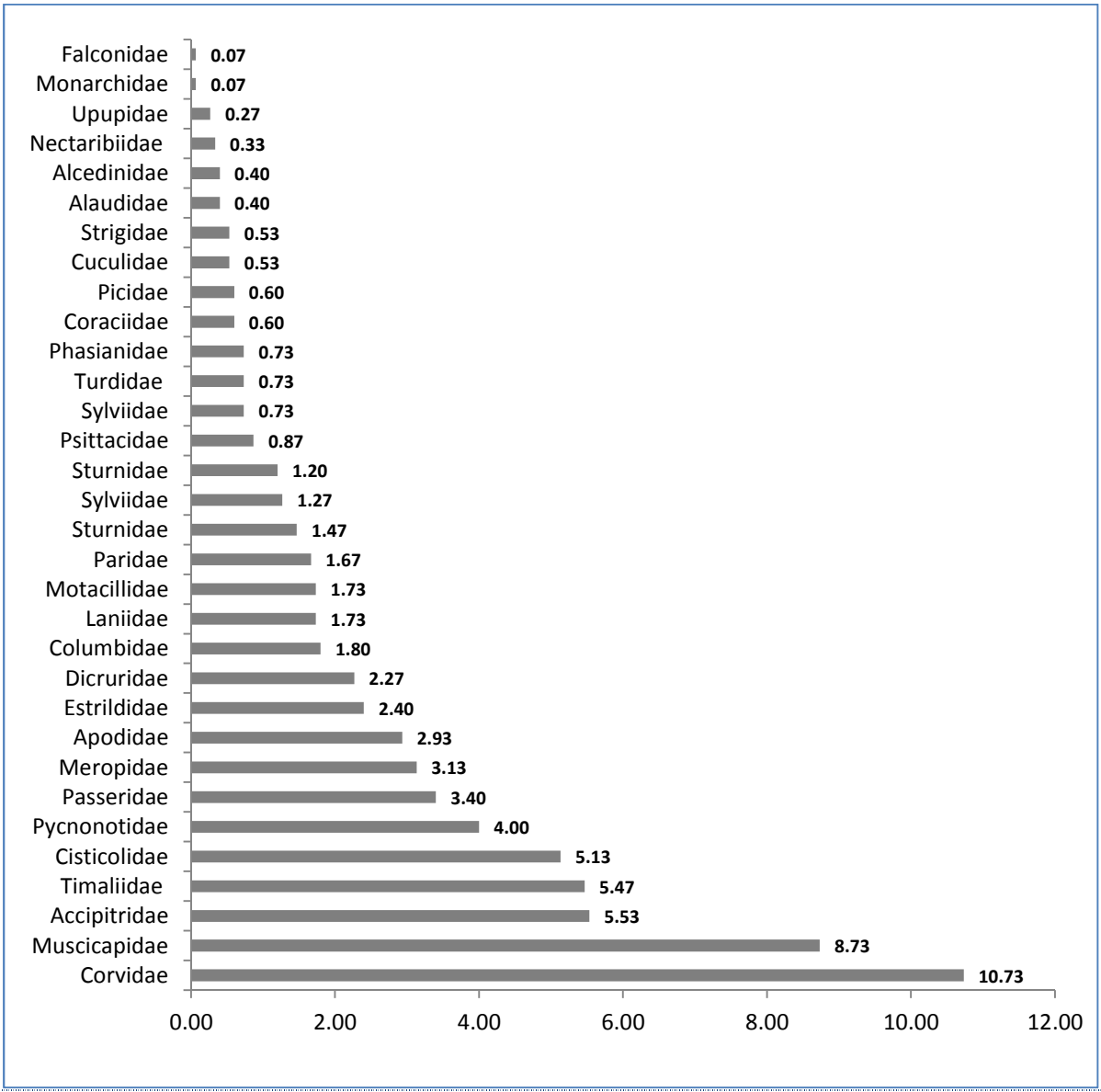


Figure 5.19: Encounter Rate of Bird Families

The critically endangered species, the white rumped vulture (*Gyps bengalensis*) and endangered Egyptian Vulture (*Neophron percnopterus*) were also recorded from the study area. The species of vultures are highly threatened different factors. The major cause of mortality is diclofenac

contamination of livestock carcasses (Green et al., 2006). The other causes such as habitat destruction, food shortage, human persecution, poisoning and pesticide use may have caused a gradual decline in vulture populations (Birdlife International, 2010). The abundance of Egyptian Vulture, Black kite (*Milvus migrans*) and crow species was higher near the waste and garbage stored land. The habitat overlapping of Jungle crow (*Corvus macrorhynchos*), Common raven (*Corvus corax*) and House crow (*Corvus splendens*) was also observed in the study area with equally distribution status of both species. The house crow proliferates in human settlements and disturbed habitats and is especially suited to coastal settlements.

We also studied the species diversity in selected sites of study area. Irrespective of altitudinal variation house sparrow was dominant species in urban areas. Similarly the Indian roller (*Coracias benghalensis*), red vented bulbul (*Pycnonotus cafer*) and white cheeked bulbul (*Pycnonotus leucogenys*) were also recorded across the study area. The two species of woodpecker, scaly bellied woodpecker (*Picus squamatus*) and grey capped pygmy woodpecker (*dendrocopos canicapillus*) and Jungle babbler (*Turdoides striatus*) dominated the forest area (dominated by chir pine). Green bee eater (Merops orientalis), pied Cuckoo (*Clamator jacobinus*), rose ringed Parakeet (*Psittacula krameri*), common myna (*Acridotheres tristis*), Brahminy starling (*Sturnus pagodarum*) and scaly breasted munia (*Lonchura punctulata*) were dominated in the agricultural lands. A single sighting of Asian paradise flycatcher (*Terpsiphone paradisi*) was also recorded while surveying the study area. The transitional habitat between cultivated land and thick forest of chir pine dominated the diversity of passerines birds such as the species of common stone chat, pied bush chat, Indian robin, flycatcher and warbler. The species of wagtail were also recorded near the water resources. Rollers inhabit scattered trees, scrublands, cultivated fields and urban parks or gardens. The main threats include loss of suitable habitat due to changing agricultural practices, loss of nest sites and use of pesticides (Kovacs et al., 2008).

In term of the abundance of recorded species, the undisturbed area depicted the higher diversity of avian fauna. That was probably because forest areas with low human occupation provide breeding ground and roosting places for various birds species.

The Habitat destruction, anthropogenic pressure in the form of tree cutting, firewood collection, grass cutting, and cattle grazing were also observed in these study sites. At several locations, nests of various bird species were observed on ground as well in bushes and on the other hand grazing pressure and cutting of bushes was quite evident. This indicates a serious threat to the breeding activity of birds in the area. The rivers and stream provide suitable habitat for grassland species as well as stream dwellers and migratory water birds. These areas are open to human access and interference. The human related threats in these areas include include water pollution by sewage drainage, industrial waste, eutrophication caused by sewage effluent and agricultural seepage carrying fertilizers and stone crushing.

Intensive biomass extraction (mainly through grazing and fuel wood collection) can bring change in vegetation structure and composition of the forest, leading to changes in bird species composition (Shahabuddin and Kumar 2005).

5.9 Species OF Special Concern

Out of 21 species found in Poonch River, 12 species viz., *Barilius pakistanicus, Schistura punjabensis, Cirrhinus reba, Labeo dero, Labeo dyocheilus, Tor putitora, Cyprinus carpio, Botia rostrata, Clupisoma garua, Ompok bimaculatus, Mastacembelus armatus* are species of special importance (**Table 5.8**). A detailed description of these species is provided in **Annexure 5B**. The species, *Barilius pakistanicus* and *Schistura punjabensis* are endemic in Pakistan including AJK. Four species, *Tor putitora* (Endangered), *Cyprinus carpio* (Vulnerable), *Botia rostrata* (Vulnerable), *Ompok bimaculatus* (Vulnerable) and *Ompok bimaculatus* (Near Threatened) have special IUCN status. Out these, *Tor putitora*, *Cyprinus carpio* and *Ompok bimaculatus* are commercially important. The other commercially important species are *Clupisoma garua*, and *Mastacembelus armatus*.

Table 5.8: Species of Concern Found in the Gulpur Hydropower Project Area

Nos.	*Scientific Name*	*Distributional status*	*IUCN Status*	*Commercial value*	*Max. Length (cm)*	*Max. Weight (Kg)*
1	*Barilius pakistanicus*	Endemic	-	-	-	-
2	*Schistura punjabensis*	Endemic	-	-	-	-
3	*Cirrhinus reba*	-	-	Fairly good	30	0.3
4	*Labeo dero*	-	-	Fairly good	75	0.2
5	*Labeo dyocheilus*	-	-	High	90	5
6	*Tor putitora*	-	Endangered	Very high	275	54
7	*Cyprinus carpio*	-	Vulnerable	High	110	40.1
8	*Botia rostrata*	-	Vulnerable	-	-	-
9	*Clupisoma garua*	-	-	Very high	61	0.5
10	*Ompok bimaculatus*	-	Near threatened	Fairly good	45	0.2
11	*Mastacembelus armatus*	-	-	High	90	0.5 g