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INLAND WATERWAYS AUTHORITY OF INDIA

Ministry of Shipping, Government of India

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT, ENVIRONMENTAL MANAGEMENT PLAN AND RESETTLEMENT ACTION PLAN FOR "CAPACITY AUGMENTATION OF NATIONAL WATERWAY.1" BETWEEN HALDIA AND ALLAHABAD

(JAL MARG VIKAS PROJECT)

(DRAFT)

CONSOLIDATED ENVIRONMENTAL IMPACT ASSESSMENT REPORT

FOR

NATIONAL WATERWAYS-1

MAY, 2016

EQMS India Pvt. Ltd.

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Abbreviations	
µg/m^3	Microgram per cubic metre
A	Ampere
AAQ	Ambient Air Quality
AD	Amphibian Dredger
amsl	above men sea level
APHA	American Public Health Association
AWPCPL	Allahabad Waste Processing Company Pvt. Ltd
BCM	Billion Cubic Microns
BDU	Below Detection Unit
BDU	Best Designated Unit
BHDs	Backhoe Dredgers
BHU	Banaras Hindu University
BOD	Biochemical Oxygen Demand
BOQ	Bill of Quantity
BTKM	Billion Tonne Kilometres
BUIDCO	Bihar Urban infrastructure development Corporation Ltd.
BWE	Ballast Water Exchange
BWMP	Ballast Water Management Plan
BWP	Ballast Water Performance
CBWTF	Common Bio Medical Waste Treatment Facility
CEC	Cation Exchange Capacity
CERs	Critical Environmental Resources
CGWA	Central Ground Water Authority
CGWB	Central Ground Water Board
CIFRI	Central Inland Fisheries Research Institute
CIWTC	Central Inland Water Corporation Limited
cm	centimetre
CNG	Compressed Natural Gas
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
Cr	Crore
CRZ	Coastal Regulation Zone
CSD	Cutter Section Dredgers
CTE	Consent to Establish
CTO	Consent to Operate
cum	cubic metre
dBs	Decibels
DEAC	District Environmental Impact Assessment Committee
DEIAA	District Environmental Impact Assessment Authority
DEM	Digital Elevation Model
DFO	District Forests Officer
DFR	Detailed Feasibility Report
DG	Diesel Generators
DGPS	Differential Global Positioning System

DO	Dissolved Oxygen
DWT	Dry Weight Tonnage
DWT	Dead Weight Tonnage
E	East
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environment Management Plan
EPC	Engineering Procurement Contractor
ESAs	Ecologically Sensitive Areas
ESC	Environment and Social Cell
ESS	Electrical Sub stations
FBP	Farakka Barrage Project
GHG	Green House Gases
GIS	Geographical Information Systems
gm	Gram
GoI	Government of India
GPS	Global Positioning System
GRB	Ganga River Basin
GW	Ground Water
ha	Hectare
HAD	Haldia Development Authority
HC	Horizontal Clearance
HDC	Haldia Dock Complex
HDPE	High Density Poly Ethylene
HFL	Highest Flood Level
hpa	Hectopascal
HPC	Name of a Consultant
hrs	hours
HSD	Hydraulic Surface Dredger
IARI	Indian Agricultural Research Institute
IBA	Important Bird Areas
IESWM	Institute of Environmental Studies & Wetland Management
IITs	Indian Institute of Technology
IMD	India Meteorological Department
IMDG-code	International Maritime Dangerous Goods Code
IMO	International Maritime Organization
INTACH	Indian National Trust for Art and Cultural Heritage
IRS	Indian Remote Sensing Satellite
IS	Indian Standards Published by Bureau of Indian Standards
ISRO	Indian Space Research Organization
IUCN	International Union for Conservation of Nature
IWAI	Inland Waterways Authority of India
IWC	International Whaling Commission
IWT	Inland Waterway Transport
JNNURM	Jawaharlal Nehru National Urban Renewal Mission

kgs	Kilograms
KLD	Kilolitre per Day
km	kilometre
KMC	Kolkata Municipal Corporation
kmph	Kilometre per Hour
KoPT	Kolkatta Port Trust
KoPT	Kolkata Port Trust
KW	Kilo watt
LAD	Least Available Draft
LC	Level Crossing
Leq	Equivalent continuous sound pressure level in dB
LPG	Liquid Petroleum Gas
m	Metre
MARPOL	International Convention for the Prevention of Pollution from Ships
meq	Milli equivalent
mg/l	Milligram per litre
mg/l	Milligram per litre
□ill^3	Microgram per cubic metre
mL	Millilitre
MLD	Millions of Litres Per Day
mmhos/cm	Mili mho/ centimetre
MoEF&CC	Ministry of Environment & Forests & Climate Change
mpn/100 ml	Most Probable Number/100 millilitre
MSIHC	Manufacture Storage import of Hazardous Chemicals
MSW	Municipal Solid Waste
MSW	Municipal solid Waste
MT	Metric Tonnes
MTPA	Million Tonne Per Annum
N	North
NAAQS	National Ambient Air Quality Standards
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCAER	National Council of Applied Economic Research
NGBRA	National Ganga Basin River Authority
NGO	Non-Government Organization
NH	National Highway
NMCG	National Mission for Clean Ganga
NOC	No Objection Certificate
Nox	Oxides of Nitrogen
NRCD	National River Conservation Directorate
NTPC	National Transport Policy Committee
NTU	Nephelometric Turbidity Unit
NW	National Waterways
NW	North West
ºC	Degree Celsius
PCC	Portland Cement Concrete
PCCF	Principle Chief Conservator of Forests

PIANC	World Association for Waterborne Transport Infrastructure
PM	Particulate Matter
PMC	Patna Municipal Corporation
PMU	Project Management Unit
ppb	parts per billion
ppm	parts per million
PPP	Public Private Partnership
PWD	Public Works Department
QA/QC	Quality Assurance/Quality Check
RCC	Reinforced Cement Concrete
RET	Rare Endangered and Threatened Species
RIS	River Information System
RITES	Name of Govt. Consultancy Organisation
ROB	Rail Over Bridge
RO-RO	Roll on and Roll Over
RWH	Rain Water Harvesting
S	South
SAV	Submerged Aquatic Vegetation
SC	Schedule Caste
SE	South East
SEAC	State Expert Appraisal Committee
SEIAA	State Environmental Impact Assessment Authority
SH	State Highway
SO2	Sulphur Dioxide
SPCB	State Pollution Control Board
Sq.km	Square kilometre
ST	Schedule Tribe
STP	Sewage Treatment Plant
SW	Surface Water
SWDS	Solid Waste Disposal Site
TDS	Total Dissolved Solids
TKM	Tonne Kilometres
TPD	Tonnes per Day
TPP	Thermal Power Plant
TSDF	Treatment Storage and Disposal Facilities
TSHDs	Trailer Suction Hopper Dredger
UNDP	United Nations Development Programme
UP	Uttar Pradesh
USA	United States of America
USDA	United States Department of Agriculture
USEPA	United State Environment Protection Authority
VBREC	Vikramshila Biodiversity Research and Education Centre
VC	Vertical Clearance
VMC	Varanasi Municipal Corporation
W	West
WB CZMA	West Bengal Coastal Zone Management Authority

WDSC	Whale and Dolphin Conservation Society
WHC	Water Holding Capacity
WNW	West North West
WWF	World Wide Fund for NGO

Disclaimer:

The report has been prepared by EQMS India Pvt. Ltd. In JV with IRGSSA & AIAID for Inland Waterways Authority of India. This is in pursuant to the task assigned by IWAI under this project. EQMS JV has undertaken detailed environmental and social assessment and developed the EIA report as per the requirement. Any third party should obtain prior consent of EQMS before copying or reproducing in whole or in part the contents of this report. EQMS JV disclaims any responsibility for any law or damage suffered by any third party by taking reliance of this report. Furthermore, EQMS will not be bound to discuss, explain or reply to quarries raised by any agency other than intended recipient of this report. All information in the report is intellectual property of the IWAI /EQMS.

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

The cargo movement through waterway is considered one of the cheapest mode of transportation internationally which is very low in India compared to the international scenario. To augment the capacity of waterways transportation in India, Govt. of India has constituted Inland Waterways Authority of India (IWAI) in 1985. IWAI has identified 5 river stretches as National priority and notified these stretches as National Waterways 1 to 5. Amongst the five notified waterways, the national waterways on Ganga (NW-1 between Haldia to Allahabad) is the longest waterways and is of prime importance considering its locational advantages. IWAI since long has been maintaining the least available depth (LAD) of 3m between Haldia and Farakka (560km), 2.5m in Farakka – Barh (400km), 2m between Barh – Ghazipur (290km) and 1.2 to 1.5m in Ghazipur – Allahabad (370km). Even currently this waterway (NW-1) is being used for various cargo movements, as well as tourists. Already good amount of cargo movement is taking place between Haldia and Farakka (e.g. 3 million metric tonne of imported coal from Haldia to NTPC plant near Farakka is being transported since October 2013 through 20 barges of 2000 dwt capacity each). Considering such a large potential and demands, IWAI has initiated the project of "Capacity Augmentation of National Waterway-1" between Haldia and Allahabad named as "Jal Marg Vikas Project". However, considering the available LAD and cargo demand scenario, IWAI is focusing on the stretch between Haldia to Varanasi at present.

The capacity augmentation of this magnitude under this project warrants additional infrastructural components such as river terminals of appropriate cargo handling capacity, provision of navigation aids; river information system; RO-RO jetties; bank protection / slope protection works; river training works; inland vessels; survey vessels, survey equipment and dredging facilities which are required to be developed in a phased and programmatic manner. Certain facilities are already planned such as multi-mode terminal at Ramnagar (Varanasi), Sahibganj and Haldia and new navigation lock at Farakka. Other developments are under finalization stages. Environmental and Social impact assessment studies have been carried out separately for each of already identified above four facilities, maintenance dredging and barge operation activities. A consolidated environmental impact assessment report is prepared for various above components and likely other developments proposed under feasibility report of Jal Marg Vikas Project being funded by World Bank. The following summarises the outcome of above studies.

2.0 Project Need and Location

Inland Waterway Transport (IWT) offers a comparatively low cost and environmentally sound alternative to road and rail transportation especially for bulk and containerized cargo. Infrastructure requirements of IWT in comparison to road and rail transport are also relatively low, although some investments are essential such as in port/terminal facilities, connecting road/rail infrastructure, navigation aid and maintenance dredging facilities. While cargo movement through other modes of transportation are often confronted with congestion and capacity problems, IWT offers a relatively congestion free and reliable mode of transport along with availability of unmatched capacity expansion due to its large untapped potential.

Till the middle of 20th century, IWT was being used as an important mode of transport in various parts of India but gradually it got confined to unorganized sector except in few states namely Goa, Assam, West Bengal, Kerala and Maharashtra primarily due to focus shift in transportation through rail and road modes. However, IWT use has shown increasing trend since 2003-2004 and touched 70 Million tonnes mark by 2011-2012 compared to only 32.48 Million tonnes in 2003-2004 which is just 0.34% of total inland cargo movements of about 1000 btkm. IWAI has set the target of increasing IWT share up to 2% of total inland cargo by 2025. The main commodities carried by IWT (which are also true with NW-1) include building materials (34%), metals\ores (19%) and coal\coke (17%). On demand side in the case of NW-1 (Allahabad – Haldia) alone 10 thermal power plants are located along Ganga river in UP & Bihar stretch and 11 more are expected to become operational soon. The total requirement of coal for these power plants will be nearly 70 million tonnes per year, 14 MT of which will have to be imported. In addition to this, there are seven fertilizer plans along NW-1. These are also estimated to generate an additional of 0.765 million ton of cargo requirement per year. Further, there is also large prospect of container movements for national as well as international trade. IWT and NW-1 in particular would play a very vital role when high quality ports/terminals and waterway connections are made available to facilitate the cargo movement in a cost effective and environmental friendly manner catering to the needs of high transportation movements due to enhanced industrial activities as compared to rail and/or road modes.

Project area under Jal Marg Vikas Project includes entire reach of the River Ganga from Haldia to Allahabad including the areas proposed for development of project related facilities & infrastructure, i.e. terminal sites, lock site, Ro-Ro jetty sites and sites for other planned development. Stretch from Allahabad to Haldia covers four states namely Jharkhand, Bihar, Uttar Pradesh & West Bengal. Map showing location of NW-1 stretch from Haldia to Allahabad is shown in **Figure 1** below.

Figure 1: Location Map of NW-1

3.0 Project Description

Proposed Project-Jal Marg Vikas aims at improvement of navigation in entire stretch of 1620 km. of NW-1 (Haldia to Allahabad). NW-1 is the Ganga - Bhagirathi - Hooghly river system. NW-1 is being fed by various tributaries at different locations. Major tributaries to NW-1 between Haldia to Allahabad are Tons, Gomti, Ghagra, Son, Gandak, Punpun and Kosi. The following interventions have been proposed and planned under the Jal Marg Vikas Project.

- Maintenance dredging to provide LAD in waterway/channel and the terminal facility
- Improved Navigation Infrastructure & Navigation Aids
  - Construction of 10 Ro-Ro jetties & ferry passenger jetties. Locations of these jetties are yet to be identified.
  - Construction of 6 terminals: Site identification and planning for 3 terminals sites at Sahibganj, Varanasi and Haldia is completed. 2 more potential sites for development of terminals are identified at Ghazipur and Kalughat. These two sites are still under consideration for finalization and planning of design at initial stage only. One more terminal site along NW-1 is being identified.
  - Construction of one Navigation Lock at Farakka, West Bengal.
  - Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment. Development of low draught cargos.
  - Development of navigation aids along NW-1 for facilitation of day & night time navigation.
- Development of efficient River Information System with all hardware & software.

- Provision for bank protection / slope protection and river training works for critical locations.

The project also envisages the creation and improvement of integration opportunities with other surface transport modes such as roads and railways, so as to improve the overall efficiency of the logistics chain by linking the waterways through various well equipped terminals and jetties.

Cargo being transported in NW-1 includes cement, fly ash, iron ore, iron ore fines, coal, steel shed, tyres, iron fines, iron ingots, Galvanized steel plain sheets, stone chips, furnace oil, high Speed diesel, lube oil, boulders, pulses, aluminium block, sand, chips, ship block, food grains, Manganese ore, Petroleum, Coke, Cooking coal, Rock Phosphate, Timber, Peas, Slag oil, and Non-cooking coal. Traffic projections for the planned infrastructure site are given at **Table 1.** The terminals cargo handling capacity are being designed considering these traffic projections.

Table 1: Traffic Forecast for Planned Navigational Infrastructural Facilities

S. No.	Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
1	Sahibganj Terminal	2.24	4.39	9.00
2	Varanasi Terminal (with current land)	0.54	1.22	1.22
3	Haldia Terminal	4.07 MTPA (1.57 other cargo & 2.5 MTPA coal transhipment)		

Source: HOWE Engineering Projects (India) Pvt.Ltd. (Design Consultant)

There are various challenges for Jal Marg Vikas Project development which includes typical characteristics alluvial river Ganga his braiding, meandering large water fluctuations between summer and monsoon months and annual silt loads of 1600 million tonnes. The maintenance dredging requirements, planned infrastructures facilities, and other facilities are planned keeping these challenges and transportation requirements in consideration. The salient features of the Jal Marg Vikas Project with the details of planned and proposed developments are given at **Table 2.**

Table 2: Salient Features of Jal Marg Vikas Project

Salient Features	Capacity/Quantity/Nos.
Facilities Planned	• 3 terminal sites (Sahibganj, Varanasi & Haldia) • 1 new Navigation lock- Farakka • River bank protection works at planned terminal sites and along Feeder canal
Facilities under Planning Stage	• 3 additional terminal sites • 10 ro-ro jetties • Barge repair and maintenance facility • River training works

	• River bank protection works at the proposed civil intervention sites
Designed capacity of Terminals	

Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
Sahibganj Terminal	2.24	4.39	9.00
Varanasi Terminal (with current land)	0.54	1.22	1.22
Haldia Terminal	4.07 MTPA (1.57 other cargo & 2.5 MTPA coal transhipment)		

Navigation Channel	Width-64m LAD-3 m from Haldia to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi at present
Design Vessel Specifications	Vessels of maximum length 110 m, beam 11.4 m, draught 2.5 m-2.8 m and air draught of 9 m will ply in the waterway
Size of Vessels	1500-2000 dWT
River Slope	Haldia to Farakka-1 in 11000 Farakka downstream-1 in 18000 Farakka to Allahabad-1 in 17,000
Maintenance Dredging	Navigation Channel-15,765,596 cum/year*
Type of Dredgers	CSD, Agitation dredgers/plough dredgers and back hoe dredgers
Dredge disposal	Preferably off-shore, onshore only if sediments are found to be contaminated

* quantities are tentative and subject to change with revision in planning

3.1 Project Implementation Schedule, Cost and Implementation Responsibilities

The project being of large spatial extent, will be developed in phases. The implementation period of 3 years is anticipated for completion of phase 1 components of the Jal Marg Vikas Project (6 terminal sites, maintenance dredging, vessel management system, shore protection works and river training works). Overall cost of the Jal Marg Vikas Project will depend on finalization of various components proposed under the project. However, fund allotted by World Bank to GOI for development of Jal Marg Vikas is about 650 million USD (~4200 Cr). The Project Director and officer of the rank of Vice Chairman of IWAI will be in charge of the implementation programme who will be assisted by Project Management Unit and Regional Directors.

4.0 Environmental Impact Assessment Process

This project is classified as Category 'A' operations under the world bank environmental screening procedures specified under its operation policy 4.01. The project triggers 7 of the World Bank safeguard policy[1] and requires comprehensive environmental assessment. This project does not require any environmental impact assessment as per the existing

[1]The world bank safeguard policies triggered are environmental assessment (OP/BP 4.01), Natural Habitats (OP/BP 4.04), Forests (OP/BP 4.36), Involuntary resettlement (OP/BP 4.12), Indigenous people (OP/BP 4.10), Physical Cultural Resources (OP/BP 4.11) and Project on International Waterways (OP/BP 7.5)

provisions of Indian Laws. The environmental impact assessment was carried out by a consortium led by EQMS India Pvt. Ltd. Initially a basin level critical environmental resource study was carried out to identify “NOGO” and “Restricted areas”. The baseline survey planning was carried out considering the output of this study as well. In addition to assessing the air, water, noise soil quality and biological environment (aquatic and terrestrial ecological aspects), sampling and testing of riverbed sediments at different locations in the entire stretch of NW-1 was also carried out. The baseline survey was carried out between: 15thSeptember, 2015 to 28thFebruary 2016 for different period and frequency at different locations covering the entire stretch of NW-1, finalised intervention areas, likely intervention areas, likely maintenance dredging areas, existing select RO-RO jetty locations, existing passenger select ferry locations and environmental sensitive areas. Being a liner project, the 500m radius on either side of the bank is considered as core influence zone, 2 Km radius as extended influence area. The terminal site will have influence area beyond 2 km. As per Indian standard practice, influence area is considered as 10 km along the NW-1 stretch and intervention areas for study purposes. The studies were carried out in tandem with preparation of detailed engineering feasibility report. Initially separate environmental impact assessment was carried out for each terminal / lock, maintenance dredging and barge operations. This was followed by carrying out environmental impact assessment for all components in the form of consolidated environmental impact assessment report. The formal informal consultation was undertaken as part of impact assessment process. The impact assessment covers all three stages of the project viz. design, construction and operation stages. The impacts are identified from all components and activities of the project on physical, biological (terrestrial and aquatic ecology) and socio – economic environment. Environmental management and monitoring programme are suggested to minimize the identified impacts and sustain the benefits. Institutional Mechanism is also proposed for effective implementation of environmental management and monitoring plan.

5.0 Project, Legal and Administrative Framework

The project has been evaluated for applicability of all National, State Laws, Rules and Regulations. The Acts, rules and guidelines applicable for the project are critically analysed to list out the permits/NOC required to be obtained by IWAI/contractor prior and during the development of the project. Environmental legislations applicable for the project are (i) Environmental Protection Act, 1986 (ii) EIA Notification, 2006 as amended till date (iii) Forest Conservation Act, 1980 (iv) Wildlife Life Protection Act, 1972 (v) CRZ Notification, 2011 (vi) Air (Prevention and Control) of Pollution Act 1981/1987 (vii) Water (Prevention and Control of Pollution) Act, 1974/1988 (viii) Hazardous and Other Wastes (Management &Transboundary Movement) Rules, 2016 (ix) Other waste management & safety rules, regulations and guidelines; Construction and Demolition Waste Management Rules 2016,

E-Waste Management Rules, 2016; Plastic Waste Management Rules, 2016; The Battery Management and Handling Rules, 2001;Ancient Monument and Archaeological Site and Remains Act, 1958.

Environmental clearance will be obtained for any project component wherever found applicable. The environmental clearance under minor mineral category of EIA notification 2006 shall be taken by the contractors as applicable before borrowing the earth and for setting up new quarry site. Consent to establish under Air and Water Acts for setting up batching plant, hot mix plant, DG sets, soak pit & septic tank/STP shall be obtained by the contractor before setting up these facilities from State Pollution Control Boards. No diversion of forest land is involved in the project, however; cutting of trees will be carried out for construction of terminals and other interventions and permission will be required from concerned authorities or forests departments as per law of respective states. Waste/used oil is the only hazardous waste likely to be generated during construction and operation stage which shall be managed as per Hazardous & Other Waste Management Rules, 2016. Other waste related regulations shall also be followed depending on nature of waste generation during construction and operation stages as defined above.

Permission under CRZ Notification, 2011 is required for establishing Haldia Terminal from West Bengal Coastal Zone Management Authority. The process for this permission has already been initiated. Permission for movement of vessel through Kashi Turtle sanctuary & Vikramshila Gangetic Dolphin Sanctuary located under Wild Life Protection Act, 1972[2]. Process has already been initiated for obtaining these permissions. There are nine archaeological sites located within 300m area of river bank on NW-1. No construction activities are proposed closed to these sites. Permissions shall be obtained from archaeological department if any construction is planned in near future within 300 m of these sites.

Additional international conventions/treaties applicable for the project have been analysed. India being signatory of IMO, is obliged to follow the environmental and safety guidelines prescribed under various conventions. Some of the regulation and guidelines applicable to vessels plying in Indian inland waterways as per IWAI includes (i) Prevention of Collision on National Waterways Regulations, 2002 (ii) National Waterways, Safety of Navigation and Shipping Regulations, 2002 (iii) The National Waterway-1 Act, 1982 (iv) New Inland Vessel Act, 2015 & Rules Under IV Act (v) Relevant other International Environmental Convention

6.0 Key safeguard documents

A detailed description of project baseline environmental conditions, identified positive and negative environmental impacts, the mitigation measures to eliminate or minimize the adverse impacts and enhance the positive impacts, detailed environmental management

[2] As per notification, restriction are imposed for fishing (larvae of Hilsha & during breeding & spawning season) only in Hislha Sanctuary

plan including institutional responsibilities, implementation schedule, environmental budget, arrangement for monitoring and evaluation and grievance redressal mechanism are provided in the consolidated environmental impact assessment report for NW-1 and environmental impact assessment report of Ramnagar (Varanasi terminal), Sahibganj terminal, Farakka Lock, and Haldia terminal. The other supplementary documents prepared under this project are i) Basin Level Critical Environmental Resource Assessment report; ii) Consolidated rehabilitation action plan for NW-1, iii) Rehabilitation action plan for Sahibganj, iv) EIA Report for maintenance dredging and barge operations

7.0 Public Consultation and Disclosure

Stakeholder's view and perception was assessed through informal and formal public consultation meetings. The different stakeholders viz. Govt. officials, NGOs, Village Panchayats (Village Administration), people (male, female) were contacted and consulted during the course of the study. Stakeholders were informed about the project components and likely environmental impacts before seeking their views. In each consultation all efforts were made to have adequate participation from women as well. Consultations has been carried out for the project in two stages. First stage consultation was undertaken during impact assessment process to identify the concerns of people which were duly addressed through appropriate mitigation measures. Second stage consultation was undertaken after preparation of EIA report so as to assess the adequacy and acceptability of the proposed mitigation measures and management plan. Public consultations ensured involvement of public, NGO, experts in the project's pre-planning stage itself and addressal of their concerns and expectation from the project.

The community members, Government officials and NGO members voiced that the proposed project will contribute in social and economic development of the region. The proposed project shall contribute to increase employment opportunities for the local people during and after project implementation. The communities welcomed the project and all were in favour of the project. However, some of the fishermen and land holders have raised some concerns about the fishing activities/yield and the compensation to be given. Major issues highlighted during consultation were adequate compensation against the land, loss of livelihood, provision of alternate employment, river water pollution, fish yield and disruption of fishing activities. Each of the issues raised by stakeholders were analysed for practical and scientific basis, and evolving appropriate mitigation, management and monitoring plan, depending on its importance and practicality.

An executive summary of consolidated EA report is available for public view in local language (Hindi and Bengali) versions at IWAI website. EIA report for entire Jal Marg Vikas Project and its executive summary is also disclosed at IWAI website and as per provisions of World Bank disclosure policies.

8.0 Alternative Analysis

Analysis of alternatives is an analytical comparison of the operational effectiveness, costs and environmental and social risks of proposed development options. This helps to analyse the options critically in relation to its impacts on all physical, social and biological environments. For this project, alternative analysis has been made for three considerations, i.e. strategic, planning and technology consideration. The summary of these analysis is presented below:

8.1 Strategic Consideration

A comparison is made for “With” & “Without” project scenario for the physical, social and biological environments and status of cargo transport scenario. “With Project Scenario” is considered better for all physical, biological, social environmental and cargo transport scenario compared to “Without Project Scenario”. With Project Scenario will improve the freight transportation efficiency, reduce the GHG emissions, fuel requirement, air emissions, land acquisition, and tree cutting for maintaining and expanding cargo movement requirement. However, impacts are anticipated more on water and aquatic ecology in “With Project” scenario compared to rail and road for which mitigation and management plans are prepared to minimize the impacts.

8.2 Planning Consideration:

This involves the consideration of options for location of the proposed interventions, suitability of intervention sites, design of the project layout and dredging extent. Locations are selected for proposed civil interventions (terminals/jetties) on the basis of potential of freight/cargo movement in the area and its connectivity with other modes of transport (Rail and Road). 10such locations were selected for development of 6 terminals and 1 navigational lock. One of the probable locations at Bhagalpur was ruled out due to presence of Vikramshila Gangetic Dolphin Sanctuary and based on “NO GO” areas identified in Basin Level Critical Resources Assessment study. Two sites at Varanasi and Sahibganj were identified few years back where land acquisition process was either completed or is near completion and thus were not included in the locational alternative analysis. However, acceptability of these sites from environmental aspects were assessed which were found acceptable. The terminal sites at Haldia, proposed to be located on Government Land (Kolkata Port Trust Land) which is already being used for shipping and industrial purposes, were considered acceptable from environmental and social aspects. The location of navigational lock at Farakka is already existing and navigation lock parallel to existing lock is proposed. Remaining seven sites were analysed from environmental, social, design considerations. Based on alternative analysis three terminal sites at Ghazipur, Tribeni (Kalyani), Kalughat near Doraiganj were considered as preferred sites for these interventions. The other three terminal sites at Barh, Kahalgaon & Balia were not

considered feasible due to (i) various environmental consideration including proximity to Vikramshila Dolphin sanctuary and Important Bird Areas, (ii) design issues such as unstable river, presence of navigational hazards and high sedimentation rate (iii) social issues concerning acquisition of land and (iv) connectivity.

Further alternative analysis was carried out for probable two sites at each of the above identified three terminal locations and Farakka lock, based on environmental, social and design consideration. As per this analysis, the preferred sites for these intervention locations were considered for design and environmental impact assessment.

At the time of impact assessment terminal designs were ready for Varanasi, Sahibganj, and Haldia terminals only. Considering technical feasibility, multiple layout options were available only for Sahibganj terminal & Farakka lock. These layout options were analysed for identification of most suitable design options. In case of Sahibganj terminal, Alternative 1 involves construction of U shaped jetty (25 m), aligned parallel to the River bank and connected to bank by approach trestle of 50 m and alternative 2 involves construction of jetty at the river bank aligned parallel to it. Both the alternatives were compared on multiple criteria, i.e. operational considerations, navigational aspects, ease of construction & maintenance, flexibility of expansion, construction cost and environmental considerations. Both the alternative layouts have certain advantages as well as disadvantages. It could be observed that in terms of available required depth round the year without need of dredging and marginal cost difference between two alternatives and environmental consideration Alternative-I is found preferred alternative for development of IWT Terminal at Sahibganj. In case of Farakka lock, alternative 1 involves construction of lock parallel to the existing lock and in alternative 2, lock will be constructed D/S of the existing lock. Considering the design, requirement of land, length of embankment, availability of depth, dredging requirement etc. It is found that the alternative 1 is better than alternative 2.

To maintain the river navigability, maintenance dredging is required to be planned so as to maintain the length and width of the channel and maintain LAD near the berths/jetty. IWAI proposed either maintaining 3m LAD throughout the NW-1 stretch or maintained different LAD in different stretches (3 m Haldia to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi). Width[3] of 64 m will be maintained throughout the navigation channel. Alternative analysis was carried out for both these options considering environmental (dredge quality, impact on aquatic ecology and water quality), social (cultural and aesthetic value, employment and socio-economic consideration) and technical feasibility (dredge quantity, navigation feasibility, economic aspects, dredgers and other infrastructure

[3] The channel width is proposed to limit to 45m in phase I which will further reduce the maintenance dredging requirements.
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requirements). As per analysis option of maintaining different LAD at different stretch was found most preferred option.

8.3 Technological Consideration:

The technological aspects were analysed in terms of dredging technology. Five type of dredgers namely cutter suction dredgers (CSD), hopper dredgers, grab/bucket dredgers and back-hoe dredgers were analysed. These were analysed based on safety, accuracy, turbidity, spills and noise criteria as well as operational feasibility. The CSD was considered as most preferred option due to least associated environmental Impact and operational feasibility. As per experience of KoPT and IWT CSD has proved to be the best option and is considered for maintenance dredging planning and environmental impact assessment.

9.0 Salient Environmental Features of NW-1

The salient features of environmental resources within influence area (10 Km) of NW-1, are presented at Table 3. Topography of the whole of NW-1 (Allahabad to Haldia) falls within a relatively flat terrain of the Indo-Gangetic plain. The elevation within the influence area of the NW-1 stretch, ranges between 1 m amsl (meter above sea level) and 321 m amsl. Highest elevation levels were observed at Sahibganj area (Jharkhand) due to presence of small hillocks. Land use within influence area of the NW-1 is majorly dominated by agricultural land. About 78.9 % of the land is under cultivation; about 7.18% land is under settlement, 7.21% of the land is under water bodies, about 3.59% land is under vegetation, 2.82% land is under dry river bed and rest of the land falls under other uses.

Table 3: Salient Environmental Features along NW-1 Alignment

S. No.	Environmental Features	Within 500 m influence area around NW-1	Within 2 km Influence area around NW-1	Within 10 km influence area around NW-1
1	**Ecological Environment**			
A	Presence of National Park/Biosphere Reserves, Tiger reserve etc.	None	None	None
	Presence of Wildlife Sanctuary	Yes Kashi Turtle Sanctuary at Varanasi Vikramshila Dolphin Sanctuary Kahalgaon to Sultanganj Hilsa Sanctuary stretch in west Bengal	None	Yes Udhwa lake sanctuary in Jharkhand (about 9 km away from NW-1
B	Reserved /Protected Forests	None	None	Yes (Bethuadahari RF, Bahadurpur RF & RF near Rajmahal Hills)
C	Wetland of state and national interest	None	None	Yes (Udhwa Bird sanctuary)

D	Migratory route for wild terrestrial animals	None	None	None
E	Presence of Schedule-I Terrestrial Fauna	None	Yes Migratory birds near Farakka Barrage and surrounding	Yes Migratory birds at important birds' areas
F	Presence of Schedule-I Aquatic Fauna	Yes Dolphin, and Turtle	None	None
G	Important Bird Area	Vikramshila sanctuary area	Yes Danapur Cantonment area Mokamatal Kurseala river course and diyara flood plain. Farakka Barrage and surround area	Yes Udhwa lake sanctuary
H	Seismicity	NW-1 falls in Zone-III (moderate risk) and zone IV (high damage risk zone) as per Seismic Zonal Map of India		
B.	**Social Environment**			
I	Physical Setting	Rural, Industrial and Urban		
J	Densely populated area	Allahabad, Sirsa, Mirzapur, Chunar, Varanasi, Zamania, Ghazipur, Gahmar, Buxar, Ballia, Chappra, Patna, Barh, Bihat, Munger, Bhgalpur, Kahalgaon, Sahibganj, Farakka, Berhampore, Katwa, Kalna, Kolkata and Haldia are densely populated areas.		
K	Physical Sensitive Receptors	Yes Ghats at Varanasi, Patna, Temples, Schools, College and Hospital. Details are provided at section 4.7		
L	Archaeological Monuments	Yes There are 9 archaeological sites located within 300 m area of the NW-1 and these are Kardmeshwar Mahadeva Mandir, Ramnagar fort, archaeological excavation site, Varanasi, Manmahal and observatory, St. John's Church, Temple of Gour Chandra and Krishnachandra at Chatra (Gaur Chandra Ghat), Hazardwari Palace, Singhi Dalan and Jami Masjid Details provided in section 4.7, Chapter-4 of EIA report.		

10.0 Anticipated Environmental Impacts and Mitigation Measures

Environmental impacts have been assessed considering present environmental setting of the project area, nature, and extent of the proposed activities. Suitable qualitative and quantitative approach was followed for identification of likely impact on each value components of environment for design construction and operation stage. The impacts were analysed under three broad categories namely (i) Impacts due to dredging operations (ii) Impacts due to barge operations (iii) Impacts due to civil interventions. Additionally, impact was analysed for climate change and riparian issues. Impacts due to land acquisition are covered under separate Social impact assessment and Rehabilitation Action Plan report and not included under this summary.

Maintenance dredging & dredge disposal will be carried out during the operational phase of the project to maintain continued navigability throughout the year from Haldia to Varanasi in NW-1. Dredging of 15.76 million cubic meter will be undertaken from Haldia to Varanasi to maintain LAD of 3 m till Barh, 2.5 m till Buxar & 2.2 m till Varanasi. Impacts of the dredging are analysed for Physical Environment: on water quality and land, Ecological Environment: on aquatic ecology and avi-fauna (6 Important bird areas, VGDS, Kashi turtle sanctuary & Hilsa sanctuary), and Socio-Economic Environment: cultural (Ghats at Patna & Varanasi), archaeological (9 nos.) and livelihood of fishing community

IWT mode though is safest and most environmental friendly mode of transportation, may have impact valued environmental components. Barge movement may impact the water quality, river bank & bank structures, air quality, noise level, aquatic ecology, health & safety, livelihood of fishermen and socio-cultural aspects.

The civil interventions will have largely construction and operation related impacts. Impacts are summarised based on the impact assessment carried out for Varanasi, Sahibganj and Haldia terminals and Farakka navigational lock. The impacts identified for these four sites are likely to be the similar for other interventions sites barring few site specific issues related to tree cutting, land acquisition, muck disposal and construction material sourcing.

The impacts are summarised below for valued environmental components in two groups i) impacts due to dredging and barge operations and ii) impacts due to civil interventions. The baseline conditions are summarised under first group itself. The impacts on climate change and riparian issues are summarised following these two groups impacts.

10.1 Impacts due to maintenance dredging and barge operations

10.1.1 Impact on land and water quality

A. Baseline conditions

Soil and River Bed Sediment Quality: Soil quality monitoring is carried out along NW-1 and within the critical impact zones considered for planned civil interventions as per CPCB guidelines. Soil type is study area is dominated by alluvial soil. Soil texture varies from sandy clay to clayey loam type and soils are marginally acidic to slightly alkaline with pH ranging from 6.62-7.86. Electrical Conductivity ranges between 135.4 & 360.5 µmhos/cm. Soils in the study area are moderately fertile.

The concentration of heavy metal & pesticides in river bed sediments was found low in concentration at each sampling location and are within acceptable limit for off-shore disposal as per “Criteria for Off-Shore Dumping of Dredged Material”, USA except for cadmium which is slightly above the prescribed limit in UP stretch. Cadmium levels can be high due to industrial effluent discharge in this section.

Ground and Surface Water Quality: Ground water quality monitoring is carried out along NW-1 and within the critical impact zones considered for planned civil interventions as per

CPCB guidelines. TDS, Total Hardness and chloride values at Haldia and Sahibganj, Howrah and Kolkata are slightly above the desirable limit but are within the permissible limits specified of IS: 10500. Fe and Zn were detected in water samples but in lower concentration. Arsenic was detected in samples collected from Bhagalpur and Munger but in lower concentration.

River water quality monitoring is carried out along NW-1 and u/s & d/s of planned civil interventions as per CPCB guidelines. River water qualities meets BDU Class 'D' Criteria of CPCB barring few parameters pH & DO which meets class 'A' criteria, i.e. for propagation of Wild life and fisheries

B. **Impact on water quality & land due to dredging operations:**

Impacts: Impact of dredging on water quality are increase in turbidity; reduced light transmittance; reduced DO; changes in salinity, temperature, pH & concentration of nutrients and release of heavy metals/chemicals. As per a study, DO level comes down suddenly by 2 to 2.5 mg/l for maximum of 2 minutes only at the dredge plume arrival point which is regained within 3-4 minutes as plume passes. As per baseline study, river bed sediments are non-toxic except in Allahabad to Buxar stretch where Cadmium level is found marginally higher compared to US standard for off-shore sediment disposal. However, this higher level is unlikely to have toxic effect on aquatic life considering the sensitivity level to cadmium exposure (short terms at LC_{50} level) to aquatic life as per Canadian Guidelines[4]. Pesticides are present in traces but much below the safe limit for off-shore disposal. Turbidity of water also increases substantially close to dredging point but it reduces with distance and almost get normalise at a distance of 700 m from dredging point. Coarser sediments settle much faster and at shorter distance. Presence of iron in sediments enhances settling of fine sediments as it acts as coagulant. Land disposal of sediments is anticipated only when sediments are contaminated and in case of Haldia terminal dredging. When the dredged material is disposed on land in form of slurry, excess water drains back to the water body which can affect the water quality.

Key Mitigation Measures: Key mitigation involves reduction in dredging quantity by studying thalweg profiles, bandalling and usage of low draught vessels. Sediment loss can be minimized by wise selection of dredger depending on strata and depth and CSD are proposed accordingly. Selection of size of cutter head and other technical specifications can further be reducing dredged sediment loss.

C. **Impact on water quality due to barge operations:**

[4]As per Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, 2014

Impacts: Vessels generate garbage, oily waste, sewage, bilge water & ballast water which can affect the water quality of the river. Usage of antifouling paints may also impact the water quality as the paints may contains toxins. Settling of the dust of the material transported on river surface again can impact the river water quality. Ship accidents/collision may lead to spillage of the commodities transported including oil which may impact the water quality of the river.

Key Mitigation Measures: Management of wastewater, oily waste, bilge water, noxious waste (if any), air emissions & garbage from vessels as per MARPOL can prevent the water quality pollution. All maintenance & repair works shall be carried out at designated locations only. Only toxin free paints should be used for anti-fouling purpose. Experienced crew should be hired to minimize the accident occurrence. Information of available LAD in form of electronic charts shall be made available to navigators and intimation of navigational hazards in form of cautionary signage shall be displayed at required locations to minimize the accidents and spillage of material in river. Oil carrying ships (>5000 dwT) shall be double hulled as prevention against oil spills.

D. Impact on river bank & river bank structures due to barge operations:

Impacts: Wave generated due to vessel movement may lead to bank erosion. Impacts are anticipated to be minimal except at Feeder canal which is narrow and have erodible banks.

Key Mitigation Measures: Restricting speed of vessels in narrow stretches & along sharp bends may minimize the erosion. Bank protection and bend straightening works can protect banks from erosion.

10.1.2 Impact on Air Quality and Noise Level

A. Baseline conditions

Meteorology: The predominant wind direction in all IMD stations located along NW-1 is from North and Northwest direction in winters and South and Southeast direction during rest of the season. The wind speed in the area ranges between 1.9 kmph (Patna) and 8.7 kmph (Kolkata). December and January constitutes winter months with daily mean minimum temperature of around 9.1^{o}C at Patna and daily mean maximum temperature of around 26.9^{o}C at Kolkata. April and May are the hottest months with daily mean minimum temperature of 24°C at Malda and daily mean maximum temperature of 40.4^{o}C at Varanasi. Relative humidity ranges between 25 & 84%. The annual rainfall in the project area ranges between 1000.3 mm (Varanasi) and 1728.5 mm (Kolkata).

Air Quality: Ambient air quality monitoring ($PM_{2.5}$, PM_{10}, SO_2, NO_2 and CO) was carried out along NW-1 and within the critical impact zones considered for planned civil interventions as

per CPCB guidelines. PM_{10} level varies from 39 to 145 µg/m^3. PM_{10} levels are within 100 µg/m^3 at all the locations except Varanasi (near bridge), Patna and Howrah. $PM_{2.5}$ levels ranges from 16 to 58µg/m^3 and are within the CPCB limit of 60 µg/m^3. Level of SO_2& NOx ranges from 4.4 to 35.6µg/m^3 and 9.0 to 48µg/m^3 respectively and are within the prescribed limits of NAAQs, 2009. CO is detected at Haldia, Howrah, Patna and Varanasi only. The 8hrs CO level at these locations ranges from 0.18 to 1.2 mg/m^3 and are within limits of NAAQs, 2009.

Noise Quality: Noise level monitoring is carried out along NW-1 and within the critical impact zones considered for planned civil interventions as per CPCB guidelines. Ambient noise levels at all monitored locations are found within the prescribed Standards of CPCB as per land use except at Kashi turtle sanctuary because of anthropogenic activities like worship, bathing etc.

B. **Impact on Air Quality due to dredging and Barge movement**:

Impacts: Barges also generate the emissions but generation of emissions by barges is far less as compared to road and rail for transportation of same quantity of cargo for same distance. Thus impacts on air quality are anticipated to be positive. As per analysis there is reduction in emission generation of all the pollutants. Comparative analysis of emissions due to three different modes is given below in **Table 4.**

Table 4: Comparative Analysis for Air Pollutants by Different Modes

Mode of Transportation	**Emission Load(Tonne/day)**				
	NOx	**SO2**	**CO**	**PM**	**HC**
Railway (Diesel Engines)	7.78	3.50	2.91	1.36	1.36
Road	27.38	3.59	10.79	4.40	7.59
IWT (For inland vessels)	6.39	0.98	2.70	0.49	1.23

Source: Analysis done using emission factors[5]

Key Mitigation Measures: Material generating dust shall be transported in covered conditions. Regular maintenance of vessels engine and propellers may significantly cut down air emissions. Adaptation of cleaner fuels like LNG can be explored.

C. Impact on Noise Levels due to dredging and Barge movement:

Impact on noise quality w.r.t air due to barge movement will be negligible and will be far less when compared to road & railways. Intermittent noise of high level may be generated only when hooters are used as warning during navigation. Noise levels w.r.t air generated due to dredging operations at source will vary from 80-90 dB(A). Noise levels reduces to 70 dB(A)

[5] The Environmental Effects of Freight, Organization for Economic Co-operation and Development, Paris and Air Quality Monitoring Research Association of India "Air Quality Monitoring Project-India Clean Air Programme (ICAP), CPCB/MoEF & EPA emission factors for rail locomotives, commercial

at distance of 100 m, 64 dB(A) at distance of 200 m and to 56 dB(A) at distance of 500 m from source. Dredging will be carried out within the navigation channel only thus the impacts of the dredging noise on the nearby settlements are insignificant only. Also dredging operations will not be carried out after 10:00 pm. Several measures are proposed to manage the noise environment of the area.

Apart from noise levels w.r.t air, high level underwater noise is generated due to dredging & barge movement. This noise has impact majorly on aquatic flora and fauna and underwater noise impacts are discussed in detail in section impact on aquatic ecology

Key Mitigation Measures: Regulation of the dredging operations between 6:00 am to 10:00 pm only, dredgers should be regularly serviced and maintain to prevent noise generation due to friction, dredgers should be fitted with noise masking equipment to reduce the noise levels, barges should use hooters as and when required, i.e. for safety of fishermen and other ships. Noise from dredgers can be reduced at source (dredger) by isolation of exhaust system, by keeping engine room doors shut and by shielding.

10.1.3 Impact on terrestrial and aquatic ecology

A. Baseline Conditions

Critical Environment Resources (CERs): Wild life sanctuaries namely Kashi Turtle Sanctuary (Varanasi, U.P.), and Vikramshila Gangetic Dolphin Sanctuary (Bihar) lies within the NW-1 stretch. Hilsa Sanctuary notified under Fisheries Act with the aim of increasing productivity of Hilsa fishes are located at 4 locations in West Bengal Stretch. Apart from this there are 6 nos. of important bird areas including Udhwa bird sanctuary located within influence area (10 km) of the NW-1 stretch. RET species like Gangetic dolphin (Schedule-1) and fresh water turtle species are present in the river stretch of the NW-1.

Terrestrial Flora: There is no major forests area present along the NW-1. The riparian flora consists of commonly found trees, shrub and herb species. No rare and endangered plant species observed in the riparian area of the NW-1.

Terrestrial Fauna: As no major forest area is present along the NW-1 stretch the terrestrial fauna is restricted to commonly found terrestrial faunal species. No Schedule-I terrestrial mammals species observed along the NW-1 stretch. However, 6 IBA located within influence area of NW-1 are the major wintering site for many of migratory water birds. Some of the rarer/endangered/vulnerable avifauna has been reported in these IBA's.

Aquatic Flora & Fauna: The aquatic floral and faunal diversity of NW-1 stretch comprise phytoplankton, zooplankton, zoo-benthos, fish and higher vertebrates. Phytoplankton is represented by Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, Xanthophyceae and Rhodophyceae groups. Dominance of Bacillariophyceae members

followed by Chrophyceae and Cyanophyceae was observed in NW-1 stretch. Zooplankton comprises of Protozoans, Rotifers and Crustaceans. Phytoplankton and zooplankton diversity is little higher in Farakka to Haldia stretch in comparison of Allahabad to Farakka stretch. Macro benthos and Macro-invertebrates constitute Annelida, Arthropoda insects and Mollusca. Fish in the NW-1 stretch is represented by total of 106 species. The higher aquatic vertebrates present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanistagangeticagangetica*) which is categorized as endangered species (Schedule-I) and few endangered and vulnerable species of fresh water turtle.

B. **Impact on Aquatic Ecology due to maintenance dredging:**

Impact: Impact of dredging on aquatic ecology are change in diversity of benthic habitat, impact on behavioural response & tissue injury of aquatic organism due to increased noise levels, blocking of fish gills due to increased sediments, intake of toxic pollutants by aquatic fauna as released during dredging, smothering of benthic flora & fauna due to dredge disposal and loss of SAV due to increased depth due to dredging. Noise generation from CSD is 160-180 d(B) and behavioural disturbance criteria for dolphins, turtles, fishes (>2 gm) & fishes (<2 gm) from any continuous noise exposures are 177 dB, 150 dB, 186 dB & 183 dB respectively. In addition, no dredging operations are proposed within or in vicinity of Kashi Turtle Sanctuary and Vikramshila Dolphin Sanctuary that minimise the possibility of the impact of dredging on such vital sensitive organisms. Thus the dredging operations noise will not lead to any significant impact on aquatic organisms.

Key Mitigation Measures: Restricting dredging in biological sensitive locations like VGDS & Kashi turtle sanctuary; and during breeding &spawning season of fishes and migratory bird season may minimize the impact on aquatic fauna significantly. Reduction in dredging noise through regular servicing & maintenance of dredgers and usage of bubble curtains can significantly reduce underwater noise. Usage of bubble curtains can reduce underwater noise to app. 10 dB.

C. Impact on aquatic ecology due to barge operations:

Impact: Impact of barge movement on aquatic ecology can be due to speeding vessels, spillage of material transported (oil majorly) and generation of high level underwater noise. Vessels if moving in high speed can collide with aquatic organisms leading to mortality and injury to aquatic organisms. Spillage of material transported can impact the habitat of the aquatic species. Oil spills are most significant among all spills as oil can form a layer breaking contact between water & air and reducing DO level, block gills and skin pores of aquatic organisms leading to mortality. Barge of size 1500-2000 dWT are expected to move in the waterways which generate noise levels of 110-180 dB as per speed. Speed is

however restricted in sanctuary area to 5 kmph and noise levels will be maximum 140 dB. Tolerance level for behavioural response of turtles and fishes are 150 dB & 177 dB. Thus impact of vessel movement on dolphins and turtles is not anticipated. However underwater noise modelling, considering noise generation of 160 dB is carried out and it is found that noise levels will attenuate to 150 dB at distance of 4.6 m from vessel. Another impact on aquatic species is masking of biological important sounds. Echoclation clicks of dolphins have dominant energy around 65 kHz and are beyond the man made frequency range thus impact is not significant. However, communication signals lie in same frequency range as of man-made noise and can be masked but they are naturally masked many times by the natural noise environment of water.

Key Mitigation Measures: Restricting speed of vessels in sanctuary area can maintain noise levels lower than 140 dB which are lower than tolerance levels of turtle and dolphins thus minimizing impact of noise on turtles and dolphins. Vessels shall be fitted with propeller guards and dolphin deflectors to minimize dolphin accidents.

D. Impact on Avifauna due to maintenance dredging:

Impact: Impact on avifauna is anticipated due to disturbance of the habitat due to dredging & disposal of dredged material on banks/shallow waters and increased ambient noise levels due to dredging operations. Noise level of 85 dB(A) are generated during dredging which dissipates within 500 m distance making impact localized.

Key Mitigation Measures: Restricting dredging operations during day time (6:00 am-10:00 pm) & during migratory season of birds near locations of IBAs will minimize the disturbance to resting avifauna during night time. Regular maintenance and servicing and usage of noise mufflers with dredgers can significantly reduce noise levels. Isolation of exhaust system and by keeping engine room doors shut and by shielding dredging noise can be reduced further. Onshore disposal, if required shall be undertaken only on TSDF.

10.1.4 Impact on Socio economic and cultural aspects

A. Baseline Conditions

NW-1 traverses through four states: Uttar Pradesh, Bihar, Jharkhand, and West Bengal. There are various densely populated areas located along NW-1 such as Allahabad, Farakka, Sahibganj, Berhampur etc. As per the Census, 2011, population of the major cities & towns along NW-1 is 1,28,75,343 (67,82,150 male & 60,93,193 females) and the total numbers of Households are 2562165, population between 0-6-year age is recorded as 13,08,682. Being project of such large spatial extent, NW-1 interfaces with various archaeological, social and cultural sensitive and important locations. There are 9 archaeological important sites along NW-1 but no activity at present is proposed to be

undertaken within 300 m of these sites. Ghats at Patna and Varanasi are another socially important features which will be impacted due to project. However, measures are proposed to minimize such impacts. There are several festivals such as Kumbh at Allahabad (Jan-Feb), Ganga Mahotsav at Varanasi (Oct-Nov), Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March), Chatt at Bihar & Jharkhand (Oct-Nov) and Ganga Sagar Mela at Sagar (January) are being celebrated at NW-1. Due to barge operation and dredging activities there could be interference in these celebrations. Mitigation measures are proposed to be undertaken to minimize such impacts.

B. Impacts on Socio-economy due to maintenance dredging:

Impact: Impact of Dredging & disposal of dredged material are anticipated on cultural &archaeological important locations and on livelihood of fishing community. Dredging operations may impact socio-economy by disrupting fishing & boat movement, generating high noise levels near dredging location, increased river water pollution, unpleasant view and increased air pollutants. These impacts are however short term and localized as will be restricted to dredging locations only. Dredging activity also pose threat to health & safety of the workers and other waterway users.

Key Mitigation Measures: Dredging will be restricted in biological & social sensitive location and at time of occurrence of fest/festival at ghats, during breeding & spawning season of fishes and during migratory bird season can minimize the impact on socio-economy. Timely intimation to fishermen about dredging operation and location can minimize the disturbance to fishermen. As enhancement fishermen can be provided with trainings by institutions like CIFRI to learn better fishing practices and available aids for fishing which will help them to enhance their livelihood. Measures for accident risks during dredging and arrangement of all first-aid should be available at dredging locations all the time.

C. **Impact on Socio-economy due to barge operations**:

Vessel movement are subjected to various threats of accidents related to natural disasters like flood or cyclonic and operational hazards like Collison, fires and spillages. However, these accidents can be reduced by taking the below proposed mitigation measures

Key Mitigation Measures: Provision of night time navigation system, maintenance dredging, adequate and efficient river information system, vessel tracking system, Electronic Charts Display Information System - ECDIS, and Automatic Information System – AIS can minimize the accidents. Most of these measures are already under implementation by IWAI in some stretches of the NW-1 and there is proposal of extending these facilities to entire

NW-1. All safety regulations as per SOLAS should be followed to maintain safety during navigation and minimize accidents.

Enhancement Measures: Support for promoting fish productivity through setting up or supporting existing fish nurseries. Also providing training and awareness support through reputed institutes or experts like CIFRI for better fishing techniques and Provision of supporting Studies for conservation of Dolphin and other sensitive studies shall be made.

10.2 Impact & Mitigation Due to Civil Interventions

Impacts due to civil interventions are expected to occur during the design, construction and operation stage of the project. Impacts due to civil interventions during different phases are discussed below

Impact during design phase:

Activities to be carried out during design phase which can impact the physical, biological and social environment are site clearance & preparation, acquisition of land & change in land use land cover. Major impacts anticipate are Removal of vegetation & tree cutting, Unpleasant view, Increased GHG emissions due to operation of construction vehicle/machinery & removal of trees, Impact on regular day to day activities in area of development due to shifting of utilities, Impact due to change in land use, Impact on drainage, Loss of households, land and assets and Loss of income source and impact on quality of life

Key Mitigation Measures

Tree cutting should be minimized by efficient planning of the interventions. Permission from forest department is essential prior to cutting of trees besides, compensatory plantation to be carried out as per respective state forest policy. Restoration and rehabilitation of locations occupied or used for construction purposes immediately after the given task(s) is over. Dedicated approach roads and improvement of haul roads should be considered to minimize the traffic congestion and air emissions. Traffic management should be undertaken to avoid peak hours. Utility shifting should be carried out during or prior construction phase but without disrupting service to public. Necessary permissions from the area development authorities and local bodies should be obtained prior development of proposed interventions. Natural drainage pattern should be maintained by provision of adequate drainage. Compensation should be given to affected households as per R & R Act, 2013.

Impact during construction phase

Activities to be carried out during design phase which can impact the physical, biological and social environment are construction activities, material transportation and operation of machinery & construction equipment. Major impacts due to these activities are Loss of top

soil, Soil contamination due to spillage of material, Bank Erosion/bed scouring, Surface water contamination due to increased run-off from construction site, High noise levels and disturbance to nearby habitation, Traffic jams, wear & tear of existing roads, increased accidents and air pollution, Unpleasant view due to construction activities, construction material storage and waste storage, Health & safety of Workers and people in nearby areas, Quality of Life, Mortality, disturbance to habitat and change in behavioural response and Tree cutting & vegetation removal

Key Mitigation Measures

The top soil shall be preserved and used for landscaping purpose and shall be given to farmers in nearby areas, if asked by them. Clean up operations shall be taken up immediately after spillage of any material. Debris and excavated earth should be disposed-off as per defined plan. Provision should be made for Septic tank & soak pit/STP, maintenance waste collection and treatment before reuse. Concreted floor for storage of fuel and oils shall be proposed. Excavated earth shall be reutilized to the extent possible in the construction activity and balance will be used for road construction or disposed for designated places like mines in case of Sahibganj. Bank/scour protection works required at planned and under planning civil intervention locations. Adequate shore & scour protection measures should be taken at Sahibganj terminal, Varanasi terminal and Farakka Lock site. Provision of acoustic enclosures for DG sets to reduce noise levels. Noise causing activities should not be carried out close to settlement areas and during night hours. Haulage roads/approach roads to be used should be maintained regularly. Restoration and rehabilitation of the areas occupied or used for construction purpose immediately after use is over. Preparation and implementation of emergency preparedness and response plan and contingency plan by contractor. Implementation of proposed environment management plant to minimize the environmental pollution and stress on existing infrastructure resources. Management of surface run-off to prevent from mixing with contaminant, provision of storm water management system, provision of sediment traps, oil interceptors with storm water drains in parking areas. Impact of piling & construction dredging should be managed by adoption of vibratory piling and usage of bubble curtains to disperse the fauna and reduce the noise level.

Impact during operation phase at intervention sites

Activities to be carried out during design phase which can impact the physical, biological and social environment are barge mooring & berthing, operational activities at terminal site and discharge of waste/waste water from intervention sites. Major impacts anticipate are Increased GHG emissions near the terminal/jetty locations due to increased material transportation and dredgers operation, Increased pollutant emissions near the terminal/jetty locations due to increased material transportation and dredgers operation, Generation of

employment, Infrastructural development, Increased run-off from site, Increased noise levels and disturbance to nearby residents & Polluted water quality

Key Mitigation Measures

Development of thick green belt area and avenue plantation at all proposed intervention sites. Provision of sprinklers and dust suppressors at terminal sites for dust suppression should be made at site. Employment should be given to local people preferably. Skill development trainings can be undertaken for locals to train them for jobs. Storm water drainage should be collected and reuse for dust supersession. Sewage should be treated in STP constructed at site and treated water should be used for dust suppression and horticulture.

10.3 Impact on Climate Change

IWT mode is most efficient and environmental friendly mode of transportation, involving least CO_2 generation when compared to rail & road. Analysis is made to estimate the CO2 emissions from different mode of transportation for transportation of same quantum of cargo for similar distance. It is estimated that to carry freight of app 19000 metric tonne from Haldia to Varanasi, CO_2 emissions of 770.95 TPD, 234.46 TDP, 220.67 TPD & 159.71 TPD will be generated from road, railway diesel, railway electric and IWT mode respectively. Thus positive impacts are anticipated on the climate due to reduction of GHG emissions.

10.4 Impact on Indo-Bangladesh Water Sharing Treaty (Riparian Treaty)

The impact on Indo-Bangladesh water sharing treaty was analysed in terms of water flow to Bangladesh and impact on aquatic ecology and sedimentation load due to NW-1. This impact was analysed nil since no water storage or diversion structure is proposed under Jal Marg Vikas Project. Aquatic life is already fragmented due to Farakka barrage and no change is expected due to Jal Marg Vikas Project as its route diverts to feeder canal through navigation channel (Farakka navigation lock) at Farakka.

10.5 Cumulative Impact Assessment

Cumulative Impact Assessment (CIA) of NW-1 from Allahabad to Farakka has been carried out for (a) analyzing the potential impacts and risks of proposed, indirect & induced developments in the context of water flow, water availability and water quality, considering human activities and natural environmental and social external drivers on the chosen Critical Environmental Resources (CERs) over time, and (b) proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible in the influence area (10 km) on both sides of the NW-1. At first Cumulative opinions of various stakeholders which are directly & indirectly impacted due to proposed development, and extensive review of the consolidated EIA report & basin critical resources

study of the proposed project has been carried out to identify the CERs. Further, overlay mapping and GIS have been extensive used for identifying the spatial distribution of CERs. Also indicators have been identified which can determine status/conditions of CERs. Baseline study has been conducted to assess the existing condition or status of the identified CERs based on these indicators in the study area. Further CERs under stress have been identified and are termed as hotspots. Also nature of the impacts due to proposed/planned & anticipated development on these hotspots has been assessed. It has been found that cumulative impacts due to proposed development of NW-1 on the hotspots will not be significant. Further, impacts triggered due to induced & indirect development can be mitigated & monitored due to construction & operation stage of the project.

11.0 Environmental Management Plan

The Environmental Management Plan (EMP) is a plan of actions for avoidance, mitigation and management of the negative impacts of the project and enhancement of positive impacts. The detailed intervention and activity specific plans for Maintenance dredging, barge operations, civil interventions are given at Chapter 7 in EIA Report. EMP includes the environmental monitoring plan (specifying the parameters, frequency and responsibilities of monitoring), institutional framework, reporting requirements, auditing requirements, training awareness and capacity building programme, grievance redress mechanism and environmental budget.

Institutional Framework of IWAI: IWAI has set up a project management unit which is staffed with Environmental and Social specialists. These specialists would work as an environment and social cell (ESC) within PMU. It is proposed that each field unit will have one designated officer responsible for environment and social aspects who will also coordinate with ESC. The responsibility of ESC will be (i) review and inspect implementation of the EMP; (ii) implementation of the environmental capacity building and awareness programme; (iii) coordinating with field units(iv) Reviewing and ensuring effective implementation of EMP and regulatory compliance by contractor, and IWAI and (v) managing the environmental reporting, and audit process. Contractor will be responsible for implementation of Environmental Management Plan and ensuring health and safety of the construction workers at site during pre-construction & construction phase of the project

Reporting Requirements: Contractor would be required to submit monthly and six monthly reports containing the status of environment, health & safety at site to PMC (Project management consultant) & PMU of IWAI. PMC will be responsible for construction supervision and ensuring effective implementation of EMP by the contractor. PMC shall report to PMU monthly about the performance and effectiveness of the EMP implemented by contractor on site and coordinate with filed units and PMU for necessary corrective actions as may be required. IWAI will also organise an independent Environment Audit

which will be submitted to Bank within 3 months of completion of the second and fourth year of implementation period.

Training & Capacity Building Programme: IWAI has already taken actions to augment the capacity of project management unit (PMU). A capacity building and training programme has been prepared which includes training of staff of Environmental and Social cell of PMU, contractor's staff (labours & engineers), PMC staff and IWAI staff on environmental management, regulatory compliance and safety aspects.

Environmental Budget: Adequate environmental budget provision has been made for the implementation of the EMP. The overall budget is INR 49.91 Crore. A detailed breakup is given in **Table 5**.

Table 5: Environmental Budget

S.No.	Description	Amount
1.	**DESIGN AND CONSTRUCTION STAGE**	**Rs in INR**
	Technical Support of preparation of guidelines, bio-diversity conservation plan for turtle and dolphin sanctuary and performance indicators	90,00,000
	Compensatory tree plantation (7000 trees) Additional tree plantation for GHG sink (18000)	15000000
	Measures to Reduce GHGs by Green buildings certification & additional tree plantation under plantation head	90,00,000
	Storm-water and wastewater management/ Construction of soak pits/ clean drinking & domestic water facility/ STP construction, Zero Discharge management	44000000
	Provision of trainings and PPE to workers	1,72,00,000
	Health check-up camps for construction workers	3,20,00,000
	Enhancement Measures Institutional Support for Vikramshila Wild Life Sanctuary through reputed institutions Support Fish productivity enhancement through fish nursery development and training fishermen Bath shelter for women along NW-1 for maintaining privacy from vessel movement Support for cleanliness at Ghats and improvement of Ghats	12,60,00,000
	Environmental Monitoring in the construction phase: Terrestrial and Aquatic Fauna, Ambient Air Quality, Surface Water Quality, Drinking Water Quality, Noise & Vibration, Soil Quality, Erosion & Siltation and River Bed Sediment	58080000
	Drainage Congestion and disposal of accumulated water/ Erosion & Sedimentation/ Reduction in dredging requirement Land/ Soil/ Noise/ Air Quality -Dust Management during construction Appointment of Safety Officers, Safety signage, fire-fighting measures & water ambulance etc.	Covered in project design and engineering cost
	SUB TOTAL (Design & Construction stage)	**310280000**
2.	**OPERATION STAGE**	

S.No.	Description	Amount
	Monitoring of performance indicators viz. Terrestrial and Aquatic Fauna including surveillance audit, Ambient Air Quality, Surface Water Quality, Ground Water /Drinking Water Quality, Noise & Vibration, Soil Quality, River Bed Sediments, Soil Erosion & Siltation, Integrity of embankments	59040000
	Emergency Preparedness: Accident Response: Ambulance equipped with requisite emergency medical aid facility, First Aid Facility, Fire-fighting Equipment, Safety Trainings, Mock Drills etc.	6,79,00,000
	Waste Water Management (STP Operation, rainwater harvesting management and maintenance)	2,16,00000
	Storm Water Management System & Waste Management System, Erosion Control and landscaping, Reduction in GHGs	To be part of OM cost
	SUB TOTAL (Operation stage)	**1,48,540,000 Or say 14.85 Cr**
3.	**ESTABLISHMENT & TRAINING and MANAGEMENT SYSTEM)**	**1,65,00,000**
4.	**SUB TOTAL (Construction + Operation + Establishment)**	**47,53,20,000 Or say 47.53 Cr**
5.	**CONTINGENCIES @ 5 % on total Environmental Costs**	**2,37,66,000 2.38 Cr**
6.	**GRAND TOTAL (in Rs)**	**499086000 Or say 49.91 Cr**

12.0 Conclusion & Recommendations

The development of project “Jal Marg Vikas” is beneficial for the economic development of country and environment due to expected model shift of cargo movement from rail and road to IWT. With the effective implementation of the proposed mitigation measures and environment management plan, anticipated negative impacts of project can be minimised and benefits further enhanced. The project will overall bring development in the area.

It is recommended that IWAI should provide desired resources for implementation of EMPs and ensure that EMPS are effectively implemented. It must institutionalize the system of period monitoring against the defined performance indicators and establish the system of half yearly reporting. It should also develop its own EHS guidelines and protocols for managing all the projects uniformly from environment health and safety prospective. System should be self-responding in nature for initiating timely corrective and preventive action if any required for the protection of environment.

CHAPTER 1. INTRODUCTION

1.1. Project Background

The cargo movement through waterway is considered one of the cheapest mode of transportation internationally which is very low in India compared to the international scenario. To augment the capacity of waterways transportation in India, Govt. of India has constituted Inland Waterways Authority of India (IWAI) through IWAI Act in 1985. Since then IWAI, with the empowerment under above mentioned Act, has identified potential waterways and has further undertaken the task to develop, maintain and regulate the waterways for navigation. IWAI has also declared following five waterways as the national priority:

- NW-1 -The Ganga (Haldia to Allahabad-1620 km)
- NW-2- The Brahmaputra (Dhubri to Sadiya-891 km)
- NW-3 The West Coast Canal (Kottampuram to Kollam with Udyogmandal and Champakara canals- 205 km)
- NW-4- The Kakinda-Puducherry stretch of Canals with Godavari & Krishna Rivers (1078 km)
- NW-5-The East Coast Canal with Brahami Rivet and Mahanadi Delta (588 km)

Amongst the above five waterways, the national waterways on Ganga (NW-1 between Haldia to Allahabad) is the longest waterways (1620 km) and is of prime importance considering its locational advantages. IWAI since long has been maintaining the least available depth (LAD) of 3m between Haldia and Farakka (560km), 2.5m in Farakka – Barh (400km), 2m between Barh – Ghazipur (290km) and 1.2 to 1.5m in Ghazipur – Allahabad (370km). Even currently this waterway (NW-1) is being used for various cargo movements, as well as tourists. Already good amount of cargo movement is taking place between Haldia and Farakka (e.g. 3 million metric tonne of imported coal from Haldia to NTPC plant is being transported since October 2013 through 20 barges of 2000 dwt capacity each). Considering such a large potential and demands, IWAI has initiated the project of “Capacity Augmentation of National Waterway-1” between Haldia and Allahabad named as “Jal Marg Vikas Project”. The capacity building of this magnitude under this project warrant’s number of additional infrastructural components (such as construction of terminals for cargo handlings, provision of navigation aids, river information systems) which are required to be developed in a phased manner. The locational overview of NW-1 is shown at **Figure 1.1**.

Figure 1.1 : Location Map of NW-1

1.2. Need of Jal Marg Vikas Project – NW-1

Inland Waterway Transport (IWT) offers a comparatively low cost and environmentally sound alternative to road and rail transportation especially for bulk and containerized cargo. Infrastructure requirements of IWT in comparison to road and rail transport are also relatively low, although some investments are essential such as in port/terminal facilities, connecting road/rail infrastructure, navigation aid and dredging facilities etc. While cargo movement through other modes of transportation are often confronted with congestion and capacity problems, IWT offers a relatively congestion free and reliable mode of transport along with availability of unmatched capacity expansion due to its large untapped potential.

Till the middle of 20th century, IWT was being used as an important mode of transport in various parts of India but gradually it got confined to unorganized sector except in few states namely Goa, Assam, West Bengal, Kerala and Mumbai primarily due to focus shift in transportation through rail and road modes. However, IWT use had picked and showed increasing trend since 2003-2004 and touched 70 Million tonnes mark by2011-2012 compared to only 32.48 Million tonnes in 2003-2004 which is just 0.34% of total inland cargo movements of about 1000 btkm. IWAI has set the target of increasing IWT share up to 2% of total inland cargo by 2025. The main commodities carried by IWT (which are also true with NW-1) include building materials (34%), metals\ores (19%) and

coal\coke (17%). On demand side in the case of NW-1 (Allahabad – Haldia) alone 10 thermal power plants are located along Ganga river in UP & Bihar stretch and 11 more are expected to become operational soon. The total requirement of coal for these power plants will be nearly 70 million tonnes per year, 14 MT of which will have to be imported. In addition to this, there are seven fertilizer plans along NW-1. These are also estimated to generate an additional of 0.765 million ton of cargo requirement per year. Further, there is also large prospect of container movements for national as well as international trade. It is therefore obvious that IWT and NW-1 in particular would play a very vital role when high quality ports/terminals and waterway connections are made available to facilitate the cargo movement in a cost effective and environmental friendly manner catering to the needs of high transportation movements due to enhanced industrial activities as compared to rail and/or road modes.

Economic Advantage: The economic advantages of this mode compared to other surface modes have been emphasized by a number of high-powered Committees including the National Transport Policy Committee (NTPC) (GOI, 1980), the Steering Committee on Transport Planning (GOI, 1987) and a number of reports and studies (NCAER, 1974, UNDP, 1993, Rao and Kumar, 1996). Some of these studies also pointed out the potential role of connectivity that this mode could perform besides cargo movements, like providing access and connectivity to far- flung areas and the maintenance of ecological balance. The cost advantages include:

- **Low capital Cost**-Cost of development of inland waterways is estimated to be a mere 5-10 percent of the cost of developing an equivalent 4-lane highway or railway. Cost for transportation of cargo through various modes is given in **Table 1.1** below in reference to the "Report of the Inter–Ministerial Committee to Identify New Areas of Private Investment in the Inland Waterways Transport (IWT) Sector" Planning Commission, (Transport Division)

Table 1.1 : Cost of Transportation Through Different Modes

Mode	VOC/Freight (Rs/Km)	Taxes	Total Rs/TKm
Railway*	1.36	3.71%	1.41
Highways**	2.50	3.09%	2.58
IWT	1.06	Nil	1.06
Source: Railways-Ministry of Railways, Road-TTSS, IWT-IWAI * Service Tax on rail Transport is 12.36% abatement is 70%			
**Service Tax on Road Transport is 12.36% abatement is 75%			

- **Low maintenance cost** -Cost of maintenance of inland waterway is about 20 percent of that of roads.
- **Low Operation Costs** – This is also least costs mode of transportation. According to Ministry of Railways, the freight costs by IWT are estimated as 1.06 Rs/ tkm compared to 1.41 Rs / tkm by railways and Rs 2.58 Rs/ tkm by highways**.**
- **Large Cargo Potential** – There is large cargo potential generation from areas along and close to NW-1 but the transportation facilities are insufficient. The potential can be judge from few of the following need:

- NW-1passes through Kolkata which is having connectivity with other states/cities and country through road and railway. Such place offers an appropriate location for development of cargo. Cargo generated at Kolkata or brought in to Kolkata from nearby areas through road/railway can be further transported to other destinations through NW-1 at lower cost
- U.P. & Bihar is large agricultural belt and have high potential of producing wheat. This wheat transportation can be undertaken through NW-1 to other parts of the country
- There are about 9 existing Thermal Power Plant (TPP) around NW-1 and 15 TPP under construction having total power generation potential of 21820 MW. Total coal requirement of these projects is 94.78 million tons per annum. Out of which imported coal requirement is 21.4 million tons per annum. At present on 3 million MTPA of coal is being transported to Farakka STPS. Coal is transported to these existing TPP through railways and all existing TPPs have their own railway siding. Imported coal is brought at Paradeep and Haldia ports. Further adequate depth is not available at Haldia port so 70% of coal is received at Paradeep port only. From these ports, coal is transported to destined locations through railways. However due to constrain capacity of railways, these power plants regularly face shortage. Pressure on railways will further increase after development of the 15 more TPP. NW-1 thus will serve as mode for transportation of coal to above listed TPPs will reduce burden on railways and reduce the gap in demand and supply of the coal.
- Jharkhand is one of the major coal producing state of India and is endowed with app. 80 billion tons of coal of all categories. App. 70 MT of coal is transported to various part of the country from Jharkhand. Coal transportation from Jharkhand can be taken through NW-1 through destined locations
- TPPs located around NW-1 will generate fly-ash which serves as raw material for cement plants and road construction. Fly-ash thus can be transported through NW-1. Assuming 25% of ash content in coal, it is estimated app. 24 million tone of fly-ash will be generated per annum.
- Large quantity of cargo of construction material, fertilizers, coal, minerals and chemicals, project cargo, food & food stuff, containers and vehicles are transported across NW-1 through road & railway. These commodities if transported through NW-1 can significantly cut down the emissions and transportation cost.
- Planning of IFFCO to use NW-1 for transportation of fertilizers produced at Paradeep plant to U.P. & Bihar

Environmental Need: Potential for Fuel Efficiency and GHG Emission: As per an estimate, 1 horse power can carry 4,000-kilogram load in water compared to 150

kilograms and 500-kilogram load by road and rail respectively. In one study[6] it is estimated that 1 litre of fuel can move 105 ton-km by inland water transport whereas the same amount of fuel can move only 85 ton-km by rail and 24 ton-km by road. By air, it is even less. Similarly, if we compare transportation of liquid cargo, the water transport can carry up to 827 Km (514 Miles) in one gallon of fuel against 95 KM (59 miles) and 523 Km (325 Miles) by road and rail transport[7] respectively. The higher energy efficiency of IWT compared to road haulage contributes to less fossil fuel consumption and therefore to less emission of CO_2, NO_x, SO_X and PM. In cases where IWT can provide alternatives for road haulage operations it can contribute to a reduction of polluting matters. The only disadvantage to IWT may be due to associated environmental impacts on aquatic life but the same is manageable with appropriate mitigation measures.

Similar to NW-1, IWAI has declared other river systems as national waterways. IWAI has planned to interlink these waterways so as to facilitate transportation of material from one waterway to another. However, all the waterways declared cannot be linked but as per study of RITES, it is possible to link four waterways out of 6 declared waterways. NW-1 can be connected to NW-2 and NW-6 using protocol route through Bangladesh. Similarly, NW5 that extends up to Paradeep Port can also be joined in the National Waterway grid through backwaters of Hooghly and Hijily tidal canal. Connectivity would further increase the area of influence of each designated waterway system. Proposed National Waterways Grid involves overall rivers length of 3220 km (excluding Indo-Bangladesh Protocol Route). Grid is likely to serves 11 states namely; Uttar Pradesh, Bihar, Jharkhand, West Bengal, Assam, Meghalaya, Arunachal Pradesh, Tripura, Mizoram, Manipur and Odisha serving 108 civil districts. Interlinking of waterways and formation of grids is however not component of this project but a proper navigable waterway is requirement for execution of such large programme. Water way development programme onNW-1 named as “Jal Marg Vikas Project” will help in execution of national waterway grid formation project.

1.3. Overview of NW-1

IWAI under Jal Marg Vikas Project – NW-1 proposes to improve the capacity of entire stretch and continue to maintain the waterways of entire stretch between Haldia to Allahabad. However, considering the available LAD and cargo demand scenario, IWAI is

[6] As per *German Federal Waterways and Shipping Administration*, *http://www.efficiency-from germany.info/ENEFF/Navigation/EN/Energyefficiency/Transport/InlandWaterways/inland-waterways.html*

[7] Tennessee Tombigbee Waterway, http://business.tenntom.org/why-use-the-waterway/shipping-comparisons

focusing on the stretch between Haldia to Varanasi at present. The capacity augmentation project primarily proposes development of the following infrastructural facilities:

- Construction of terminals of appropriate cargo handling capacity and Equipment for facilitating integration with other modes of transportation. Three terminal sites and one lock site have already been identified namely terminals at Haldia, Sahibganj& Varanasi and new lock site at Farakka. Tribeni and Ghazipur are identified potential sites for terminal development. One more site is to be finalized for development of terminal
- Provision of all types of navigation aids for day and night navigation.
- River information system with all hardware and software
- Provision of RO-RO Jetties
- Provision for bank protection / slope protection
- Provision of river training works for critical locations
- Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment
- Dredging facilities for maintenance of waterways
- Barge Maintenance & Repair Facility

Some of the above facilities are finalised and some are in the process of identification and design.

1.4. Objective of EIA study

The implementation and development infrastructure facilities as mentioned above under this project will cause various associated environmental & social impacts. The objective of this study primarily focuses on identification, assessment and quantification of the all significant impacts and their mitigation to bring them within acceptable threshold associated with all stages of project implementation namely- design, construction and operation phases of project implementation. The likely impacts are first identified for all project implementation activities with respect to physio-chemical, ecological and social environments. Institutional mechanism is also proposed to make the implementation effective to ensure that there are no significant impacts left by incorporating the requisite EMP and EMoP. Attempts have been made to identify impacts for potential activities and measures suggested to be incorporated in the design as feasible. These measures will be further updated once design aspects are fully finalised.

Since the project is being developed with support and funding from the World Bank, the EIA study framework adopted is in accordance with the operational policies of World Bank, as well as the requirements defined under Environmental Impact Assessment Guidance Manual on Ports and Harbours and Guidelines (MoEF&CC), for carrying out such EIA study.

1.5. Extent and Limitation of EIA Study

The Environmental Assessment was done in tandem with the preparation of Feasibility Report of the proposed project design. Design details and detailed layout plans of various proposed infrastructural facilities and civil interventions associated with NW-1 implementation are not yet finalized for all the components. Therefore, the EIA is based on up-to-date project details provided by the engineering consultant during the preparation of the report[8], primary field investigations / assessment, secondary data collated from different Gov. Departments (centre as well as of four states as UP, Bihar, Jharkhand and W. Bengal). The secondary data/information was collated from agencies such as Inland Waterways Authority of India, State Pollution Control Board, Indian Meteorological Department, Public Works Department, Public Health & Engineering Department, District Collectorate, Irrigation Department, Statistic Department, District Fisheries Department, Mining Department, Ganga Pump Canal Nahar Pariyojna Office, Forest Department, published journals\books besides various local bodies. Summary table of secondary data sources concerning different aspects is tabled in the end of this chapter. Inputs from the extensive public consultation (as described in the report) were also taken into consideration. Professional judgement and subjective interpretation of facts and observations has been applied for the preparation of the EIA Report, since the entire project is under various stages of development. As the project is under design phase thus the figures presented for planned and proposed facilities are tentative and are subject to change with the changes proposed to be undertaken by Design Consultant of the project

1.6. EIA Contents

The EIA report is presented in 8 chapters following this introduction chapter.

Chapter 1: Introduction: This chapter describes project framework, objective and background including the need of the project.

Chapter 2: Policy, Legal and Administrative Framework: This chapter deals with the identification & listing of applicable legislations and applicable administrative framework. It also provides screening of applicable operational policies of World Bank and other international practices and guidelines.

Chapter 3: Description of Project: This chapter describes the various project components incorporated in the overall project framework. It also provides details the alternatives analysed before final selection of the most appropriate option having minimal environmental and social impact implications.

Chapter 4: Description of Environment (Environmental profile and baseline of the project and study area): This provides background information based on primary and secondary information for physical, biological, social and cultural resources of project and study areas.

Chapter 5: Anticipated Environmental Impacts and Mitigation Measures: Here first the anticipated potential impact for each environmental and cultural resource are first identified and then quantified. For each potential impact the mitigation measures are

[8] The engineering details may change at detailed project report preparation stage. In the situation of change of the design, the EIA and EMP reports will be updated accordingly.

delineated in order to mitigate the impacts up to the threshold of acceptable residual levels.

Chapter 6: Environmental Management Plan and Grievances Redress Mechanism: This chapter provide the details on the management plans and the institutional mechanism required along with resources required for effective implementation of the proposed mitigation measures and the monitoring framework essential during construction as well as operation period. It also highlights the institutional mechanism as well as capacity building needs for the implementation.

Chapter 7: Information Disclosure, Consultation, and Participation: This chapter highlights the process followed for the public consultation carried out with the various stakeholders namely public, NGO, Government bodies, prominent local bodies upfront of the project implementation initiatives. It also highlights the information generated during this process for incorporating in the final version of the report

Chapter 8: Conclusions and Recommendations: This chapter provide the summary of findings and concluding remarks.

1.7. Methodology

This project is classified as Category 'A' operations under the world bank environmental screening procedures specified under its operation policy 4.01. The project triggers 7 of the World Bank safeguard policy[9] and requires comprehensive environmental assessment. This project does not require any environmental impact assessment as per the existing provisions of Indian Laws. Initially a basin level critical environmental resource study was carried out to identify "NOGO" and "Restricted areas". Input of this study was used for this environmental assessment.

The EIA study was carried out using reconnaissance survey, review of previous studies, field visits, consultation with stakeholders & NGOs, review of existing data and primary data collection. The methodology was evolved considering the defined terms of reference of IWAI for the study. Extensive use of geographic information system is made to analyse the land use, drainage pattern, elevation profile and identify the environmental features of the study area. Topo-sheets as available and Google maps were used for the above. Since it is having strong interface with aquatic ecology, larger emphasis was given for primary data collection with regard to zooplanktons, phytoplankton, fishes and aquatic fauna. Establish sampling, and observation techniques were applied for this assessment.

The scope of the EIA extends well beyond the vicinity of the NW-1. The area considered for collection of data and assessment of impacts is termed as study area for this study purpose. Study area for this project is divided into 500 m, 2 km and 10 km for different parameters depending on their sensitivity and availability. Details of the study area are given below:

[9]The world bank safeguard policies triggered are environmental assessment (OP/BP 4.01), Natural Habitats (OP/BP 4.04), Forests (OP/BP 4.36), Involuntary resettlement (OP/BP 4.12), Indigenous people (OP/BP 4.10), Physical Cultural Resources (OP/BP 4.11) and Project on International Waterways (OP/BP 7.5)

500 m radius: This zone is considered as core impact zone as this zone is likely to have maximum interface with project development. All the parameters of environmental, socio-economy and cultural importance are studied within this zone.

2 km radius: This zone is considered as immediate buffer zone as this will interface with project development but not to the extent of 500m zone. All the parameters of environmental, socio-economy and cultural importance are studied within this zone also.

10 km radius: This zone is considered as extended buffer zone. Parameters studied under this zone include environmental sensitive locations as notified by GoI, land use change, socio-economy, and geology, seismicity& drainage pattern.

Since project is based on river, alternative analysis is undertaken for with and without project, technological aspects and sitting of interventions. Alternate analysis of the sites has been undertaken for selection of sites and infrastructure like roads, railway etc. for proposed interventions under this project. Analysis was carried out considering physical, biological and socio-economic impacts and technical and financial feasibility. Analysis of alternatives has also been considered at planning level of the each proposed interventions. The established practices (like trend analysis, expert assessment, stakeholders' perception and concerns, resource availability) were followed to identify potential impact associated with the proposed project activities. Appropriate tools and techniques (like use of Air Quality and Noise prediction models) were used to identify and predict the magnitude of the impacts. Suitable mitigation measures are suggested based on the intensity of the impacts identified for offshore and onshore activities both. The Environmental Management and Monitoring plan with institutional requirements is also prepared to ensure effective implementation of the mitigation measures proposed.

1.8. Data Collection

The objective of data collection was to provide a database of existing conditions, to be used for predicting the likely changes that are expected and for monitoring such changes. The first step was to undertake a project scoping exercise, identify the parameters to be considered, and outline the activities for collecting data on identified parameters. Sources of data were identified. Relevant available data pertaining to physical, biological (terrestrial and aquatic), and socio-economic aspects of the environment was collected from various secondary sources supported by primary data collection.

Primary data was also collected with focus on sensitive receptors like religious places, habitat areas, noise, air quality, water quality (ground and surface water both), soil, biodiversity (terrestrial and aquatic both). The air quality data was collected as per latest National Ambient Air Quality standards. The Ambient air quality monitoring stations were selected over the study area to get representative data of the area. Similarly, ambient noise level was monitored for day and night near sensitive locations, residential, and project areas. The water quality of surface and ground were monitored in the study area to get representative water quality information. River bed samples were also tested to assess the contamination level of river bad materials. The primary data was collected between September, 2015 & February, 2016

1.9. Public Consultation

Local knowledge about the ecosystem and problems associated with such a development project including sourcing of construction material and men river interface were carefully assessed and used in impact assessment and for developing mitigation plans. Consultations were held focusing on air quality, noise effect, water supply, drainage, aquatic and terrestrial flora and fauna, physical cultural resource of importance, environmental sensitive ecosystems or areas that may be affected by the project. Formal institutional level public consultation and opportunistic informal meetings involving local villagers and those who are likely to be affected due to the proposed projects were organized to determine potential environmental and socio-economic impacts. Interactions were also made with NGOs and concerned government officials. Consultation was carried out in two stage: Stage I during EIA report Preparation and stage II post EIA report preparation. A detailed description of the public consultation is presented in Chapter 7.

1.10. References

Secondary data for areas along NW-1 was also referred to authenticate & validate the primary information collected. The list of information sources, nature of data collected, purpose of data use and other reference are presented at **Table 1.2.**

Table 1.2 : Summary of Secondary Data with Sources

Source organisation	Report/source Name	Type of data
CPCB &MOEF&CC	CPCB Gazette notification dated 18.11.2009 on AAQ, Noise Notification, and BDU criteria	AAQ Standards BDU Criteria Standards Noise Standards
	Water Quality Assessment River Ganga 2013	Water Quality of NW-1 stretch
MOEF & CC	Endangered Species Brochure, 2009	Endangered Species
Indian Meteorological department	Climatological Normal 1961-1990	Met Data
	First order seismic micro zonation IMD	Seismicity and seismic map and Cyclone Hazard Prone Map
MOEF & CC	Jharkhand Wetland Atlas, Prepared by Space Applications Centre (ISRO), Ahmedabad and Institute of Environmental Studies & Wetland Management (IESWM), Kolkata)	Wetland information
MOEF & CC	Information on Wetlands	Wetland information
Central Ground Water Board	Ground Water Boucher of Project Districts	Geology, Ground water related information
Botanical Survey of India	Red Data Book of Indian Plants	RET species
Zoological Survey of India	Red data book on Indian Animal	RET species
IUCN (International Union for	Gland, Switzerland: International Union	RET species

Source organisation	Report/source Name	Type of data
Conservation of Nature) 1980	for Conservation of Nature. IUCN (International Union for Conservation of Nature) 1980.*World Conservation Strategy: Regional strategies for international river basins and seas*.	
IWC (International Whaling Commission) 2000	Report of the standing sub-committee on small cetaceans. *Journal of Cetacean Research and Management* 1 (Supplement),	Cetacean fauna
Mohan, R. S. L. and Kunhi, K. V. M. 1996.	Fish oil as alternative to river dolphin, *PlatanistaGangetica*(Lebeck) oil for fishing catfish *Clupisomagarua*in the River Gangetic, India. *Journal of the Bombay Natural History* Society 93, 86-88.	Oil impact on Aquatic fauna
Gland, Switzerland: IUCN.Perrin, W.F. 1999.	Selected examples of small cetaceans at risk. Pp. 296-310 in: *Conservation and Management of Marine Mammals* (eds. J.R. Twiss, Jr. and R.R. Reeves) Smithsonian Institution Press, Washington, DC.	Aquatic fauna
NGBRA (Indian Institutes of Technology)	GRB EMP: Ganga River Basin Environment Management Plan	Flora& Fauna
NGBRA (IIT Consortium)	Main Plan Document by Consortium of 7 Indian Institute of Technology's (IITs)	Ganga basin
NGBRA (Indian Institutes of Technology)	Status of Higher aquatic vertebrates in Ganga river (Ganga River Basin Management Plan) By Consortium of India's IIT Institutes	Higher aquatic vertebrates
NGBRA	Hilsa an assessment of in lower ganga basin (Ganga River Basin Management Plan) By Consortium of India's IIT Institutes	Fish
NGBRA (Indian Institutes of Technology)	Status of fish and fisheries in Ganga river (Ganga River Basin Management Plan) By Consortium of India's IIT Institutes	Fish
NGBRA	River Ganga at a Glance: Identification of Issues and Priority Actions for Restoration	Waterways quality
NGBRA (IIT Consortium)	Main Plan Document by Consortium of 7 Indian Institute of Technology's (IITs)	Ganga basin
Publication of BHU university	Flora of BHU	Flora

Source organisation	Report/source Name	Type of data
Kashi Turtle Sanctuary	Management Plan of Kashi turtle sanctuary	Turtle
Kalpavirksha	India's Notified Ecologically Sensitive Areas (ESAs)	Sensitive ecosystem
Chaudhary, S. K., Smith, B.D., Dye, S., Dye, S. And Prakash, S. 2006.	Conservation and Biomonitoring in the Vikramshila Gangetic Dolphin Sanctuary, Bihar, India. *Oryx,* 40 (2), 189-197	Dolphin
Quaritich.Braulik, G. 2000.	Entrapment of Indus dolphins (*Platanista minor*) in irrigation canals: incidence, implications and solutions. *International Whaling Commission, Scientific Committee Document* SC/52/SM9, Cambridge, UK.	Dolphin
Harison, R. J. 1972.	Reproduction and reproductive organs in *Platanistaindi* and *Platanista Gangetica. Invest Cetacea*.	Dolphin
Hua, Y., Zhao, Q., & Zhang G. 1989.The habitat and behaviour of Lipotesvexillifer. In W. F. Perrin, R. L. Jr. Brownell, K. Zhou & J. Liu (Eds.)	*Biology and conservation of the river dolphins* Occasional Paper of the IUCN Species Survival Commission (No.3., pp. 92-98).	Conservation Dolphin
Kannan, K. Sinha, R.K., Tanabe, S., Ichihashi, H. and Tatsukawa, R. 1993	Heavy metals and organochlorine residues in Gangetic Dolphin from India. Marine *Pollution Bulletin* Vol. 26 No. 3 pp 159-162 pergamon press U.K.	Heavy metal impact on Dolphin
Kannan, K., Tanabe, S., and Tatsukawa, R. And Sinha R.K. 1994.	Biodegradation capacity and residue pattern of organochlorines in Gangetic Dolphins from India. *Toxicological and Environmental Chemistry*.	Dolphin toxicology
Kasuya, T. 1972.	Some information on the growth of the Gangetic Dolphin with a comment on the Indus dolphin. *The Scientific Reports of the Whales Research Institute*	Morphology of dolphin
Mohan, R. S. L. and Kunhi, K. V. M. 1996.	Fish oil as alternative to river dolphin, *Platanista Gangetica* (Lebeck) oil for fishing catfish *Clupisomagaruai*n the River Gangetic, India. *Journal of the Bombay Natural History* Society 93, 86-88.	Oil impact on Aquatic fauna
KK Vass, S K Mandal, S Samanta, V R Suresh and P K Katiha, (CIFRI)	The Environment and Fishery status of River Ganges	Fish

Source organisation	Report/source Name	Type of data
Srivastava, P. And M.P. Singh, M.P. (2013)	Phenology and Biodiversity of Riparian Plant Species of Ganga River Bank at Bharwari (Kaushambi), U.P., India. Indian J.Sci.Res. 4(1)	Flora
Sahibganj Forest Division	Forest Working Plan of Sahibganj Forest Division	Flora and Fauna
Kalpavirksha	India's Notified Ecologically Sensitive Areas (ESAs)	Sensitive ecosystem
R.J. Rao Conservation Biology Lab School of Studies in Zoology Jiwaji University, Gwalior	The Diversity, Ecology and Conservation Management of Freshwater turtles in Ganges River System	Ecology & Turtles
Agriculture Department	Agriculture plans	Cropping pattern
Census of India, Govt. Of India	Census of India 2011	Census data
Census of India, Govt. Of India	District Statistics Hand Book & Village Profile of the Project Districts	Basic Amenities
Kelkar, N., Krishnamurthy J., Choudhary, S., and Sutaria, D. 2010.	Coexistence of fisheries with River Dolphin Conservation. *Conservation Biology*, Vol. 24 (4): 1130-1140.	Dolphin conservation
WWF-Nepal. 2006	Conservation and Management of river dolphins in Asia. *Proceedings of the regional meeting on conservation and management of river dolphins*. 26-27 May, Kathmandu, Nepal.	Dolphin
Forest Division	Forest Working Plan of Kashi Forest Division, Farakka Division	Flora and Fauna
Guideline, Standard and recommendations as published by Environmental Committee of PIANC	• Initial Assessment of Environmental Effect of Navigation and Infrastructure Project (WG 143-2014) • Sustainable waterway within the context of Navigation and Flood Management (WG 107-2009) • Climate Change and Navigation (TG3-2008) • Dredging Management Practices for the Environment (WG 100-2009) • Dredging Material as a Resources (WG 104-2009) • Environmental Impact Assessments of Dredging and Disposal Operation (WG 10-2006) • Biological Assessment Guidance for Dredged Material (WG 8-2006) • Ecological and Engineering Guidelines for Wetland Restoration in relation to the Development, Operation and Maintenance of Navigational Infrastructure (WG 7-2003) • Management of Aquatic Disposal of dredged material (WG 1-1998)	

Source organisation	Report/source Name	Type of data
	• Dredged Material Management Guide 1997. • Guidelines for sustainable Inland Waterways and Navigation WG 6-2003 • Environmental guidelines for aquatic, nearshore and upland confined disposal facilities for contaminated dredged material WG 5-2002 • Dredging the environmental facts-where to find what you need to know? PIANC-IADC-WODA brochure-2001 • Environmental management framework for ports and related industries WG 4-1999 • Dredging: the fact WODA brochure-PIANC-IADC-CEDA-IAPH1999	

Chapter 2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1. Introduction

India has well defined institutional and legislative framework. The legislation covers all components of environment viz. air, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India is also signatory to various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under various conventions and protocols. World Bank has also defined its Environmental and Social Safeguard Operational Policies. This assessment is about the applicability of above laws and regulations, conventions, protocols, and safeguards.

The applicability of legislation to the navigational channel (waterway) improvement, will be assessed under separate EIA being carried out for waterways and NW-1 as a whole.

2.1.1. *Overview of Indian Environmental Legislation and Administrative Framework*

The Government of India has framed various laws and regulations for protection and conservation of natural environment. The legislations are broadly divided under following categories.

- Environmental Protection
- Forests Conservation
- Wild Life Protection

The umbrella legislation under each of above category is highlighted below:

The Environment (Protection) Act 1986 was enacted with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country. Various rules are framed under this Act for grant of environmental clearance for any developmental project, resources conservation and waste management.

The Forest Conservation Act 1980 was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

Wild Life (Protection) Act 1972 amended 2003 was enacted with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. It defines rules for the protection of wild life and ecologically important protected areas.

The MoEF&CC and the pollution control boards (CPCB - Central Pollution Control Board and SPCBs - State Pollution Control Boards) together form the regulatory and administrative core of the part. Other Ministries/Statutory Bodies/Departments responsible for ensuring environmental compliance and granting various clearances

includes state ministry /dept. of environment, regional offices of MoEF&CC and state forests/wildlife departments.

2.1.2. *Applicable Environmental Legislation*

As per the nature of the project, screening has been done to identify the legislations applicable to the project. Legislations applicable to the project are further divided into the legislations framed by Govt. of India and Regulations applicable for vessels plying in inland waterways framed by IWAI and Ministry of Shipping, GoI. Regulations of Govt. of India applicable to the project are given in **Table 2.1** and legislations framed for vessels plying in inland waterways framed by IWAI and Ministry of Shipping, GoI are given in **Table 2.2** below.

Table 2.1 : Summary of Environmental and Other Legislation with Applicability Screening

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Environmental Protection Legislations					
Environment Protection Act-1986 and Rules there under including EIA Notification 14th Sep 2006 and amendment till date	To protect and improve overall environment. Requires prior environmental clearance for new, modernization and expansion projects listed in schedule 1 of EIA Notification, 2006	Considered Not Applicable (EIA Notification 2006 does not classify terminals/jetties/ floating terminals on river or dredging in the river as a project requiring environmental clearance. The applicability of this legislation should be re-assessed periodically from the concerned authority during NW-1 project development and implementation stages to ensure conformity with changes in the regulations if any). Borrowing of earth for road construction as may be required, will require prior environment clearance under mining category.	Environment Clearance Construction stage for EC for borrowing earth as applicable	MoEF&CC & SEIAA/SEAC /DEAC/DEIAA	IWAI/EPC Contractor for obtaining environmental clearances as applicable. EPC contractor shall also be responsible for EMP implementation and compliance to environmental clearance conditions.

Air (Prevention and Control of Pollution) Act, 1981, 1987	An act to prevent and control Air pollution	Applicable. The applicability is due to emission from operation of construction equipment like batching plants, hot mix plants, DG sets, and similarly, during operation stage backup power generation, material handling related aspects.	Consent to Establish &Consent to Operate	SPCB	EPC contractor, for setting up each facility (terminal/ jetty/ floating terminals etc.), batching plant, hot-mix plant as prior to its establishment from SPCB CTO shall be taken by contractor for batching plant, hot-mix plant & quarry site as required prior to operation and it should be renewed before the expiry of permit. EPC contractor shall also obtain CTO for each proposed facility under the project before its handover.
Water Prevention and Control of Pollution) Act, 1974, 1988	An act to prevent and control water pollution.	Applicable. It is applicable for the projects having potential to generate effluent during any stage of the project. Effluents are expected to be generated during both the construction and operation phase of the project.	Consent to Establish & Consent to Operate	State Pollution Control Boards	CTE should be taken by contractor for disposal of sewage and construction of septic tank/soak pit prior to start of construction from SPCB CTE/CTO for each proposed facility under the project shall also be obtained by EPC contractor along with CTE / CTO under Air Act.

Noise Pollution (Regulation and Control Act) 2000 and amendment till date	Ambient Noise Standards for different areas and zones	Applicable due to generation of noise during construction and operation stage.	No permits issued under this act	SPCB & CPCB	EPC contractor and IWAI to ensure compliance to Ambient Noise Level Standards.
Hazardous & Other Wastes (Management and Transboundary Movement) Rules, 2016	Protection to general public against improper handling storage and disposal of hazardous waste. The rules prescribe the management requirement of hazardous wastes from its generation to final disposal.	Applicable. Project has potent to generate hazardous waste (Waste Oil) during both construction and operation phase.	Authorization for storage and handling hazardous waste	SPCB & MoEF& CC	EPC Contractor shall obtain authorization for handling, storage and disposal of hazardous waste (Waste Oil) along with CTE/CTO for air and water act.
MSIHC Rules, 1989	Usage and storage of hazardous material	Applicable only for storage of highly inflammable liquids like HSD/LPG	No specific permit is required, however precautions defined under the material safety datasheets shall be followed for use of hazardous substances listed under the schedules attached to this notification if any proposed to be used. Safety audit and other	Chief Controller of Explosives, MoEF&CC and DC	EPC contractor and IWAI

			requirements shall have to be complied if storage quantity exceeds the regulated threshold limit		
The Bio Medical Waste Management Rules, 2016	To control storage, transportation and disposal of Bio Medical Waste.	Applicable Applicable for the disposal of bio-medical waste from first aid centres and dispensaries	No specific permit is required. Just comply with the handling and disposal requirements of the rule	Disposal through authorized disposal agency	EPC contractor and IWAI
Construction and Demolition Waste Management Rules, 2016	To manage the construction and demolition waste	Applicable Applies to all those waste resulting from Construction, re-modelling, repair & demolition of any civil structure of individual or organization who generates construction and demolition waste such as building material, rubble, debris.	Approval required from local authorities, if waste generation is >20 tons in a day or 300 tons per project in month	Local Authorities. Segregation, management and disposal of waste as per rules.	EPC contractor and IWAI
E-Waste (Management) Rules, 2016	To manage the E-waste but not covering lead acid batteries and radio-active waste	Not Applicable as IWAI will not fall any of the categories. (Rule applies to every manufacturer, producer, consumer, bulk consumer, collection centres, dealers, e-retailer, refurbisher, dismantler and recycler involved in manufacture, sale, transfer, purchase, collection, storage and processing of e-waste or electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational)	To obtain authorization from SPCB. Filing of return and maintenance of records in the forms given in the Rules	SPCB	Not Applicable

Plastic waste Management Rules, 2016	To manage the plastic waste generated	Applicable Rule applies to every waste generator, local body, Gram Panchayat, manufacturer, Importers and producer.	No authorization to be obtained. Waste management and minimization to be done. Fee to be paid to local bodies, if applicable	Local bodies	EPC contractor and IWAI
The Batteries (Management and Handling) Rules 2001	To regulate the disposal and recycling of lead acid batteries	Applicable Applicable for disposal of used lead acid battery if likely to be used in any equipment during construction and operation stage.	No specific registration required. Compulsion to buy and sale through registered vendor only.	MoEF&CC	EPC contractor and IWAI
Coastal Zone Management Act 2011	To regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.	Considered Applicable only for Haldia Terminal. However, it is proposed to be confirmed from concerned WB CZMA)	CRZ Clearance	West Bengal State Coastal Zone Management Authority and MoEF&CC	IWAI (IWAI has already started the process confirming and obtaining CRZ clearance for Haldia Terminal)
Forest Conservation and Wildlife Protection Legislation					
The Forest (Conservation) Act, 1980 and amendments The Forest (conservation) Rules 1981 and amendments till date	To protect forest by restricting conversion of forested areas into non-forested areas and deforestation	Not Applicable. No forest land is being diverted. However large no. of tree cutting is envisaged for which NOC from forest department as per applicable rules of the state. (it will be required in Up and West Bengal as per current rules of the states for cutting of the trees).	Forest Clearance / Permission for tree cutting.	Forest Department, MoEF&CC	NOC shall be obtained from forest department prior tree cutting in UP and West Bengal. Compensatory plantation shall be carried out in minimum ratio of 1:8. NOC shall be obtained by contractor.

Biological Diversity Act, 2002	Conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto	Not Applicable	No permit issued under this Act.	National Biodiversity Authority and State Biodiversity Board	Not Applicable
Wild Life Protection Act, 1972, 1993	To protect wildlife through notifying National Parks and Sanctuaries and buffer areas around these zones	Not Applicable as no development is being undertaken within the buffer zone of the eco-sensitive zone notified under this act. Necessary permission shall be obtained for virgin movement of vessel through these zone (Kashi Turtle Sanctuary and Vikramshila Dolphin sanctuary). Permission shall be taken for any intervention if planned at any stage within the buffer zone of eco-sensitive zones. No clearance is required under Hilsa Sanctuary as it is enacted only for fish productivity enhancement under Fisheries Act and not	Wild life clearance	Chief Conservator Wildlife, Wildlife Wing, Forest Department, MoEF&CC	Necessary permission shall be obtained for virgin movement of vessel through these zone (Kashi Turtle Sanctuary and Vikramshila Dolphin sanctuary). Permission shall be taken for any intervention if planned at any stage within the buffer zone of eco sensitive zones. (IWAI has already started process of obtaining permission for movement of vessel through these

		under this Act.			sanctuaries have already been started)
Safety and Other Related Legislations					
Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Requirement of preparation of on-site and off-site Disaster Management Plans for accident-prone areas.	Not Applicable. The project does not involve handling of any hazardous chemical during both construction and operation phase which may lead to continuous, intermittent or repeated exposure to death, or injury.	No permits issued under this act	Central, State & District Crisis Group	Not Applicable
Public Liability and Insurance Act 1991	Protection from liability arising due to accidents from handling of hazardous chemicals.	Not Applicable. The project does not involve storage of any chemicals (HSD) beyond the threshold limit during construction and	No permits issued under this act. Owner of project shall take out insurance policies providing for contracts of insurance so as he is insured against liability to give relief, before handling any such hazardous material	Collector of the Area	Not applicable
Explosive Act 1884 & Explosive Rules, 2008	Safe transportation, storage and use of explosive material	Not Applicable as no explosive (as described in act & rules) shall be used in the construction and operation stage of the project.	Permission for storage and usage of explosive	Chief Controller of Explosives	Not applicable
Petroleum Rules, 2002	Use and Storage of Petroleum products	Applicable as storage of HSD/LPG or any other petroleum product may be required for the	License to store petroleum beyond prescribed	Chief Controller of Explosives/DC	EPC Contractor / IWAI

		project purpose	quantity.		
Central Motor Vehicle Act 1988 and amendment Central Motor Vehicle Rules, 1989 and amendments till date	To minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise pollution.	Applicable, for all the vehicles at site during construction & operation phase	No permit issued under this Act	Motor Vehicle Department (Licensing authority, registration authority &State Transport Authorities)	EPC Contractor to follow Rules for all the construction vehicles being used at site during construction purpose. IWAI shall follow the rules for all its vehicles at site during operation phase and should also monitor that loading & unloading vehicles also complied these rules
The Gas Cylinder Rules 2004	To regulate the storage of gas / possession of gas cylinder more than the exempted quantity	Applicable if contractor store more than the exempted quantity of gas cylinder.	License to store gas cylinder more than the regulated quantity	Chief Controller of explosives	Contractor
Ancient Monuments and Archaeological Sites and Remains Act, 1958	Conservation of cultural and historical remains found in India. According to this Act, area within the radii of	Applicable only if any intervention is planned within 300 m of archaeological protected sites falling along the NW-1	No objection certificate	Archaeological Dept. GoI, Indian Heritage Society and Indian National Trust for Art and Culture	Not applicable as yet as no intervention planned within 300m of these sites. However, it shall be applicable if any such intervention

	100m and 300m from the "protected Property" are designated as "protected area" and "controlled area" respectively. No development activity (including building, mining, excavating, blasting) is permitted in the "protected area" and development activities likely to damage the protected property is not permitted in the "controlled area" without prior permission of the Archaeological Survey of India (ASI).			Heritage (INTACH).	is planned in future within 300 m of such resource.
Merchant Shipping Act, 1958	To prevent marine pollution from ships	Considered Applicable as these cargos are also required to register in India under this act.	Registration Certificate	National Shipping Board	IWAI shall ensure that all the barges plying in the waterways

	beyond 5 km of the coastline and to make the transportation safe.				are complying with the rule as applicable
Guidelines for evaluation of proposals/requests for ground water abstraction for drinking and domestic purposes in Notified areas and Industry/Infrastructure project proposals in Non-notified areas, 2012	To regulate extraction of ground water for drinking and domestic purpose	Applicable if ground water is extracted for meeting drinking/domestic water needs of employees and visitors at proposed facility & vessels	No objection certificate	Central ground Water Authority/Board & MoEF&CC	Contractor/IWAI shall obtain NOC from CGWA/CGWB prior digging any bore well during construction & operation phase

Note: applicable social legislations are not listed here as these are covered under SIA and RAP reports being prepared separately.

Table 2.2 : Regulations Applicable on Vessels/Barges Plying in Inland Waterways

Name	Key Requirement	Applicability	Administrative Authority
Prevention of Collision on National Waterways Regulations, 2002	Regard to precautions required by the ordinary practice of Seamen and limitation of the vessel	Applicable for all the vessel plying in National Waterway	IWAI
National Waterways, Safety of Navigation and Shipping Regulations, 2002	Ensuring safety of navigation and shipping on the national waterways	Applicable for all the vessel plying in National Waterway	IWAI
The National Waterway-1 Act, 1982	Provision for regulation and development of that river for purpose of shipping and	Applicable for all the vessel plying in National Waterway	IWAI

	navigation on the NW-1 and for the matters connected therewith or incidental thereto		
New Inland Vessel Act, 2015 & Rules Under IV Act	Economical and safe transportation through inland waters	Applicable for all the vessel plying in National Waterway	IWAI

2.2. International Best Practices & Guidelines

2.2.1. *Operational Policies of World Bank*

The project is being developed with the financial aid from World Bank. World Bank has its operational policies which safeguards the different environment and social components. World Bank operational policies triggered for this project are listed in **Table 2.3**.

Table 2.3 : World Banks Operational Policies - Environmental & Social Safeguard

Name	Key Requirement	Applicability	Remarks
OP 4.01 Environmental Assessment	Ensures sustainability and environmental feasibility of the project. Projects are classified into A, B & C category depending on the nature and extent of the impact.	Triggers	Project classified as Category A considering nature of activities and impacts
OP 4.04 Natural habitats	Ensures conservation of natural habitats and discourages disturbance of nay natural habitat due to project development by recommending adoption of alternative method/route/approach or adopting management measures	Triggered	Triggered for Sahibganj & Varanasi Terminal Projects. No other project is in close vicinity of such endangered or protected environment
OP 4.36 Forests	Ensures that project activities donot disturbs/interfere with the forest, forest dwellers activities, fauna and flora of the forest. Prevents and discourages deforestation and impacts on rights of forest dependent people.	Triggers	No diversion of forest land is involved however large number of tree cutting is involved. Permission will be required for felling these trees from forest department.
OP 4.12 Involuntary Resettlement	Ensures minimal involuntary resettlement by considering feasible alternatives project design, assisting displaced people to improve their former	Triggers	Applicable for facilities which involves land acquisition like Sahibganj terminal, Varanasi terminal etc.

	living standard.		
OP 4.10 Indigenous people	Ensures protection of the dignity, right and cultural uniqueness of indigenous people and ensures they receive social and economic benefits	Triggers	No indigenous group of people will be affected directly by project, however ST population is residing within 10 km radius area of the Sahibganj terminal.
OP 4.11 Physical Cultural Resources	Ensures preservation of property of cultural and religious importance, heritage and property of natural importance and enhancement of cultural properties	Triggers	Applicable for Sahibganj terminal project as it involves shifting of one of the community temple which exists at the site. It may be applicable for other sites for civil interventions which are under planning and identification
OP 7.5 Projects on International Waterways	Projects on international waterways may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections	Triggered	NW-1 traverse through Farakka canal to Hoogly River and does not affect or change the water treaty between India and Bangladesh in any way. However due to movement of vessels in River Ganga in Farakka area which is part of international riparian treaty between India & Bangladesh, this policy is considered triggered with a view to give advance intimation of NW-1 plans of this area to Bangladesh

World Bank's operational policy 4.01 (OP 4.01) categorize the project into Category A, B & C on the basis of nature and extent of the impacts anticipated from the project. Scope of Environmental assessment studies depends on the category in which the project falls and is defined below.

Category A - Projects with significant environmental impacts and requiring a full Environmental Assessment (EA),

Category B - Projects with moderate environmental impacts and requiring a lesser level of environmental assessment,

Category C - Projects which require no environmental analysis.

Proposed Project involves augmentation of navigation capacity of NW-1 by developing various facilities like terminals, jetties, navigation aids etc. along the NW-1. Project is spread over app 1600 km and has impacts on various environment and social component. Components to be impacted due to project development are quality of life, livelihood, terrestrial and aquatic ecology, air quality, water quality, economy of the country, noise levels etc. Also it is anticipated impacts are both positive and negative but will be significant. Thus the project is classified as Category A and a detailed environment and social assessment study has been undertaken for the project.

2.2.2. *Relevant International Environmental Convention*

2.2.2.1 International Maritime Organization Conventions

India is member state of the International Maritime Organization (IMO). All the vessels plying in marine environment are bound to follow these conventions. These conventions are aimed at ensuring environmental protection and safety of seamen. These guidelines shall also be followed by vessels/barges plying in inland water bodies to the extent possible. IMO Conventions/ Protocols relevant to the project are given in **Annexure 2.1.** Conventions which majorly are in environmental context include MARPOL Convention 1973/78 & Ballast Water Management, 2004.

MARPOL Convention, 1973/78

The MARPOL Convention, an international convention is responsible for the preventing pollution of the marine environment by operational or accidental discharges from the ships. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years.

This international convention was adopted in 1973 at International Maritime Organization (IMO) and covered pollution by oil, chemicals, and harmful substances in packaged form, sewage and garbage. The Protocol of 1978 relating to the 1973 International Convention for the Prevention of Pollution from Ships (1978 MARPOL Protocol) was adopted at a Conference on Tanker Safety and Pollution Prevention in February 1978 held in response to a spate of tanker accidents in 1976-1977. Measures relating to tanker design and operation were also incorporated into a Protocol of 1978 relating to the 1974 Convention on the Safety of Life at Sea, 1974.

The MARPOL Convention includes regulations that are aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations – The convention currently includes six technical annexes delineate below:

Annex I: Regulations for the Prevention of Pollution by Oil

Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk

Annex III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form

Annex IV: Prevention of Pollution by Sewage from Ships

Annex V: Prevention of Pollution by Garbage from Ships

Annex VI: Prevention of Air Pollution from Ships (entry into force 19 May 2005)

Ballast Water Management, 2004

Under this heading, IMOs' setup "International Convention for the Control and Management of Ship's Ballast Water and Sediments, 2004" for preventing the introduction of unwanted organisms and pathogens from ship's ballast water and sediment discharges. This is aimed to arrest the potentially devastating effects of the spread of harmful aquatic organisms carried by ballast water. This convention will require all ships to implement a Ballast Water Management Plan (BWMP) and delineates the standards for the Ballast Water Exchange (BWE) and Ballast Water Performance (BWP) under BWMP.

2.2.2.2 United Nations Convention on the Law of the Sea, Montego Bay, (1982):

This Convention was adopted by India on 10th December 1982 at Montego Bay, Jamaica. Main objectives of the convention are:

- To set up a comprehensive new legal regime for the sea and oceans, as far as environmental provisions are concerned, to establish material rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment; and
- To establish basic environmental protection principals and rules on global and regional cooperation, technical assistance, monitoring, and environmental assessment, and adoption and enforcement of international rules and standards and national legislation with respect to all sources of marine pollution.

Thus the convention can be referred to understand the environmental protection principals and procedures to minimize the environmental pollution due to movement of vessels/barges and related operations

2.2.2.3 International Maritime Dangerous Goods Code (IMDG-code)

The IMDG code relates to methods of safe transport of dangerous cargoes and related activities. It sets out procedures for documentation, storage, segregation, packing, marking and labelling of dangerous goods. This convention can also be referred to understand the procedures followed by the vessels carrying the dangerous goods to ensure safety and avoid spillage and accidents.

2.3. Environmental Standards & Guidelines

Project involves various activities, which may interfere with various environmental components. Thus it is required to control those activities so as the concentration of pollutant in environment shall not exceeds its assimilation capacity. CPCB has issued some standards for disposal of effluents and quality of surface water body which should be referred and adhered to with regards to prescribed discharge standards at any point of time. India does not have any standard yet for disposal of dredged material, water quality in and around harbour/ports/terminals, thus standards issued by other renowned bodies are referred. Suggested list of standards are listed below and given in detail at **Annexure 2.2**.

- Standards for discharge of effluent in inland surface water bodies and Marine Coastal Areas (Source: G.S.R 422 (E) dated 19.05.1993 and G.S.R 801 (E) dated 31.12.1993 issued under the provisions of E (P) Act 1986)
- Classification of Surface water Bodies on basis of Quality (Source: Guidelines for Water Quality Management-CPCB, 2008)
- Water Quality Standards for Coastal Waters, SW-IV & V-Harbour and Navigation & controlled waste disposal (EIA Guidance Manual for Ports & Harbours, MoEF&CC, GoI)
- Standards for permissible level of water quality indicators (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Permissible limit for off-shore dumping of dredged material (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Criteria for harmful bottom sediments (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Approximate Quantity of Suspended Sediments Generated by Dredging or Dumping Operations (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992).

2.3.1. *Guideline, Standard and recommendations as published by Environmental Committee of PIANC*

PIANC- the World Association for Waterborne Transport Infrastructure is the forum which provides expert advice on cost-effective, reliable and sustainable infrastructures to facilitate the growth of waterborne transport. PIANC has published various guidelines for ensuring the sustainable development of waterborne transport. Some of the guidelines as applicable to the project are listed below. These guidelines can be referred to make the Inland water transportation system sustainable and environmental friendly.

- Dredging Management Practices for the Environment (WG 100-2009)
- Dredging Material as a Resources (WG 104-2009)
- Ecological and Engineering Guidelines for Wetland Restoration in relation to the Development, Operation and Maintenance of Navigational Infrastructure (WG 7-2003)
- Management of Aquatic Disposal of dredged material (WG 1-1998)
- Dredged Material Management Guide 1997.
- Guidelines for sustainable Inland Waterways and Navigation WG 6-2003

2.4. Key safeguard documents

A detailed description of project baseline environmental conditions, identified positive and negative environmental impacts, the mitigation measures to eliminate or minimize the adverse impacts and enhance the positive impacts, detailed environmental management plan including institutional responsibilities, implementation schedule, environmental budget, arrangement for monitoring and evaluation and grievance redressal mechanism are provided in the consolidated environmental impact

assessment report for NW-1 and environmental impact assessment report of Ramnagar (Varanasi terminal), Sahibganj terminal, Farakka Lock, Haldia terminal. The other supplementary documents prepared under this project are i) Basin Level Critical Environmental Resource Assessment report; ii) Consolidated rehabilitation action plan for NW-1, iii) Rehabilitation action plan for Sahibganj, iv) EIA Report for maintenance dredging and barge operations.

Chapter 3. PROJECT DESCRIPTION

3.1. Background

This chapter provides the base information of development proposed. The impact analysis is carried out considering the proposed project components. This chapter is presented in following three broad parts:

A: General Introduction to Jal Marg Vikas Project, Need, connectivity and River related information

B: Alternative Analysis

C: Development of Navigation Channel, Planned and proposed Project Components

Each of above section is elaborated in detail under respective section below.

A: **GENERAL INTRODUCTION TO JAL MARG VIKAS PROJECT, NEED, CONNECTIVITY AND RIVER RELATED INFORMATION**

3.2. Introduction- Jal Marg Vikas Project

NW-1 is natural waterway, extends from Haldia (Sagar) to Allahabad and spans 1620 km crossing the states of Bihar, Jharkhand, Uttar Pradesh & West Bengal. NW-1 is The Ganga - Bhagirathi - Hooghly river system between Haldia & Allahabad. It links the ocean gateway ports of Haldia and Kolkata to Bhagalpur, Patna, Ghazipur, Varanasi and Allahabad, their industrial hinterlands, and several industries located along the Ganga basin. Alignment of NW-1 is depicted in **Figure 3.1** below.

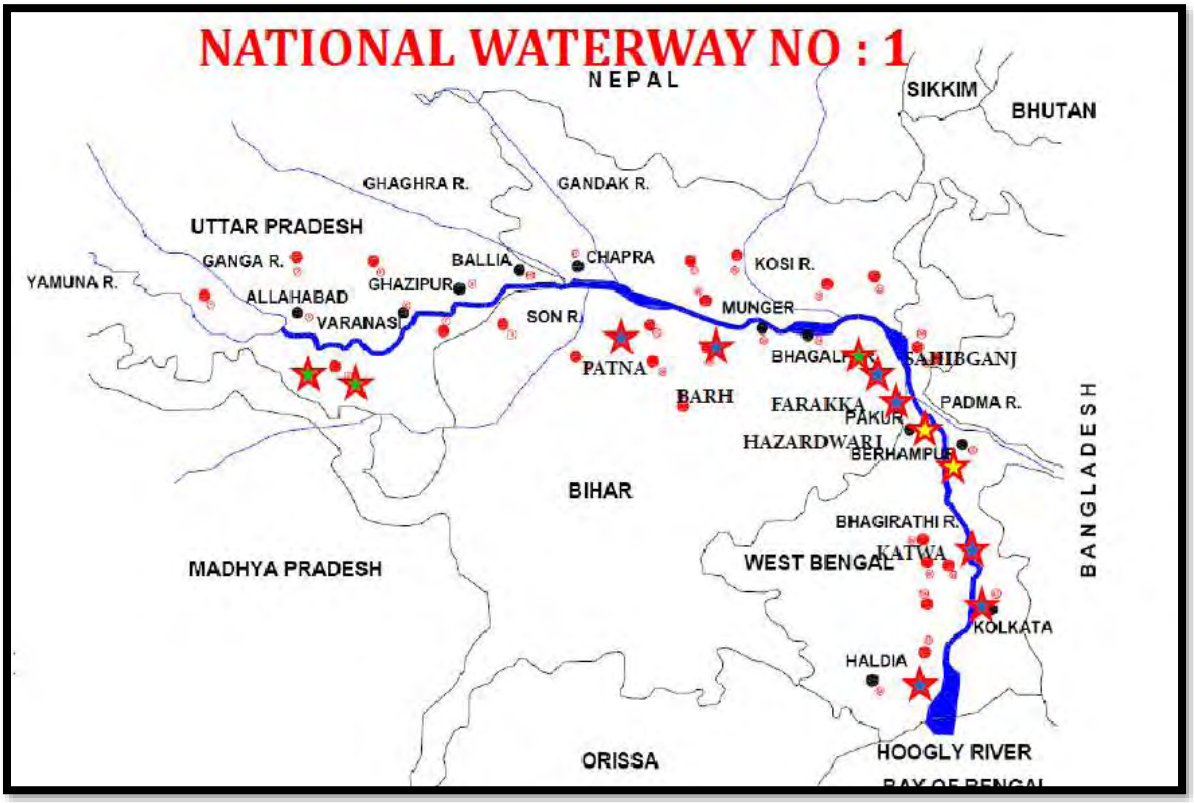


Figure 3.1 : Alignment of NW-1

NW-1 is being fed by various tributaries at different locations. Major tributaries to NW-1 between Haldia to Allahabad are Tons, Gomti, Ghagra, Son, Gandak, Punpun and Kosi. Jal Marg Vikas project is aimed at augmentation of navigation in the waterway by maintaining the LAD in the waterway throughout the year for navigation, development of the navigational infrastructure and navigation aids, river training works at critical location, equipment of the necessary barges/dredgers/boats for navigation purpose and development of efficient River information system. However, to optimize the project impacts and the cost, at present it is proposed to augment the stretch between Haldia and Varanasi only. Dredging operations for maintenance of LAD will be carried out between Haldia and Varanasi only.

3.3. Project Location

Project area includes entire reach of the River Ganga from Haldia to Allahabad including the areas proposed for development of project related facilities & infrastructure, i.e. terminal sites, lock site, Ro-Ro jetty sites and sites for other planned development. Stretch from Allahabad to Haldia covers four states namely Jharkhand, Bihar, Uttar Pradesh & West Bengal. Map showing location of NW-1 stretch from Haldia to Allahabad is depicted in **Figure 3.2**.

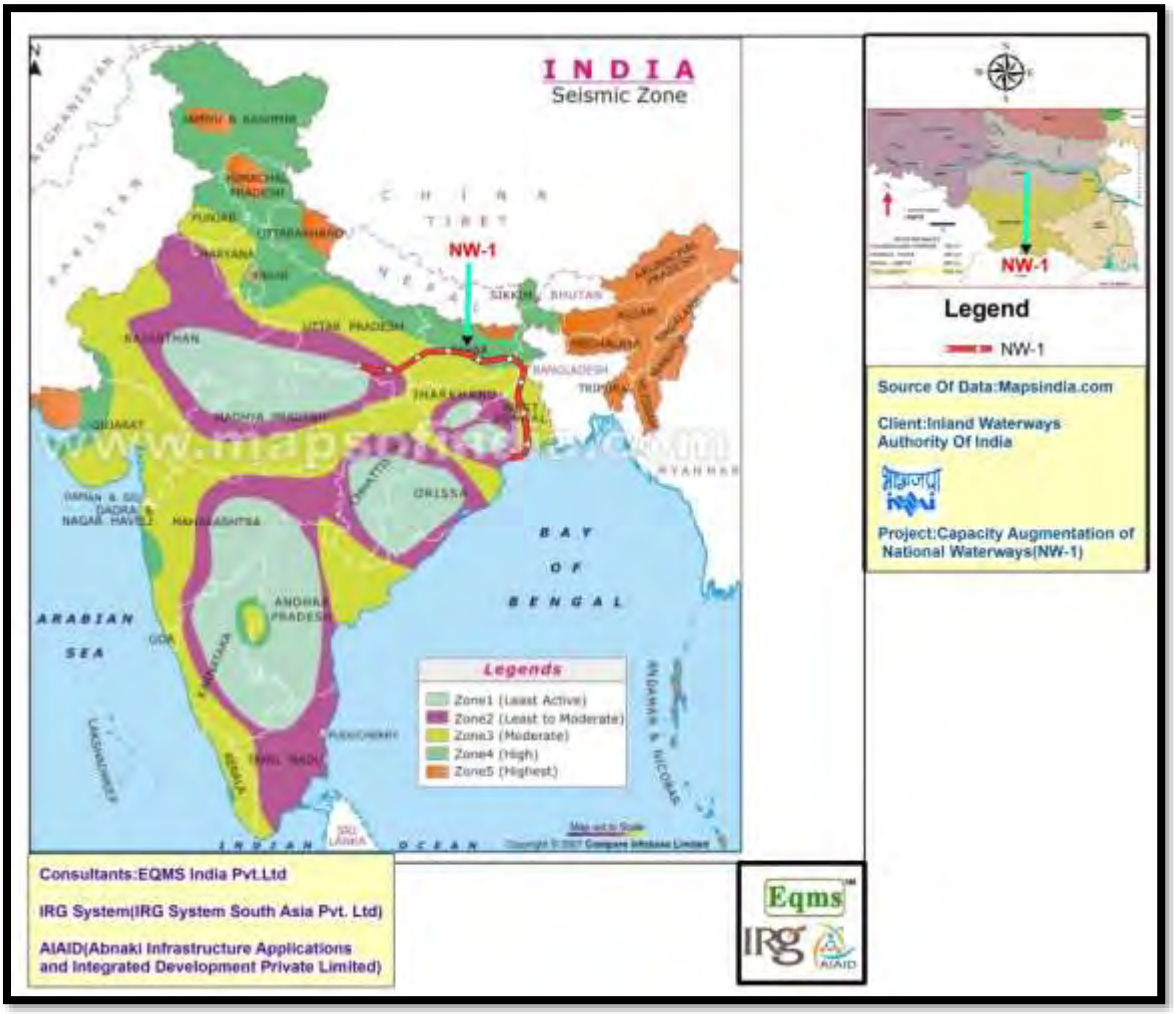


Figure 3.2 : Location Map of NW-1

3.3.1. *Rail and Road Connectivity to NW-1*

There is good rail and road connectivity at important places across NW-1 which enhances the utility of MW-1 for easy movement of material from one mode of transport to another. The connectivity details are provided at **Table 3.1.**

Table 3.1 : Road & Railway Infrastructure at Important Places Across NW-1

S. No.	Place	Road Connectivity	Railway Connectivity
1.	Allahabad (N)	NH 2, NH 27, NH 96	Delhi - Kolkata
2.	Allahabad (S)	NH 27, NH 76	Allahabad - Mirzapur
3.	Mirzapur (N)	SH 5, NH 2	
4.	Mirzapur (S)	NH 27	Mirzapur - Chunar
5.	Varanasi (N)	NH 29, NH 56, NH 233	Varanasi-Ghazipur

6.	Varanasi (S)	NH 2, NH 7	Mirzapur-Buxar
7.	Ghazipur (N)	NH 19	Ghazipur - Ballia
8.	Ghazipur (S)	NH 30, NH 97	Chunar-Buxar
9.	Ballia (N)	NH 19	Ballia - Chapra
10.	Buxar (S)	NH 30	
11.	Patna (N)	NH 77	Chapra - Begusarai
12.	Patna (S)	NH 30A,31,83 & 98	Patna - Jamalpur
13.	Bhagalpur (N)	NH 31, NH 106	Bhagalpur-Sahibganj
14.	Bhagalpur (S)	NH 80	Patna - Jamalpur
15.	Katihar (N)	NH 31, NH 131A	
16.	Sahibganj (S)	NH 80	Sahibganj-Farakka
17.	Farakka (E)	NH 81, NH 34	
18.	Farakka (W)	NH 80, NH 60	Farakka - Behrampur
19.	Behrampur	NH 34	Behrampur - Nabadwip
20.	Nabadwip	NH 34	Nabadwip - Raghunathpur
21.	Barrackpur	NH 34, NH 35	Barrackpur-Kolkata
22.	Kolkata	NH 34, NH 35	Kolkata - Bagnan
23.	Howra	NH 6, NH 2	
24.	Haldia (W)	NH 6, NH 41, NH 116B	Howra- Haldia
25.	Haldia (E)	NH 117	--

3.4. Size and Magnitude of the Project

Proposed Project-Jal Marg Vikas aims at improvement of navigation in entire stretch of NW-1 (Haldia to Allahabad). Length of the waterway is about 1620 km and traverses through 4 states namely Jharkhand, Uttar Pradesh, Bihar and West Bengal. Developments planned under the Jal Marg Vikas project includes

- Maintenance dredging to maintain the LAD in waterway/channel and the terminal facility
- Improved Navigation Infrastructure& Navigation Aids
  - Construction of 10 Nos. of Ro-Ro jetties & ferry passenger jetties. Location for these jetties is not yet identified.
  - Construction of 6 Nos. of terminals. Site identification and planning for 3 terminals sites at Sahibganj, Varanasi and Haldia is completed. 2 more potential sites for development of terminals are identified at Ghazipur and Kalughat. These two sites are still under consideration for finalization and planning is at initial stage only. One more terminal site is to be identified along NW-1.
  - Construction of Navigation Locks

- Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment. Development of low draught cargos
- Development of navigation aids along NW-1 for facilitation of day & night time navigation

- Development of efficient River Information System with all hardware & software
- Provision for bank protection / slope protection and river training works for critical locations

3.4.1. *Existing and Anticipated Cargo at NW-1*

Cargo movement exists at present also in NW-1. 27,16,436 MT of cargo (15,11,961,380 TKM/1.512 BTKM) was transported via NW-1 during 2012-2013 (IWAI). Cargo transported include cement, fly ash, iron ore, iron ore fines, coal, steel shed, tyres, iron fines, iron ingots, Galvanized steel plain sheets, stone chips, furnace oil, high Speed diesel, lube oil, boulders, pulses, aluminium block, sand, chips, ship block, log, pulses, Manganese ore, Petroleum, Coke, Cooking coal, Rock Phosphate, Timber, Peas, Slag oil, and Non-cooking coal.

An Indo-Bangladesh Protocol on Inland Water Transit & Trade also exists between India and Bangladesh apart from intra country water transport. Under Indo-Bangladesh Protocol, inland vessels of one country can transit through the specified routes of the other country. The existing protocol routes are: Kolkata – Pandu-Kolkata, Kolkata-Karimganj–Kolkata, Rajshahi-Dhulian-Rajshahi, and Pandu-Karimganj-Pandu. For Inter-country trade, four ports of call have been designated in each country, namely; India – Haldia (West Bengal), Kolkata (West Bengal), Pandu (Assam), Karimganj (Assam) and Silghat (Assam) and Bangladesh-Narayanganj, Khulna, Mongla, Sirajganj and Ashuganj.

Cargo traffic and the commodities transported in NW-1 vary in different stretches. Cargo volume by rail & road mode along NW-1 stretch for year 2014 is given at **Table 3.2.**

Table 3.2 : Current Traffic Along NW-1 Stretch (2014)

Commodities	By Road (in tonne)	By Rail (in tonne)	Total Cargo (in tonne)
Coal	45258500	18723758	68222258
Construction Material	30171490	14429354	44760679
Consumer Goods	191811	0	191811
Container	2033280	0	2033280
Fertilizer	156900	1377741	1534641
Food and Food Stuff	1404369	484233	1888602
Gas and Petroleum	8400	217026	475976
Minerals and Chemicals	43950	575750	1953161
Project Cargo	186560	18250	228622
Vehicles	37100	100000	137100
Total Cargo (in tonnes)	79492360	35926112	121426130

Source: HPC&HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

As per projection study undertaken by survey and marketing consultant HPC for growth of traffic for planned project life of 30 years. Three scenarios are considered for forecasting, i.e. base case (in absence of Jal Marg Vikas Project), Medium Augmentation case (Jal Marg Vikas project with 3 m LAD upto Farakka, 2.5 m until Patna and 2 m upto Varanasi) and Full augmentation case (LAD of 3 m upto Patna and 2.5 m upto Varanasi). For the study purpose HPC has considered medium case augmentation. Since traffic will generate different for different stretches, the traffic projections is made for three different stretches, i.e. Haldia-Varanasi, Haldia-Patna & Patna-Varanasi. The traffic projection for these stretches as per medium case augmentation is given below in **Table 3.3, 3.4 & 3.5.**

Table 3.3 : Traffic Forecast for Stretch-1 (Haldia-Varanasi)

Cargo Type	Commodity	Forecast Medium Augmentation Case (tons)				
		Forecast MAC 2015 (t)	Forecast MAC 2020 (t)	Forecast MAC 2025 (t)	Forecast MAC 2035 (t)	Forecast MAC 2045 (t)
Dry Bulk	Stone chips	99,336	1,01,52,467	1,27,98,104	1,70,90,680	1,98,68,049
Dry Bulk	Coal	32,82,875	74,05,156	84,57,510	1,04,26,875	1,16,59,733
Dry Bulk	Iron ore	0	85,444	1,12,020	1,52,328	1,61,924
Dry Bulk	Limestone	0	3,889	4,932	6,925	8,050
Dry Bulk	Sand	0	1,38,070	1,74,090	2,32,932	2,70,785
Bagged	Food & Foodstuff	0	15,61,662	18,88,883	23,85,956	25,19,450
Bagged	Cement	0	8,27,552	12,13,633	20,34,856	25,62,950
Bagged	Fertilizer	0	60,061	66,117	75,037	80,216
Bagged	Plastic granules	0	9,383	12,270	18,713	24,250
Bagged	Textile	0	1,25,941	1,80,823	3,11,868	3,99,577
Neo-bulk	Logs & woods	63,151	86,976	1,08,042	1,45,196	1,82,878
Neo-bulk	Paper	0	3,745	5,282	8,320	10,480
Neo-bulk	Petroleum	2,62,460	5,15,815	6,61,925	9,25,784	10,70,067
Neo-bulk	Project cargo	0	3,79,560	4,43,000	5,67,556	7,14,850
Neo-bulk	Statues	0	1,07,208	1,21,296	1,37,339	1,37,339
Neo-bulk	Steel products	0	8,86,183	10,89,119	14,69,146	18,50,424
Ro-Ro	Vehicles	0	47,863	65,484	1,09,045	1,45,370
Container	General cargo	0	18,72,123	27,83,131	48,68,543	63,44,978
Total		37,07,822	2,42,69,096	3,01,85,663	4,09,67,100	4,80,11,367

Source: HPC & HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Table 3.4 : Traffic Forecast for Stretch-2 (Patna-Varanasi)

Cargo Type	Commodity	Forecast Medium Augmentation Case (tons)				
		Forecast MAC 2015 (t)	Forecast MAC 2020 (t)	Forecast MAC 2025 (t)	Forecast MAC 2035 (t)	Forecast MAC 2045 (t)
Dry bulk	Coal	0	2,51,993	2,46,256	2,68,992	2,71,067
Dry bulk	Sand stone	0	5,185	6,576	9,233	10,733
Dry bulk	Limestone	0	3,889	4,932	6,925	8,050
Bagged	Food & Foodstuff	0	3,32,723	4,35,396	5,94,442	6,28,316
Bagged	Textile	0	61,229	73,563	1,01,778	1,30,401
Bagged	Plastic granules	0	9,383	12,270	18,713	24,250
Bagged	Cement	0	8,13,646	11,93,886	20,03,696	25,23,702
Neo-Bulk	Paper	0	3,745	5,282	8,320	10,480
Neo-Bulk	Project cargo	0	2,02,152	2,24,605	2,77,894	3,50,014
Neo-bulk	Steel products	0	4,81,730	5,77,518	7,69,196	9,68,820
Neo-bulk	Statues	0	1,07,208	1,21,296	1,37,339	1,37,339
Ro-Ro	Vehicles	0	47,863	65,484	1,09,045	1,45,370
Container	General cargo	0	17,43,011	25,91,191	45,32,781	59,07,393
Total		0	38,11,763	53,12,000	85,69,361	1,08,44,869

Source: HPC & HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT

Table 3.5 : Traffic Forecast for Stretch-3 (Haldia-Patna)

Cargo Type	Commodity	Forecast Medium Augmentation Case (tons)				
		Forecast MAC 2015 (t)	Forecast MAC 2020 (t)	Forecast MAC 2025 (t)	Forecast MAC 2035 (t)	Forecast MAC 2045 (t)
Dry bulk	Stone chips	0	23,98,814	30,23,922	40,38,168	46,94,401
Dry bulk	Coal	32,82,875	69,39,211	79,69,586	98,53,827	1,10,56,473
Dry bulk	Iron ore	0	9,71,959	12,25,242	16,36,197	19,02,091
Dry bulk	Limestone	0	3,23,986	4,08,414	5,45,399	6,34,030
Dry bulk	Sand	0	68,652	84,513	1,12,091	1,41,182
Bagged	Food & Foodstuff	1,62,487	63,63,580	79,20,893	1,04,42,930	1,19,90,623
Bagged	Fertilizers	0	17,94,026	26,47,350	45,96,517	59,75,527
Bagged	Plastic granules	0	23,258	32,621	50,627	58,517

Bagged	Textile	0	2,22,364	3,02,610	4,71,792	5,99,523
Neo-Bulk	Logs and wood	0	6,47,972	8,16,828	10,90,798	12,68,061
Neo-bulk	Petroleum	2,62,460	14,63,318	18,43,599	24,76,593	28,74,916
Neo-Bulk	Project cargo	0	2,64,189	3,15,652	4,24,786	5,19,963
Neo-bulk	Steel products	0	9,39,231	11,52,032	15,42,578	19,02,495
Ro-Ro	Vehicles	0	25,886	30,543	41,522	53,199
Container	General cargo	0	2,17,457	2,95,933	4,65,037	5,85,405
Total		37,07,822	2,26,63,903	2,80,69,739	3,77,88,862	4,42,56,407

Source: HPC& HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT

Though above traffic projection indicated sufficient traffic cargo potential till 2045, however design consultant has considered different traffic forecasted the traffic again for the presently designed infrastructure facility. These terminals are designed on the basis of the traffic expected to be shifted at these sites from rail/road to IWT mode. Traffic projections for the planned infrastructure site are given below in **Table 3.6.**

Table 3.6 : Traffic Forecast for Planned Navigational Infrastructural Facilities

S. No.	Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
1	Sahibganj Terminal	2.24	4.39	9.00
2	Varanasi Terminal (with current land)	0.54	1.22	1.22
3	Haldia Terminal	4.07 MTPA (1.57 other cargo & 2.5 MTPA coal transhipment)		

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT

3.4.2. *Depth of Navigation Channel*

It is planned to maintain depth of 3 m all along the stretch from Haldia to Allahabad but to optimize the cost and minimize the environmental damage, it is planned to maintain depth of 3 m from Haldia to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi at present[10]*.*

3.4.3. *Width of Navigation Channel*

It is planned to provide two-way cargo movements in the navigation channel and maintaining the width of channel between 60-120 m. However, at present it is planned to

[10]***Source of Data:(Detailed Feasibility Study for Jal Marg Vikas Project and Detailed Engineering for its Ancillary Works and Processes between Haldia to Allahabad by HOWE Engineering Projects (India) Pvt. Ltd).***

maintain the channel width[11] of 64 m and side slopes of 1:10 from section Haldia to Varanasi.[12]

3.4.4. *Size of the Vessel/Ships*

As per IWAI planning, vessels of maximum length 110 m, beam 11.4 m, draught 2.5 m-2.8 m and air draught of 9 m will ply in NW-1 waterway (***reference Detailed Feasibility Study for Jal Marg Vikas Project and Detailed Engineering for its Ancillary Works and Processes between Haldia to Allahabad prepared by HOWE Engineering Projects (India) Pvt. Ltd)***. However, the vessel size will vary in different stretched as per the available LAD and type and quantity of cargo to be transported. Vessels of size 1500-2000 DWT is expected to ply in the waterway. Study for cargo estimation is under process and size of the vessels will be finalized accordingly.

At present, planned vessels designed run on diesel, however IWAI is planning to switch to CNG for operating the vessels. Proposal and study for the feasibility of using CNG as fuel is under process. IWAI is interacting with various agencies for design of the high capacity vessels which can move in low draft so as to reduce the dredging requirement.

3.5. Challenges for Project Development

When it comes to the implementation of Jal Marg Vikas Project to ensure navigation in entire NW-1 throughout the year, various challenges come in picture. NW-1 is alluvial river with typical characteristic of braiding, meandering and large water level fluctuation between summer and monsoon months.

Wide variations in water level are observed ranging from 2.5 m at Farakka to 16.5 m at Allahabad. Current velocity varies between 0.2m/s during lean season to 4.0 m/s during flood season in the stretch between Allahabad to Farakka. Current velocity is 1.2 m/s in Feeder Canal & 1.7 m/s (max.) in Bhagirathi river stretch.

Ganga carries annual silt load of 1600 million tons. Fine silt leads to rapid shoal formation. It becomes difficult to maintain even 2 m depth during low water season throughout the stretch. The stretch between Haldia and Tribeni (196 km) is tidal and the Least Available Depth (LAD) of more than 3.0 m is maintained naturally therein. IWAI has to erect bandals and carry out dredging to maintain the LAD in upper stretches of Tribeni. Due to unavailability of adequate depth/width and navigational infrastructure facilities, navigation of the large cargos throughout the year is not possible. Major challenges for navigation in NW-1 are listed below

1. Highly braiding and meandering river
2. Large water level fluctuation
3. Unavailability of LAD for navigation throughout NW-1 and unreliable water depths
4. High silt load & shoal/bar/island formation leading to splitting of main channel
5. Growing of bars reducing the available depth
6. Lateral migration of the river and change in navigation line

[11] ***The width of the channel is being reduced to 45 m under phase I development. This will further reduce he dredging requirements. However, these details are under finalization stage.***

[12] ***Source of Data:(Detailed Feasibility Study for Jal Marg Vikas Project and Detailed Engineering for its Ancillary Works and Processes between Haldia to Allahabad by HOWE Engineering Projects (India) Pvt. Ltd).***

7. Existence of power line pylons at various locations
8. Existence of pontoon bridges. About 7 pontoon bridges are present between Buxar and Allahabad which are in use. Pontoon bridges are significant threat to navigation
9. Existence of Bagmari siphon in the Farakka feeder canal for irrigation purpose which generates eddy currents, reduces water level by 0.1-0.2 m in immediate vicinity of the structure and reduction in buoyancy of vessel due to presence of air bubbles in water column above this siphon leading to increase in vessel draught
10. Existence of critical bridges (bridges with Horizontal Clearance (HC)&Vertical Clearance (VC) less than 70 m & 9 m respectively). Details of the critical bridges are given below in **Table 3.7** below
11. Inadequate navigation infrastructure and aids like channel marking, inadequate fairway width, navigation lights, signals, RIS, lack of modern vessel based navigation aids, absence of effective waterway reporting & tracking system.

Table 3.7 : Details of Critical Bridges on NW-1

S. No.	Location	Chainage	Horizontal Clearance (HC)-m	Vertical Clearance (VC)-m
1	Pakur Bridge	525	49.07	12.15
2	Rajendra Setu- Semaria	853	40.00	10.00
3	Malaviya-Varanasi (Rajghat Bridge)	1308	101.50	6.56 (10.37-50%, 7.97-1-% & 7.18-1%)
4	Mirzapur	1398	30.50	2.52 (7.08-50%, 4.21-1-% & 3.22-1%)
5	Rabindra Setu/Howrah Bridge Howrah	157.8	--	9.0
6	Swami Vivekananda Setu	166.4	100	8.8
7	Bridge at Digha	990.5	20	--
8	Rajendra/Mokama Bridge, Hathida	--	--	10.6 -50%, 9.67-10% & 9.57-1%
9	Buxar Road Bridge	--	--	10.91-50%, 9.43-10% & 9.23-1%
10	Ghazipur Road Bridge	--	--	11.82-50%, 10.35%-10% & 10.12-1%

Source: IWAI &HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Apart from above bridge, some bridges at Varanasi, Balua, Hoogly and Munger are also navigational hazard. Available width of the navigation channel is reduced significantly due to presence of bridge piers of these bridges or due to their orientation w.r.t river flow or due to their location.

12. Some of the bends in the NW-1 are significant w.r.t. navigation. There are 10 significant bends in U.P. stretch, 1 bend at U/s of Farakka and 63 significant bends in West Bengal. Due to presence of these bends, additional channel width will be required. Details of the significant bends are given in **Table 3.8**.

Table 3.8 : Details of Navigationally Significant Bends in UP stretch of NW-1

S. No.	Stretch	No. of Bends
Uttar Pradesh-10		
1.	Saidpur-Varanasi	2
2.	Chunar-Mirzapur	2
3.	Rampur Ghat	5
4.	Sirsa-Allahabad	1
Jharkhand-1		
1.	U/s of Farakka Navigation Lock	1
West Bengal-63		
1.	Haldia Diamond Sand	1
2.	Diamond Sand – Howrah Bridge	5
3.	Howrah Bridge - Tribeni	3
4.	Tribeni - Balagarh	2
5.	Balagarh - Kalna	2
6.	Kalna - Samudragarh	3
7.	Samudragarh - Nabadrip	2
8.	Nabadrip – Patuli	6
9.	Patuli - Katwa	4
10.	Katwa - Plassey	7
11.	Plassey - Chunarigacha	5
12.	Chunarigacha - Behrampur	5
13.	Behrampur - Mahamuadpur	7
14.	Mahamuadpur - Nasipur	6
15.	Nasipur - Jangipur	3
16.	Jangipur – Farakka Lock	2

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Project Jal Marg Vikas is aimed at minimizing the above mentioned challenges to ensure the navigation in the entire stretch during most of the time in year. Implementation of project will focus on maintaining the LAD for navigation in the desired stretches, improving existing navigation infrastructure, developing new infrastructure, improved navigation aids and navigation cargos.

3.6. River Morphology &Mobility

River Ganga is significantly mobile and changes flowing pattern in one season to another. Changes in river typology/morphology have been studies from last 10 years' satellite imagery by HPC. From the study it was found that, in the upper reaches, from Allahabad to Doriaganj, the river is meandering or sinuous with minor secondary

branches and several chutes. The river shows a clear change of planform typology at area around Patna younger. The change is from a meandering to an anabranching typology, with multiple channels. Change in planform is due to confluence of various tributaries namely Ghagra & Gandak in left bank and Son & Punpun in the right bank. The river typology changes again, downstream of Munge where the channel shows a sinuous channel with a certain degree of braiding. Bars are common in this area. Between Kahalgaon and Manihari the main channel clearly splits in two, with a certain degree of braiding in each channel. The contribution of the Kosi River takes place near Kahalgaon. From Manihari to Farakka there is one main sinuous channel and several sinuous secondary channels. Downstream stretches of Farakka to Farakka lock and Farakka lock to Jangipur lock is an artificial canal. Reaches downstream of Jangipur Lock show a meandering channel with different degrees of sinuosity, from tortuous to irregular meanders. From Jangipur Lock to Tribeni the presence of oxbow Lakes is common, and cut-offs meanders[13]. Detailed morphology of the river in different reaches is given in **Table 3.9**. Changes in the River morphology are depicted in the images given in **Figure 3.3** below.

Table 3.9 : Morphology of River (NW-1) in different reached

S. No.	Reach/Stretch	Chainage	Morphology
1.	Sagar Road – Haldia	(0-35)	Split channel with central islands
2.	Haldia – Diamond Sand	(35-60)	Split channel with central islands
3.	Diamon Sand –Howrah Bridge	(60-145)	Sinuous channel
4.	Howrah Bridge -Tribeni	(145-193)	Irregular meandering channel with some sporadic central bars
5.	Tribeni-Balagarh	(193-221)	Irregular meandering channel with split channels and bars. Oxbow lakes and cut-offs visible
6.	Balagarh-Kalna	(221-245)	Tortuous meandering channel showing split channels at bends. Oxbow lakes and cut-offs visible
7.	Kalna-Samudragarh	(245-263)	Irregular meandering channel showing some degree of split at a few locations. Oxbow lakes and cut-offs visible
8.	Samudragarh-Nabadweep	(263-280)	Tortuous meandering channel with bars at the near the inner bank of bends
9.	Nabadweep-Patuli	(280-322)	Tortuous meandering channel with chutes at bends and several split channels. Oxbow lakes and cut-offs visible

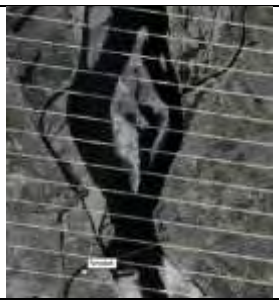
[13]***Source of Data:(Detailed Feasibility Study for Jal Marg Vikas Project and Detailed Engineering for its Ancillary Works and Processes between Haldia to Allahabad by HOWE Engineering Projects (India) Pvt. Ltd).***

10.	Patuli-Katwa	(322-345)	Tortuous meandering channel with localised bars and chutes at bends and some degree of split channels. Oxbow lakes and cut-offs visible
11.	Katwa-Palassey	(345-371)	Meandering single channel, wider at bends with some chutes. Cut-offs visible
12.	Palassey-Chaurigacha	(371-400)	Irregular meandering channel showing chutes at bends and split of channels at particular locations. Oxbow lakes and cut-offs visible
13.	Chauriga-Chaberhampur	(400-421)	Sinuous channel except for the approximately last 5 km of the reach. In that area the channel shows tortuous meanders and oxbow lakes. Cut-offs also visible
14.	Berhampur-Mohammadpur	(421-449)	Irregular meandering single channel. Oxbow lakes visible
15.	Mohammadpur- Nasirpur	(449-479)	Tortuous meandering single channel with central bars at certain locations. Oxbow lakes and abandoned meander channels visible
16.	Nasirpur-Jangipur Lock	(479-505)	Tortuous meandering single channel. Cut-off and abandoned meander channels visible
17.	Jangipur Lock-Farakka Lock	(505-544)	Artificial channel
18.	Farakka Lock- Rajmahal	(544-583)	Composite river with one main sinuous channel with bars and islands and several sinuous secondary channels. Several oxbow lakes can be seen
19.	Rajmahal-Manihari	(583-633)	Composite river with one main channel with bars and islands and several sinuous side channels
20.	Manihari-Karagola	(633-660)	Split river with sinuous channels with a certain degree of braiding that converts in a single main sinuous channel with several side channels

21.	Karagola-Kahalgaon	(660-690)	Split river with sinuous channels with a certain degree of braiding
22.	Kahalgaon-Bhagalpur	(690-715)	Sinuous channel with a certain degree of braiding showing bars and islands
23.	Bhagalpur - Sultanganj	(715-746)	Sinuous channel that shows some degree of braiding. The area shows clear oxbow lakes
24.	Sultanganj-Munger	(746-793)	Sinuous channel that shows some degree of braiding in a stretch of a few kilometres. It is a clear cut-off with the old bendy channel still showing some activity
25.	Munger-Mahendrapur	(793-820)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
26.	Mahendrapur-Semaria	(820-853)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
27.	Semaria-Barh	(853-891)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
28.	Barh-Mehnar	(891-925)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
29.	Mehnar-Patna	(925-955)	Anabranched river with channels with a certain degree of braiding showing bars and islands
30.	Patna-Doriganj	(955-1000)	Split sinuous channels with a high degree of anabranching
31.	Doriganj-Ballia	(1000-1063)	Meandering single channel, wider at bendswith some chutes and several sub parallel anabranches
32.	Ballia-Buxar	(1063-1124)	Sinuous single channel, wider at bends with some chutes and a sinuous side channel and certain degree of braiding
33.	Buxar-Ghazipur	(1124-1178)	Sinuous single channel, wider at bends with some chutes and a

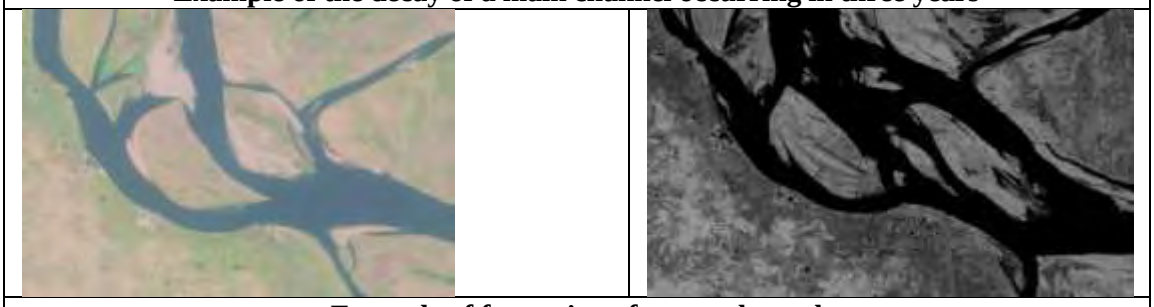
			sinuous side channel
34.	Ghazipur-Saidpur	(1178-1254)	Sinuous channel that shows some degree of braiding in a stretch of around 10 kilometres
35.	Saidpur-Varanasi	(1254-1311)	Meandering single channel, wider at bendswith some chutes and a side channel
36.	Varanasi-Chunar	(1311-1344)	Meandering single channel, wider at bendswith some chutes and a side channel
37.	Chunar-Mirzapur	(1344-1398)	Meandering single channel, wider at bendswith several chutes
38.	Mirzapur-Rampur Ghat	(1398-1419)	Sinuous channel that shows some degree of braiding in a stretch of a few kilometres
39.	Rampur Ghat-Sirsa	(1419-1506)	Meandering single channel, wider at bendswith some chutes and a sinuous side channel; stretches of few kilometres with split of channels less than 200 m wide
40.	Sirsa-Allahabad	(1506-1547)	Meandering single channel, wider at bendswith some chutes and a sinuous side channels.

Source: HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant)

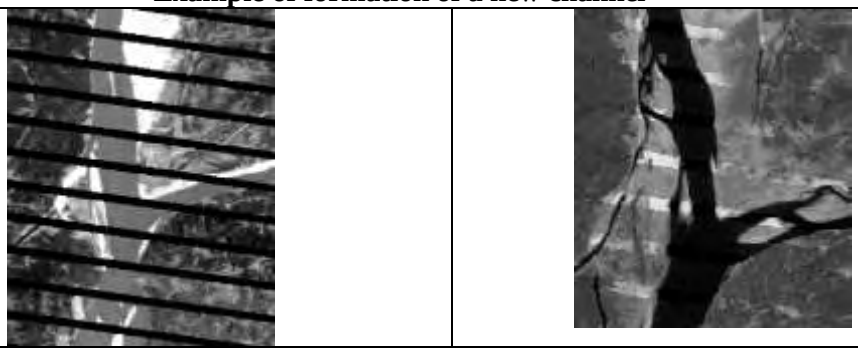


Formation of a big island with two main channels upstream of Farakka Barrage. Images from 2011(left) and 2015 (right)

Example of the decay of a main channel occurring in three years



Example of formation of a new channel



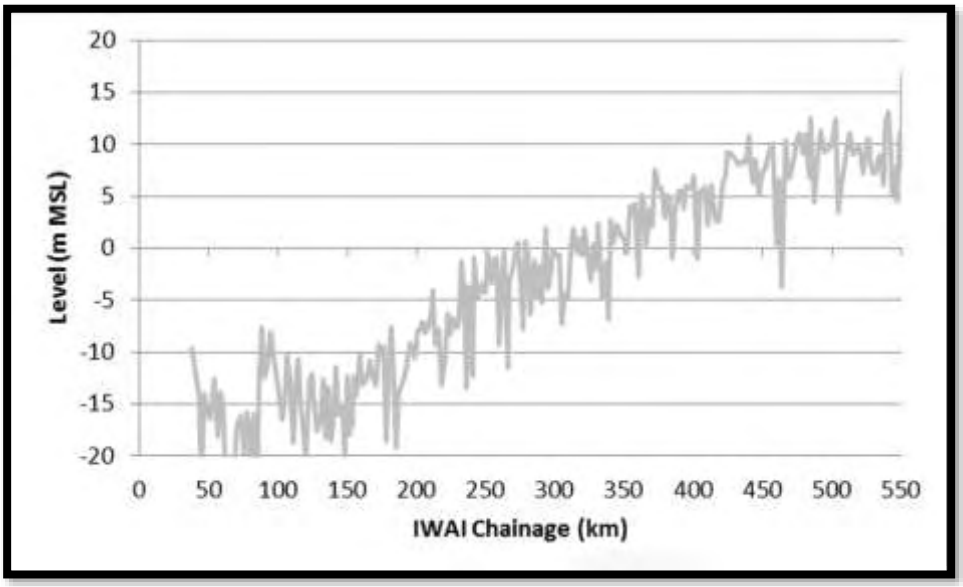
Example of lateral migration of main channel

Source: IWAI &HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.3 : Satellite Imagery of Different Years to Study Change in River Morphology

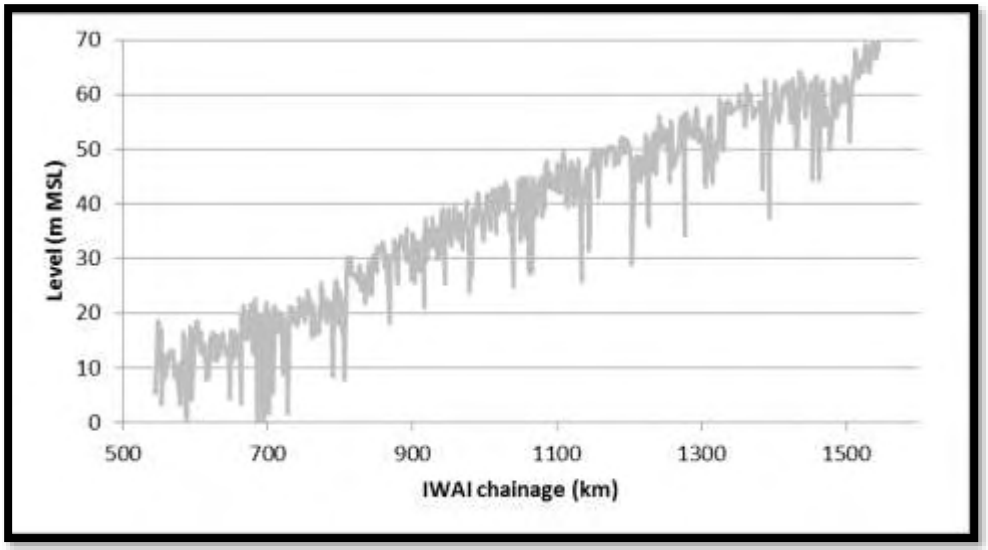
3.7. Bathymetry of NW-1 & River Slope

Bathymetric survey is carried out between Haldia to Allahabad. Longitudinal profile of the river bed between Haldia to Farakka and Farakka to Allahabad are given in **Figure 3.4 & 3.5.**



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.4 : Longitudinal profile of river bed from Haldia to Farakka



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.5 : Longitudinal profile of river bed from Farakka to Allahabad

From **Figure 3.5,** it is clear that between Chainage 50-150 km which is tidal stretch of river, river bed slope is flat. Then there is 250 km where river bed slope is 1 in 11,000 which flattens in the 50-100 km downstream of the Farakka lock to around 1 in 18,000. River slope from Farakka to Allahabad is 1 in 17,000. Longitudinal profile of river slope from Farakka to Allahabad is given in **Table 3.10** below.

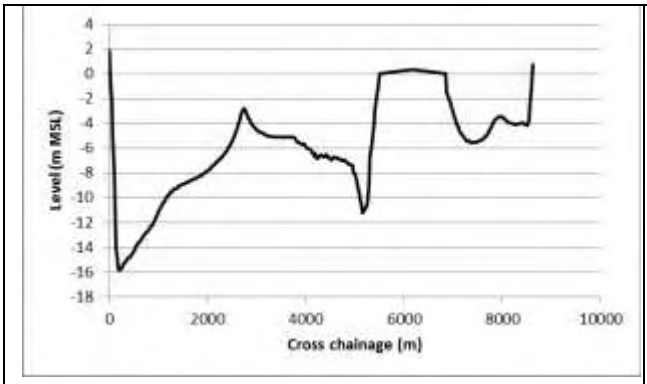
Table 3.10 : Longitudinal Profile of River Slope from Farakka to Allahabad

Reach	General slope for the 50 km reach	General slope for the 100 km each
550-600	1 in 10,000	1 in 32,000
600-650	Flat	
650-700	1 in 12,000	1 in 12,000
700-750	1 in 12,000	
750-800	1 in 12,000 (flat)	1 in 10,000
800-850	1 in 5,000	
850-900	1 in 350,000 (flat)	1 in 15,000
900-950	1 in 7,000	
950-1000	Flat	1 in 25,000
1000-1050	1 in 10,000	
1050-1100	1 in 18,000	1 in 15,000
1100-1150	1 in 14,000	
1150-1200	1 in 22,500	1 in 26,000
1200-1250	1 in 30,000	
1250-1300	Flat	1 in 15,000
1300-1350	1 in 7,000	
1350-1400	1 in 75,000	1 in 50,000

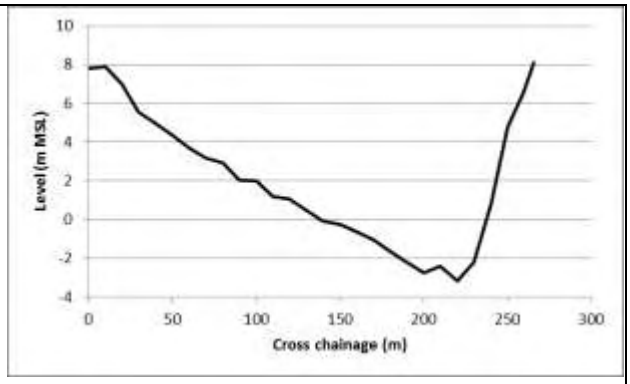
1400-1450	1 in 37,000	
1450-1500	Flat	1 in 12,000
1500-1550	1 in 5,000	

Source: IWAI &HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

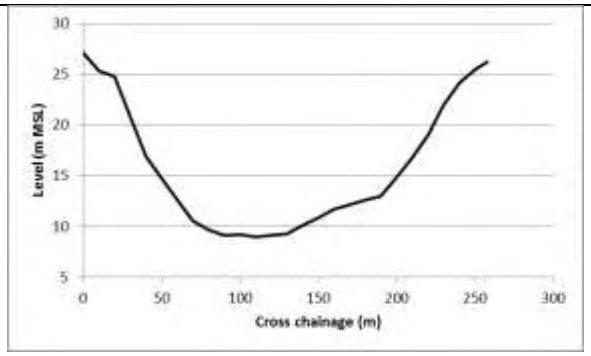
Cross section profile of the NW-1 at various location has also been studied by design consultant at various locations like Haldia, d/s Farakka lock, around island near Patna, Ghazipur, Varanasi, Allahabad & at meandering bend. Cross section profile of river is given at **Figure 3.6.**



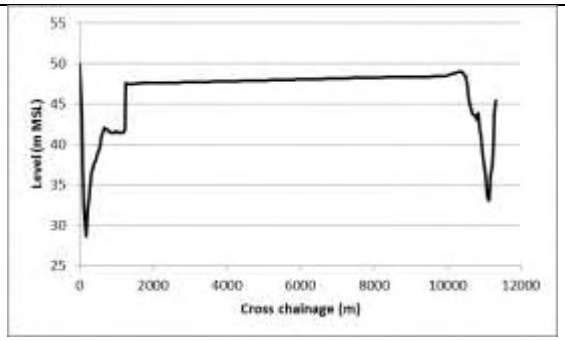
Cross section of river at Haldia



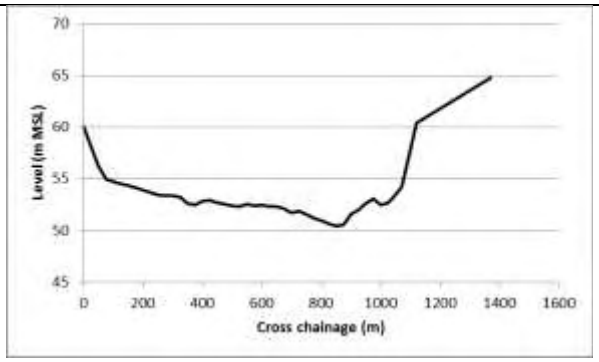
Cross section of river at meandering bed (ch-0326)

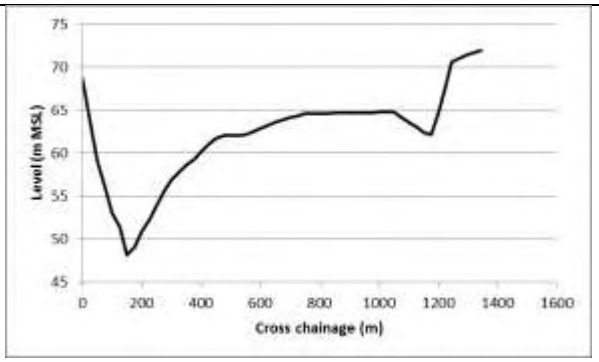


Cross section of canal d/s Farakka lock

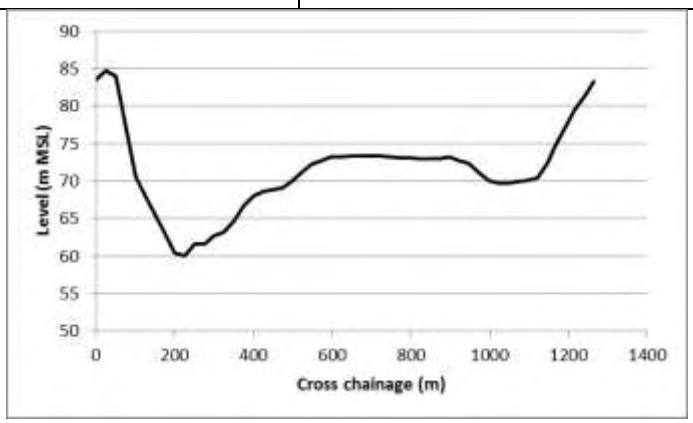


Cross section of river near large island at Patna





Cross section of river at Ghazipur	Cross section of river at Varanasi (deep)



Cross section of river at Allahabad

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.6 : Cross-Sectional profile of river bed at Various Locations in NW-1

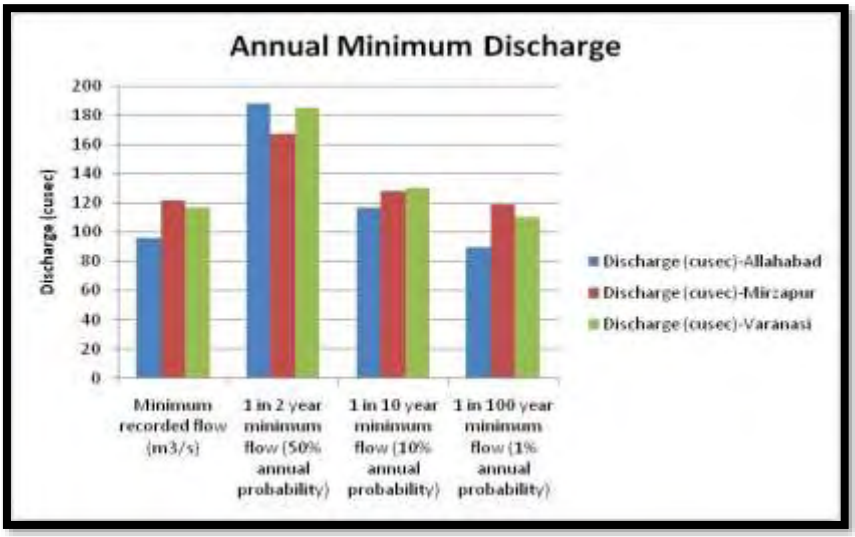
3.8. Available Flow in NW-1

The Ganga River is characterised by high flows during the monsoon season, approximately from July until October, and low flows during the rest of the year. Annual minimum discharges provided by IWAI at Allahabad, Mirzapur and Varanasi during the last 3 years are given below in **Table 3.11 & Figure 3.7.**

Table 3.11 : Annual minimum discharges obtained from statistical analysis

Parameter	Discharge (cusec)		
	Allahabad	Mirzapur	Varanasi
Minimum recorded flow (m3/s)	96	122	117
1 in 2-year minimum flow (50% annual probability)	188	167	185
1 in 10-year minimum flow (10% annual probability)	117	128	130
1 in 100-year minimum flow (1% annual probability)	90	119	110

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)



Source: IWAI

Figure 3.7 : Annual minimum discharges obtained from statistical analysis

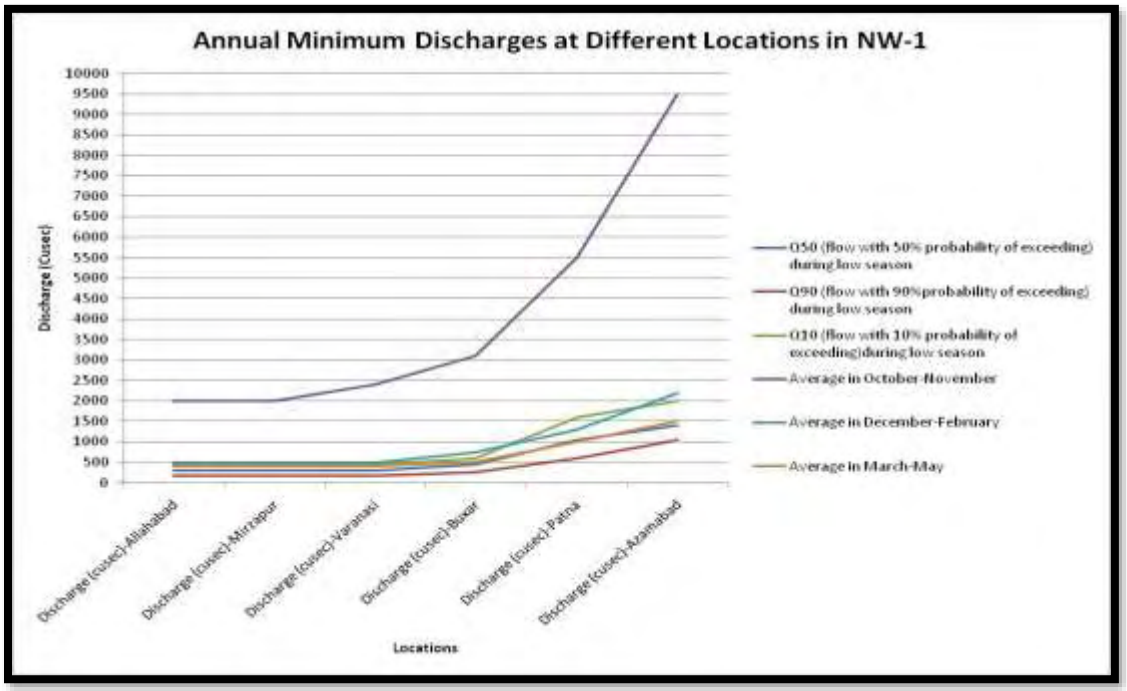
As per data available with IWAI, lowest flow recorded at Buxar was 225 cusec and lowest available flow at Patna 689 cusec. These flows are considerably lower than the average dry season flows. The design discharge for the feeder channel at Farakka is around 1,100 m^3/s.

As per the data available in the report "Status on River Ganga: State of the Environment and Water Quality" by the National River Conservation Directorate (2009), discharges with a probability of exceeding 50%, 10% and 90% of times at 6 stations namely Allahabad, Mirzapur, Varanasi, Buxar, Patna and Azamabad during low flow season are given in **Table 3.12 & Figure 3.8** below.

Table 3.12 : Annual Minimum Discharges at Different Locations in NW-1

Flow regime	Discharge (cusec)					
	Allahabad	Mirzapur	Varanasi	Buxar	Patna	Azamabad
Q50 (flow with 50% probability of exceeding) during low season	300	300	300	450	1050	1400
Q90 (flow with 90% probability of exceeding) during low season	175	175	175	250	600	1050
Q10 (flow with 10% probability of exceeding) during low season	450	450	450	600	1600	2000
Average in October-November	2000	2000	2400	3100	5500	9500
Average in December-February	500	500	500	750	1300	2200
Average in March-May	400	400	400	500	1000	1500

Source: National River Conservation Directorate



Source: National River Conservation Directorate

Figure 3.8 : Annual Minimum Discharges at Different Locations in NW-1

3.9. Sediment Load in NW-1

NW-1 comprises of the River Ganga and the tributaries system between Haldia and Allahabad. Rivers originating from the Himalaya region (Ganga, Ghaghara and Gandak) are characterized by a predominance of fine and very fine sand. The rivers draining from the Indian craton region (Tons, Son and Yamuna) bring much coarser sediments with higher contents of coarse and medium sand. Sediments are classified into suspended and bed load depending on the size of the particles. Sediments of diameter smaller than 125µm are transported in suspension and can be deposited during the low flow period. Sediment size decreases from Allahabad to Farakka. Sediment load at different locations and tributaries of NW-1is given below in **Table 3.13.**

Table 3.13 : Sediment Load at Different Locations and Tributaries of NW-1

Locations	**Sediment Load (MT/Year)**		
	From CWC (available online)	**From Abbas and Subramanian (1984)**	**From Jain and Sinha (2003)**
Ganges at			
Allahabad	-	228	-
Farakka	-	729	729
Kolkata	-	328	-
Gomati	-	6	6
Ghaghara	-	125	125

Son	22	50	-
Gandak	33	24	82
Kosi	73	-	193

Source: HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant)

3.10. Water Level of NW-1

NW-1 experiences high water level variations, i.e. of order of 10 m during high season. In general, water levels are at their highest in August-September and sharply decrease in October-November. In general, they continue to decrease during the whole low flow season, from December to May, and start to raise again in June-July. The variability of water levels during the dry season is lower than during the high season, with variations of the order of 2-3m. The period of the year in which the minimum water level can occur varies with location along the river. In the upstream reaches from Allahabad to Ghazipur the minimum water levels occur from April to July. Downstream of the three major tributaries, Ghagra, Son and Gandak that join the river near Patna, the minimum water levels can occur between February and June as a result of the influence of snow melt. Minimum & Maximum surface water levels at 7 gauging stations between Allahabad and Farakka for 3 annual probability of occurrence is given in **Table 3.14 & 3.15 & Figures 3.9 & 3.10** below

Table 3.14 : Minimum Water Levels for a Range of Annual Probabilities

Location	Minimum Water Level (m)		
	50%	10%	1%
Allahabad	71.45	70.72	70.38
Mirzapur	63.10	62.58	62.37
Varanasi	58.59	57.91	57.27
Ghazipur	52.45	51.69	51.27
Patna	40.88	40.27	39.56
Hathida	33.28	32.59	32.18
Kahalgaon	23.64	22.96	22.57

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

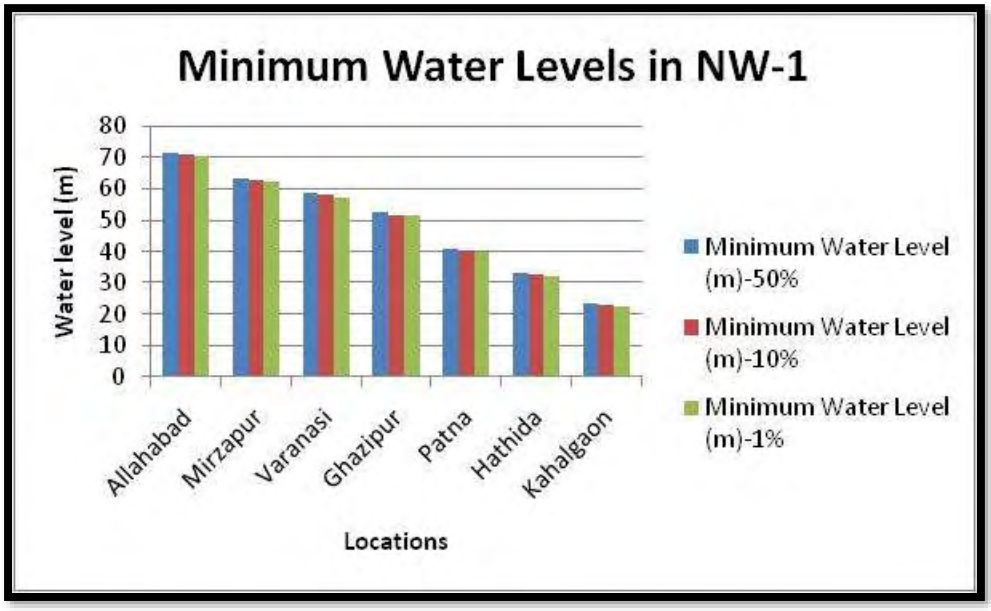


Figure 3.9 : Minimum Water Levels for a Range of Annual Probabilities

Table 3.15 : Maximum Water Levels for a Range of Annual Probabilities

Location	Maximum Water Level (m)		
	50%	**10%**	**1%**
Allahabad	82.36	85.67	87.22
Mirzapur	75.65	78.77	79.89
Varanasi	70.0	72.48	73.37
Ghazipur	62.88	64.78	65.18
Patna	49.36	50.44	50.91
Hathida	41.78	42.85	43.01
Kahalgaon	30.99	32.70	32.90

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

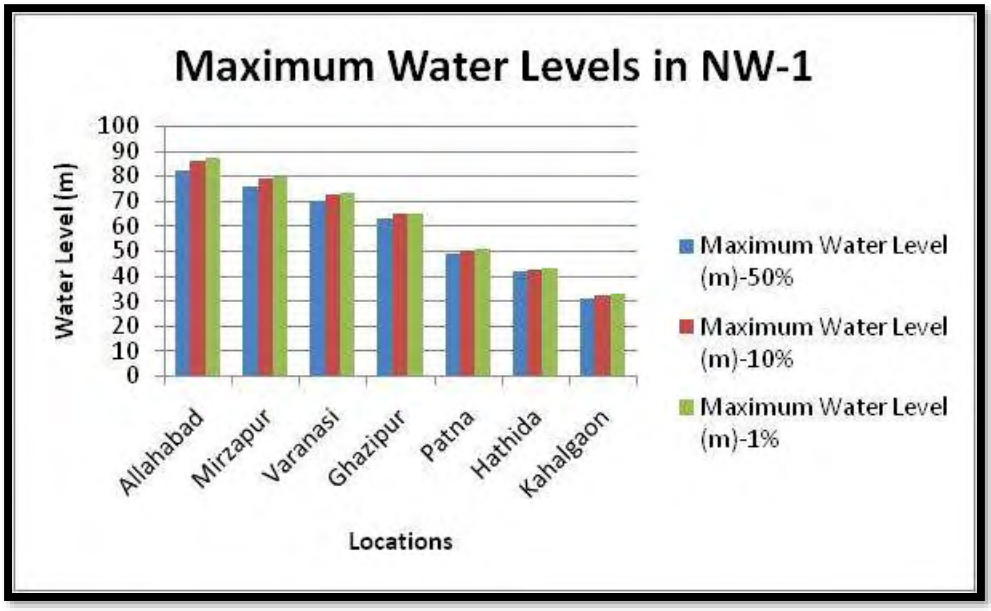


Figure 3.10 : Maximum Water Levels for a Range of Annual Probabilities

3.11. Tidal Variation in NW-1

Tides affect the Hugli River as far as Nabadwip, at Chainage 280km. According to the Admiralty Tide Tables (Indian Ocean 2015), there is an average spring tidal range of 4.8m at Haldia. The average spring tidal range on the NW-1 route reaches a peak at Diamond Harbour, of around 4.9m before diminishing with distance landward, such that it has reduced to about 4m in Kolkata, to 1.5 to 2.0m at Tribeni (IWAI 2012 NW-1 River Pilot), and effectively to zero at Nabadwip.

The tides are predominantly semi-diurnal, with two high waters, and two low waters occurring during any 24-hour period. The tidal conditions are largely governed by the (predictable) tidal cycles, but the river freshwater discharge influences the local conditions in the tidal stretch of the river significantly. In the tidal section of the waterway, in general terms, the water will continue to flow down-river on the ebb (falling tide). However, the flow direction is reversed to flow up-river on the flood (rising tide).

One of the important feature of tidal stretch of NW-1 is presence of tidal bore[14] which is significant risk to navigation. When a tidal bore forms in a river, the direction of flow of the water changes abruptly as the bore passes. There may be significant surges for some time after the passage of the bore wave. KoPT predicts the occurrence of the tidal bores for the year.

B: ALTERNATIVE ANALYSIS

3.12. Analysis of Alternatives

[14]A tidal bore (or bore) is tidal phenomenon that, in particular conditions, causes the flooding tide to propagate up an estuary as a distinct wave resulting in high energies on the river bed and in the water column and a rapid change in water level associated with passage of the wave. At low water, during spring tides, the flow of the flood current is checked by the shallow and restricted bed of the Hugli River and by the seaward flow of water from the upper reaches. These conditions can lead to the creation of a tidal bore. The Hugli River tidal bores are associated with periods of large tidal ranges

Analysis of alternatives is an analytical comparison of the operational effectiveness, costs and environmental and social risks of proposed development options. This helps to analyze the options critically in relation to its impacts on all physical, social and biological environment. For this project, alternative analysis has been made for three considerations, i.e. strategic, planning and technology consideration and they are briefed below

3.12.1. *Strategic Consideration*

This analysis enables us to justify that why and how much the project is viable. A comparison is made for "With" & "Without" project scenario for the physical, social and biological environments. This helped in assessment and comparison of the potential impacts on these environments in both the scenario. The scenario having minimal impact is recommended for selection. This has helped us to find the benefit of development of the project. Detailed analysis is given below in **Table 3.16.**

Table 3.16 : Alternative Analysis- "With & Without Project Scenario"

Environment	Without Project	With Project
Status of Transportation Infrastructure[15]	IR is oversaturated[16] in many sections. Ideally coal and iron ore are supposed to be trucked by road for short distances, mainly from mines to rail sidings only. However, at present larger volume of cargo is being transported via road due to insufficient capacity of IR. Road network is also not sufficient and adequately developed especially in minor towns/villages. Density of road network in India is high but the road quality suffers in terms of pavement thickness, distressed bridges etc. Thus to cater the freight transportation, there is high need of expansion & improvement of IR & road network.	IWT mode will facilitate shift of the freight from roads & IR leading to reduction in congestion on already congested IR & roads. This may reduce the need of expansion and will make the transportation safe and reliable. Infrastructure development for developing waterway involves comparatively lesser expenditure than required for developing IR & road network for transportation of equivalent amount of freight.

[15]Transportation network for freight and passenger is backbone of economy of every country. Transportation network should be robust, reliable, cost efficient, time efficient, energy efficient and environment friendly which can ensure intime delivery of goods with no or minimal emissions or pollution involved. Economy of India is world seventh largest in the world by nominal GDP. But various hurdles are in the way to achieve further higher economic growth and some are inadequate transportation network & infrastructure, poverty, unemployment etc. India's rail network is world's 4th longest and most heavily used system in the world and India's road network is 2nd largest road network in the world. But due to its high population, India's road & railway network is over utilized and insufficient to cater the freight transportation requirement of the country. Thus there is need of expansion of the road/ railway network or to find out alternate & efficient mode of transportation

[16]Oversaturation has implications for the quality of service of freight trains and severely restricts IR to meet customer expectation. Some of the section of IR has been working above their capacity, especially on eastern corridor line, i.e. Delhi-Howrah Currently this route face 140-150% of capacity utilization and rail route is considered congested, if its utilization is more than 80%. Speed of the freight trains remained stagnant from 25-29 kmph against design average speed of 60 kmph. Majorly nine commodities are transported trough trains such as coal (46%), iron ore (13%), cement (11%), fertilizers (5%), steel (5%), raw material for steel plants (5%) except iron ore, cement (11%), food grains (5%), petroleum products (4%) and container traffic (4%) and others (2%)

Physical Environment	**GHG Emissions:** In this scenario GHG emissions associated with freight transportation through rail/road mode will continue to generate, thereby increasing overall GHG emission load. Emission. GHG Emissions associated for movement of cargo estimated to be transported through NW-1 (calculated for maximum terminal capacity as planned in phase I) through from rail & road are 84 billion & 277 billion g/yr respectively. **Air Quality:** Air emissions will continue to result due to continued transportation of freight by road/rail. NOx; SOx; CO; PM & HC emissions associated for movement of cargo estimated to be transported through NW-1 (calculated for maximum terminal capacity as planned in phase I) through rail & road are 9.9, 2.8; 1.3, 1.28; 3.9, 1.06; 1.6, 0.5 & 2.77, 0.5 billion g/yr respectively. Also increasing freight transportation would require expansion of the road & railway network. Construction and operation of increased road/railway network will further add to the air emissions. Cutting of trees required for expansion of road/railway network will further deteriorate the air quality	**GHG Emissions:** Reduction in overall GHG emissions as IWT involves minimal fuel consumption thus minimal GHG emissions when compared to road & rail. As per analysis carried out, it is estimated that CO_2 (potential GHG) emissions associated with IWT for freight transportation (calculated for maximum terminal capacity as planned in phase I) from Haldia to Varanasi is 58.4 billion g/yr. **Air Quality:** Reduction in overall air emissions as IWT involves minimal fuel consumption thus minimal emissions are anticipated. As per analysis carried out, it is estimated that NOx; SOx; CO; PM & HC emissions associated with IWT for freight transportation (calculated for maximum terminal capacity as planned in phase I) from Haldia to Varanasi is 2.3; 0.36; 0.99; 0.2 & 0.5 billion g/yr. However, air emissions in immediate vicinity of the terminals are likely to increase due to increased nos. of vehicular movement near the terminal areas. These air emissions can be managed or reduced by using clean fuels like CNG or low sulphur diesel in transportation vehicles, development of adequate road network to prevent congestion and provision of avenue plantation. Air pollutants will be generated during construction phase of IWT infrastructure facilities but those will be short term, temporary and far less than generated in construction of road/railways.
	Water Quality: Due to construction of road/paved surfaces, run-off is likely to increase. This run-off may be contaminated with oil & grease. This run-off, if enter the water body may have impact on the aquatic flora	**Water Quality:** Impact is anticipated both during construction & operation phase. Water quality will be impacted during construction phase due to increased contaminated run-off from construction site, pilling and

	& fauna. The run-off generation will increase with increased network of rail/road which may be required to cater the increasing freight transportation	dredging activities for construction of off-shore structures. Water quality may be impacted during operation phase due to plying of vessels, dredging operations, usage of antifouling paints, discharge of waste/sewage/bilge water by vessels. These impacts are manageable by taking proposed mitigation measures.
	Loss of agricultural land and top soil: No loss of agricultural land/top soil is anticipated in existing scenario, i.e. without project scenario. But there is continual expansion of railway and road network to meet the freight & passenger transportation requirement of the country, which requires acquisition of agricultural land and loss of top soil. Also soil is required for construction of roads which is majorly sourced from agricultural fields.	**Loss of agricultural land and top soil:** Land requirement is minimal and is required only for development of civil interventions like terminal, jetties, locks. Land requirement is far less than the land required for road & railway projects.
	Material Sourcing: Construction materials like asphalt, aggregates, soil, paints, steel, cement etc. will be required for repair and maintenance of existing road/railway and expansion of road/railway. Material requirement for construction of road/railway are fairly large as compared to waterway project	**Material Sourcing:** Construction material like aggregates, cement, sand, steel etc. will be required for construction of navigational facilities and river bank protection works. However, the material requirement is comparatively lesser than required for maintenance and expansion of road & railway network
Terrestrial & Aquatic ecology	**Terrestrial Ecology:** Terrestrial ecology will not be directly impacted in without project scenario. However, the very need of expansion of road & railway network to increase the freight transportation may involve cutting of large nos. of trees and/or impacting the forest areas affecting the terrestrial	**Terrestrial Ecology:** Impact on terrestrial flora is anticipated only if the land acquired for development of civil interventions supports vegetation. While selection of site, areas of ecological importance and protected areas are avoided.

	ecology. Also the existing road crosses various eco-sensitive zones & forest areas and expansion if such roads will have greater impact on terrestrial ecology. **Aquatic ecology** Road/railways running along NW-1 crosses river Ganga at various locations. Construction of bridges leads to deterioration of aquatic ecology due to reduction in flow. Expansion of these bridges & construction of new bridges will have significant impact on aquatic ecology	**Aquatic Ecology:** Development of off-shore structures, barge operations and dredging activities has significant impact on aquatic ecology which requires to be managed adequately to minimize the impact.
Socio-economic Environment	**Loss of Valuable Time and efforts**: In without project scenario, insufficient transportation system will persist. Delays in material transportation and gaps in need and supply will persist. Public at large will continue to waste time in waiting at traffic jams triggered at railway crossings and roads. **Pressure on land:** Expansion of road/railway network will involve loss of land and livelihood of the farmers. **Pressure on Existing Resources**: People tends to settle in the area which has good connectivity leading to congestion in the area and increased pressure on the existing resources of that area. **Movement safety:** Road transportation is highly vulnerable to accidents. Accidents involve loss of life, injuries and damage of road infrastructure. **Employment Opportunities:** Employment generation involved only for construction of new road/railway alignment and maintenance of road/rail networks	**Loss of Valuable Time and efforts:** Shift of freight to IWT mode will reduce the congestion on road/rails thereby reducing the congestion. Also IWT ensures timely delivery/transportation of the material due to systemized movement of the vessels. **Pressure on land:** Land acquisition may be required for development of the civil intervention facility but it will be comparatively lesser than rail/road projects **Pressure on Existing Resources**: Increased traffic movement and other activities are anticipated at location of civil interventions which may lead to increase in pressure of existing resources like road, water supply etc. of that area. **Movement safety:** IWT mode is safest mode of transportation. **Employment Opportunities:** Employment generation is anticipated at proposed civil interventions and large no. of indirect employment may generate due to the increased freight transportation

Conclusion for Strategic Alternative Analysis:

Analysing both the scenarios for above mentioned criteria it is concluded that "With Project Scenario" is beneficial for all physical, biological and social environment when compared to "Without Project Scenario". With Project Scenario will improve the freight transportation efficiency, reduce the GHG emissions, fuel requirement, air emissions, land acquisition, tree cutting and land requirement required for maintaining and expanding road/railway network. However significant impact are anticipated on water and aquatic ecology in "With Project" scenario for which mitigation and management plans are to be prepared to minimize the impact.

3.12.2. *Planning Consideration*

This involves the consideration of options involved in planning stage, i.e. location of the proposed interventions, suitability of site, design of the project layout and dredging extent. This enables to select the option having best planning/design with minimal implication on physical, biological & socio-economic environment. Detailed planning alternative analysis is discussed in sections below

3.12.2.1 Selection of Locations for Civil Interventions

Locations are selected for proposed civil interventions (terminals/jetties) on the basis of potential of freight/cargo generation of the area and its connectivity with other modes of transport (rail & road). Ten such locations were selected for development of 6 nos. of terminals and 1 no. of lock.

One of the probable location at Bhagalpur was ruled out due to presence of Vikramshila Gangetic Dolphin Sanctuary and based on "NO GO" areas identified in Basin Level Critical Resources Assessment study. Some sites like site at Varanasi and Sahibganj were already identified by IWAI for development of terminals and land acquisition process was initiated so no alternatives were considered for such sites. Also alternatives for sites located on Government owned lands like Haldia terminal (located within industrial area) are not considered due to its insignificant impacts on socio-economy and environment. However, acceptability of these sites from environmental aspects were assessed which were found acceptable. Also with location perspective, a lock is required to be constructed at Farakka only near the existing lock. Thus for construction of lock also the location is pre-decided as per requirement. Alternative analysis of locations was carried out for social, environment and engineering feasibility. Detailed location alternatives analysis is given below in **Table 3.17** below.

Table 3.17 : Location Alternative Analysis

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
1.	Terminal site at Varanasi, U.P.	**Environment Considerations:** • Very less tree cutting associated (8 khajur tree & 4-5 babool shrubs) **Social Considerations:** • Site is agricultural fallow land with no development • Site already acquired by IWAI • Site is accessible and is close to highways, roads & railway • Settlements located are at app. 500 m from site thus minimal impact due to project activities **Design Considerations:** • Availability of LAD required for berthing and movement of barges	**Environment Considerations:** • Varanasi turtle sanctuary located at app. 2.3 km downstream of the site in North direction **Social Considerations:** • Site not directly connected to any public paved road at present	Selected	No alternatives assessed as site already selected and land already acquired. Anticipated impact on turtles due to barge movement is analysed to be low as nos. of barge movement will be app. 1-2 per day with regulated speed of 5kmph.	

2.	Terminal site at Haldia, W.B.	**Environment Considerations:** • No/very less tree cutting involved • Area located within industrial area thus raw materials to be transported available in shorter distance **Social Considerations:** • Site located within industrial zone of Haldia Dock complex • No R & R as site belongs to Haldia Dock Complex • Site well connected with roads & railways **Design Considerations:** • No river bank protection is required as already carried out by Haldia Dock Complex • Site close to Haldia Dock Complex and can share the facilities	**Environment Considerations:** • Haldia was listed as critically polluted area by MoEF&CC but now moratorium on further development have been lifted on 17th September 2013. **Social Considerations:** • Haldia listed as notified zone by CGWB for extraction of water, however no ground water usage is proposed **Design Considerations:** • Requires significant maintenance dredging	Selected	No alternatives assessed as site located on Govt land and is within the industrial complex. Dredging can be minimized as per requirement of the freight transportation	

3.	Terminal site at Sahibganj, Jharkhand	**Environment Considerations:** • Location of stone quarries in nearby areas thus locally available material to be transported • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Sahibganj is one of major centre of the Jharkhand for sourcing building & construction material • Site is close to highway & railways, i.e. within 1-1.5 km **Design Considerations:** • Availability of sufficient depth for berthing & movement of ships at app. 75 m inside the river and thus minimum dredging is required	**Environment Considerations:** • Requires cutting of app. 600 trees (orchard) • Existence of dolphins in this stretch of River which is Schedule 1 species as per Wildlife Act, 1972 **Social Considerations:** • Involves R & R thus significant social impacts but site acquisition already initiated • Site is not connected to any paved road at present 7 approach road is required to be constructed **Design Considerations:** • River banks and bed are required to be protected from erosion & scouring	Selec ted	All the negative impacts listed are manageable with proposed environment & social management plans thus no major drawbacks associated with the site	

4.	Terminal site at Ghazipur, U.P (2 sites considered at Ghazipur)	**Environment Considerations:** • Sites are not part of or close to any eco-sensitive location **Social Considerations:** • Railway and agricultural land available for locating the terminal • Good connectivity • Availability of cargo	**Environment Considerations:** • Dredging may be required to carry out at one of the selected location **Design Considerations:** • River unstable and channel gets silted up	One site selected at Ghazipur	Analysis to be carried out for selection of one of the two sites considered. No major environment, social or design issue associated	
5.	Terminal site at Ballia, U.P.	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Site is close to road & rail which connects to other cities like Varanasi, Gorakhpur & Patna • App. 15 ha of agricultural land available at the identified location **Design Considerations:** • Stretch is easily navigable • Availability of	**Environment Considerations:** • Site highly prone to flooding • Problems of sedimentation & bank erosion and requirement of river training works **Social Considerations:** • Approach road will have required to be constructed for connecting the site • Provision of railway connectivity to the terminal site may be a problem • Involves land acquisition	Not Selected	Lot of site maintenance, river training work, dredging work are involved	

		sufficient cargo for transportation	**Design Considerations:** • River is unstable and show migration • High sedimentation due to confluence of secondary channel & tributaries near the site • Presence of migration sand bars • Potential of complex flows at confluence points of primary & secondary channel during medium & low flow			
6.	Terminal site at & near Doriaganj (Semaria), Bihar (2 sites considered at Doraiganj & Kalughat)	**Environment Considerations:** • Locally available raw material (sand) for transportation • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Area well connected by road & Railways to all major cities • Agricultural land available for setting up terminal facility **Design**	**Environment Considerations:** • Requires tree cutting **Social Considerations:** • May Involves land acquisition	One of the two sites considered is selected	No major environmental engineering and social issues associated with the site	

		Considerations: • River channel is stable • No shoal formation and availability of LAD • Availability of sufficient cargo for transportation				
7.	Terminal site at Barh, Bihar	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Site close to road & railways connecting site to the major cities • App 11.5 ha of agricultural land available **Design Considerations:** • Availability of sufficient cargo for transportation especially coal due to presence of TPP (NTPC)	**Environment Considerations:** • Large nos of tree cutting involved • Location of important bird areas (IBAs) in Barh **Social Considerations:** • Requires demolition of houses located within site and involves R & R **Design Considerations:** • Highly mobile river channel with secondary channel and large central shoal • Location of large pylon in the river obstructing the navigation	Not Selec ted	Stretch not feasible for navigation and large no. of tree cutting required	

8.	Terminal site at Kahalgaon, Bihar	**Social Considerations:** • Site close to road & railway network connecting site with rest of the city & other cities • App. 18 ha of agricultural land with no development available **Design Considerations:** • Relatively stable river channel • Availability of deeper river channel along opposite banks	**Environment Considerations:** • Few trees located at the site which may require to be cut • Bank erosion prominent • Site prone to flooding • Location near Vikramshila Dolphin Sanctuary **Social Considerations:** • Involves acquisition of land and R & R activities **Design Considerations:** • Presence of rocky outcrops in upstream of proposed site	Not Selected	High flooding risks and navigational hazards and near the Vikramshila Dolphin Sanctuary	
9.	Terminal site at Tribeni, W.B. (2 sites are considered)	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Site well connected with road & railways • Availability of agricultural land **Design**	**Social Considerations:** • Involves land acquisition and R & R • Site is low lying and requires significant land filling and thus have associated impacts like borrowing of earth, loss of agricultural	One of the two sites considered is selected	One of the two sites is selected. No major environment, social and design constraint	

		Considerations: • River is stable in this stretch • Availability of sufficient cargo for transportation	soil etc. **Design Considerations:** • Some design constrains at both the sites			
10.	New Lock at Farakka	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Land belongs to FBP and can be transferred thus no R & R involved • No major development at the site **Design Considerations:** • Lock is required at Farakka as existing lock is not properly functioning and is essential component of navigation channel of NW-1	**Environment Considerations:** • Inundation of existing land	One of the two sites considered is selected	Site is to be selected in Farakka as lock is essential component of navigation here. No major environmental, design and social constraints associated with Farakka site	

Conclusion for Location Alternative Analysis:

Out of the total 10 locations, 6 locations were finalized for construction of terminal and one location is finalized for development of lock. Varanasi, Sahibganj & Haldia terminal sites were pre-decided. Also location of lock was pre-decided, i.e. Farakka. There is requirement of navigation lock in that stretch due to large water level difference in river & feeder canal and existing lock does not work optimally. Environmental, social and biological impacts of development of terminal & lock on these locations are identified and accordingly mitigation and management plans are developed.

Remaining six sites were analysed from environmental, social, design considerations. Based on alternative analysis three terminal sites at Ghazipur, Tribeni, Kalughat near Doraiganj were considered as preferred sites for these interventions. The other three terminal sites at Barh, Kahalgaon & Balia were not considered feasible due to (i) various environmental considerations including proximity to Vikramshila Dolphin sanctuary and Important Bird Areas, (ii) design issues such as unstable river, presence of navigational hazards and high sedimentation rate (iii) social issues concerning acquisition of land and (iv) connectivity.

Further alternative analysis was carried out for probable two sites at each of the above identified three terminal locations and Farakka lock based on environmental, social and design consideration. As per this analysis the preferred sites for these intervention locations were considered for design and environmental impact assessment.

3.12.2.2 Selection of specific site at each selected location

One or more sites were analysed at each selected locations for setting up proposed terminal or lock facility. Sites were selected and analysed for environmental, social and design consideration and the analysis is given in **Table 3.18.**

Table 3.18 : Site Alternative Analysis

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
1a	Terminal site at Ghazipur, U.P.- Site 1	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Site belongs to Indian railways and thus does not involve R & R • Site directly connected with existing IR and connects to NH through small paved road • Availability of the cargo traffic. NH-97 has large volume of traffic which can be diverted here	**Environment Considerations:** • Requires large quantity of dredging and thus high threat to aquatic ecosystem and issues of disposal of dredged sand **Social Considerations:** • Land available is only 3 ha which is insufficient for terminal development without any demolition and requires demolition of 20 houses to acquire 2 ha additional land **Design Considerations:** • Site located on secondary channel of River	Not selected	Dredging requirement is too high and it will have high associated cost and damage to aquatic environment	

			Ganga which is silted up and is dead channel			
1b	Terminal site at Ghazipur, U.P.- Site 2	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Site is private agricultural land with no development on it • Good road & railway connectivity of site. **Design Considerations:** • Site is located on main channel of River Ganga • Availability of LAD of 2.5 m close to shoreline • Availability of the cargo traffic. NH-97 has large volume of traffic which can be diverted here	**Social Considerations:** • No paved road connecting the site and approach road is to be constructed • Involves land acquisition **Design Considerations:** • River is not stable at this location and River training works may require to be carried out	Selected	No major environmental and social impact anticipated with site and will also help in reducing the freight load from NH-97 thereby reducing GHGs and other air pollutants	

2a	Terminal site at Doriaganj (Semaria), Bihar	**Environment Considerations:** • Locally available raw material (sand) for transportation • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Area well connected by road & Railways to all major cities • App. 12 ha of agricultural land is available for development of terminal. Land does not support and development at present **Design Considerations:** • River channel is stable • No shoal formation and availability of LAD • Availability of sufficient cargo for transportation	**Environment Considerations:** • Requires tree cutting **Social Considerations:** • Involves land acquisition	Not Selected	Involves tree cutting and acquisition of agricultural land	

2b	Terminal at Kalugha, Sitabganj, Bihar	**Environment Considerations:** • Locally available raw material (sand) for transportation • No environmental sensitive location will be affected **Social Considerations:** • Availability of sufficient land • Site well connected by road & railway • Site is vacant and involves no development **Design Considerations:** • Availability of sufficient LAD • River section suitable for navigation	**Social Considerations:** • Involves acquisition of land	Selected	Site has no environmental, design & social issues associated	
3a	Terminal site at Tribeni, W.B.-Site 1	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Site is close to	**Environment Considerations:** • Site is low lying area and requires filling **Social Considerations:** • Involves land acquisition and R	Selected	Availability of sufficient cargo, no major environmental issues, stable river channel with manageable river bank protection works makes site suitable for terminal	

		road & railways which will connect site to rest of the town and other cities • App 40 ha of agriculture/brick kiln land available **Design Considerations:** • River is stable in this stretch • Availability of sufficient cargo for transportation • Site is not part of or close to any eco-sensitive location	& R **Design Considerations:** • Site located on inside bend of the river and naturally deep water is available on opposite bank of the river • Requires maintenance dredging for maintaining berth pocket and approach channel to terminal		development	
3b	Terminal site at Tribeni, W.B.- Site 2	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Availability of 10 ha of agricultural land for development of terminal with no development • Site is located	**Environment Considerations:** • River training works are not acceptable at the site due to built up nature of land • Site is low lying and requires significant land filling and thus has associated impacts like borrowing of earth, loss of	Not Selected	Disadvantages cannot be overcome through mitigation and management measures	

		close to railway and road connecting site to other cities • Internal road of city connects site to the highway **Design Considerations:** • Availability of sufficient cargo for transportation	agricultural soil etc. **Social Considerations:** • Site is located in thickly populated area • Traffic pressure on internal city road will increase significantly after development of terminal and its expansion will be problem due to location in thickly populated area **Design Considerations:** • Extension of railway line to the site is not easily feasible • Possible water intake is located within the site • A channel connecting to the main river at both ends is traversing the area & is probably a source of water for intake structure for			

			water supply to the town • Shallow water depth along the river bank and dredging will be required to maintain the approach channel			
4a	New Lock at Farakka Parallel to existing lock	**Environment Considerations:** • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Land belongs to FBP and can be transferred thus no R & R involved • No major development at the site • Land required is 14.86 ha **Design Considerations:** • Length of extension of U/s channel is 190 m & D/s channel is 310 m • Dredging	**Social Considerations:** • Some farmers practice agriculture on the FBP land	Selected	No disadvantage associated with the site and is better w.r.t the second site selected for development of the lock	

		requirement of 0.5 lakhs cum in U/s approach channel and 0.8 lakhs cum in D/s approach channel to maintain LAD of 3 m • Length of FBP road to be realigned-675 m • Length of boundary wall to be constructed-1180				
4b	New Lock at Farakka D/S of existing lock	**Environment Considerations:** Site is not part of or close to any eco-sensitive location **Social Considerations:** • Land belongs to FBP and can be transferred thus no R & R involved • No major development at the site	**Environment Considerations:** **Social Considerations:** • Land required is 26.46 ha, large as compared to other option considered **Design Considerations:** • Length of extension of U/s channel is 575 m & D/s channel is 460 m • Dredging requirement of 1.5 lakhs cum in U/s approach	Not Selected	No major environment or engineering issues associated but parallel site is better in all respect to this site	

			channel and 1.5 lakhs cum in D/s approach channel to maintain LAD of 3 m • Length of FBP road to be realigned-980 m • Length of boundary wall to be constructed-1672			

Conclusion for Site Alternative Analysis:

Alternative sites were selected in case of 4 selected locations for development of terminals and lock, i.e. terminal site at Gazipur, Tribeni and at/near Doraiganj and lock site at Farakka. Considering environmental, social and environmental implications of development of terminal, suitable sites are selected.

3.12.2.3 Design Planning

After selection of site for development of the terminals, alternatives are selected for layout design and alignment of proposed roads and railways for connecting the site. Design planning helps to optimize the project cost during construction as well as during operation phase. Such alternatives are considered at few locations as per the requirement of locations. Details of the same are given in sections below. Alternative layout designs and location of road/rail alignment to provide connectivity is assessed in case of Sahibganj terminal & Farakka lock only. No major issues are associated with the Varanasi & Haldia site so no alternatives were considered

A. <u>Alternative layout Designs at Sahibganj Site</u>

Two layout designs were considered for development of the terminal at Sahibganj site. Alternative 1 involves construction of U shaped jetty (25 m), aligned parallel to the River bank and connected to bank by approach trestle of 50 m and alternative 2 involves construction of jetty at the river bank aligned parallel to it. Both the alternatives were compared on multiple criteria, i.e. operational considerations, navigational aspects, ease of construction & maintenance, flexibility of expansion, construction cost and environmental consideration. Detailed multi-criteria analysis for both the alternatives considered is given below in **Table 3.19.**

Table 3.19 : Alternative Layout Analysis of Sahibganj Terminal

S. No.	Criteria Description	Anternative-1	Alternative-2
1.	Dredging at Jetty	As the berth is located in deep water and connected to shoreline by approach trestle, there is no requirement to carry out the dredging.	As the berth is located on river bank itself where shallow water is available, there is requirement to carry out the dredging.
2.	Dredging in approach channel, turning circle and maneuvering area	As there are some pockets in approach channel, turning circle and maneuvering area where water available is less than the required draft of design vessel, dredging is required to be carried out.	Same as Alternative-1 but the dredging quantity is worked out to be more in this alternative.
3.	Scope for Expansion	As sufficient river front is available, there is enough scope for expansion in Alternative-1.	Same as Alternative-1
4.	Degree of Operation	As the cargo is proposed to be handled by combination of dumpers, pay loaders and barge loaders in Phase-1, the degree of operation is good in this alternative.	Same as Alternative-1

5.	Ease of Construction	As Alternative-1 involves construction of jetty along with 50 m long approach trestle, the construction can be carried out easily by well-established methods.	As Alternative-2 involves construction of jetty at river bank only, the construction can be done easily in relatively short time as compared to Alternative-1.
6.	Cost of Construction	The cost of construction for Alternative-1 works out to be marginally higher in comparison to Alternative-2.	The costs of construction for Alternative-2 is marginally lower than Altenrative-1.
7.	Environmental Consideration	Reduced dredging requirement will have lesser need for disposal of dredged material and also will have lesser disturbance to river system and aquatic life.	Larger dredging will have comparatively larger disturbance to river system and aquatic life.
8.	Layout		

Based on multi criteria matrix presented above, both the alternative layouts have certain advantages as well as disadvantages. It could be observed that in terms of available required depth round the year without need of dredging and marginal cost difference between two alternatives, and environmental consideration Alternative-I is preferred alternative for development of IWT Terminal at Sahibganj in Jharkhand.

B. **Alternative Layout Design of Farakka Lock**

Two Options for locating the new navigation lock have been considered. In Option - I, the new lock will be located parallel to the existing lock and in Option - II, it will be located D/S of the existing lock. Sufficient distance between the two locks has been kept in Option 1 so that there is no danger to the structure of existing navigation lock. Detail comparison of Option-I and Option II is provided in **Table 3.20.**

Table 3.20 : Alternate Site Analysis (Option-I & Option-II)

S. No.	Parameter	Option-I	Option-II	Remarks
1	Land Required (ha)	14.86	26.46	Land required in Option-II is almost two times
2	Length of extension of U/S Approach Channel (m)	190	575	• Length is almost three times in Option-II as compared to Option-I. • While Option-I involves construction of only the left Bank of the channel and protection works on left bank only, Option-II involves construction of both the banks of the channel and bank protection works on both the banks. This means additional cost in Option-II.
3	Assuming water depth	0.05	0.15	Quantity of excavation in Option-II is almost three times than that in Option-

	of the channel as 3-m, approximate quantity of dredging in excavation for U/S Approach Channel (million mm^3)			I.
4	Length of extension of D/S Approach Channel (m)	310	460	• Length is 150-m more in Option-II. • While Option–I involve construction of only the left bank of the channel and protection works of left bank only, Option-II involves construction of both the banks of the Channel and bank protection works on both the banks. This means additional cost in Option-II
5	Assuming water depth of the channel as 3-m, approximate quantity of earth work in excavation for D/S Approach Channel	0.08	0.15	Quantity of excavation in Option-II is almost double than that in Option-I.
6	Length of FBP Inspection Road to be realigned (m)	675	980	Length of the road to be realigned is almost 50% more in Option-II. It means requirement of additional land as well as additional cost.
7	Length of Boundary Wall to be constructed (m)	1180	1672	Length of the boundary wall in Option-II is about 500-m more than the length in Option-I. It means requirement of additional land as well as additional cost.
8	Layout Design	 Option-1		 Option-2

In view of advantages of Option, I over Option II as listed above, the Option I (locating new Lock parallel to the existing lock) is recommended. Dredging requirement for option I is almost half the requirement in option II. Length of extension of U/s & D/s approach channel is almost three times in option II as compared to option I. 675 m of existing FBP road will

required to be realigned in option I whereas 980 m will be required in option II. Thus it is anticipated disturbance in case of option II is more than that in option I. Thus it is recommended to adopt the option I. Present EIA study has been carried out considering the impact of considered option I only.

C. **Alternative Approach Road Alignments: Sahibganj Terminal**

At present site is not connected with any paved road. It is proposed to develop a four lane approach road to connect the site to NH-80. Two alignments are considered for development of the six lane road. Both the alignment's start & end points are at the same location and both alignments will cross the LC-54 of existing Railway line. On LC-54, it is proposed to provide the ROB to ensure smooth movement of vehicles. Comparative analysis of both the alignments is given below in **Table 3.21**

Table 3.21 : Alternative Road Alignment Analysis for Sahibganj Terminal

S. No.	Criteria Description	Anternative-1	Alternative-2
1.	Environmental Consideration	Cutting of trees	Cutting of trees
2.	Social Consideration	This alignment involves widening of the rural road and large nos. of households will be impacted. Movement of large no of trucks will cause increased noise level in village area.	Large land acquisition but lesser displacement & dislocation.
3.	Design Consideration	Length of this alignment is 1 km. Brownfield alignment and involves improvement of rural road.	Length of this alignment is 1.5 km. Greenfield alignment.
4.	Alignment		

Based on alternative analysis, it is concluded that environmental & social impacts on both the alignments are equal as both alignment involves tree cutting, land acquisition and displacement & dislocation of pucca structures. However, considering the design, alternative 1 is found to be more feasible.

D. **Alternative Railway Siding Alignments Considered for Sahibganj Site**

It is proposed to develop railway connectivity for terminal site with existing Railway Line. Three options are considered for giving the connectivity to the terminal site and are given below.

- 1st Option-Near Sahibganj railway Station
- 2nd Option-From Level Crossing Gate No. 53 or 54 at Sakrigali Railway Station
- 3rd Option-From loop line at Sakrigali Railway Station

All the three options are analyzed for environmental, social and design consideration and detailed analysis is given below in **Table 3.22.**

Table 3.22 : Alternative Railway Siding Alignment Analysis for Sahibganj Terminal

S. No.	Criteria Description	Anternative-1	Alternative-2	Alternative 3
1.	Description	Railway track is proposed to take-off near Sahibganj Railway Station and following existing main line leading to the entrance of the terminal	Two sub-options as Options 2A & 2B are identified where the railway track from Level Crossing Gate No. 53 & 54 shall take-off and following the curve leading to the entrance of the terminal	Railway track is proposed to take-off from loop line at Sakrigali station and following a U-turn leading to the entrance of the terminal
2.	Environmental Consideration	Involves tree cutting	Involves tree cutting	Involves tree cutting
3.	Social Consideration	Involves land acquisition, disturbance to pucca structures and R & R	Involves land acquisition, disturbance to pucca structures and R & R	Involves land acquisition, disturbance to pucca structures and R & R
4.	Design Consideration	This option is not found to be feasible as no railway land is available near Sahibganj Station to have additional track and also length of track works out to be on higher side.	Both these sub-options have not been found to be feasible in view of the high level difference between the track and terminal area exceeding the permissible gradient and curve limits under the Railway rules.	Found feasible considering the length of track, permissible gradient, degree of curve and cost involved
5.	Alignment			

Based on alternative analysis, it is found that only alternative 3 is technically feasible. Social & environmental implications of all the three alignments are same.

3.12.2.4 Maintenance of LAD

Dredging is required to be carried out so as to maintain the length and width of the channel and maintain LAD near the berths/jetty. IWAI proposed either maintaining 3m LAD throughout the NW-1 stretch or maintained different LAD in different stretches (3 m Haldia to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi). Alternative analysis was carried out for both these options considering environmental (dredge quality, impact on aquatic ecology and water quality), social (cultural and aesthetic value, employment and socio-economic consideration) and technical feasibility (dredge quantity, navigation

feasibility, economic aspects, dredgers and other infrastructure requirements). Both the options have their pros and cons and are discussed at **Table 3.23.**

Table 3.23 : Alternative Analysis for Dredging Quantity

Considerations	Option 1 (3 m LAD in entire NW-1) In CUM	Option 2 (LAD of 3 m Haldia to Barh (Bihar), 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi) In CUM	Remarks
Dredging Quantity in Dry Season	31,079,576	1,57,60,596	Option 2 is app. 50% of option 1 hence less environmental, social and economic impacts associated with option 2
Navigation	In entire NW-1	Possible from Haldia to Varanasi during dry season	Option 1 provides better navigation facilities
Cost	High	Comparatively lower	Cost in option 1 is app. double the cost in option 2 due to doubling of quantity
Dredgers and other infrastructure requirement	32-33 (if dredgers work for 10 hours in month of 25 days in double shift)	16 (if dredgers work for 10 hours in month of 25 days in double shift)	Requirement of dredgers and dredging infrastructure is almost double in option 1 as compared to option 2
Disturbance to social, cultural and aesthetic value	Comparatively more than option 2	Comparatively less than option 1	Option 1 will have more disturbance as it covers the larger stretch
Disturbance to aquatic flora & fauna	Comparatively more than option 2	Comparatively less than option1	Option 1 will have more disturbance as it covers the larger stretch
Employment	More	Less	Since the dredging is to be undertaken at larger stretch in option 1, employment to larger nos. of people will be provided in option 1.

As per above analysis option of maintaining different LAD at different stretch was found most preferred option.

3.12.3. *Technology Consideration*

This enables to select the technology best suited for the site specific environment and having minimal implication of environment, social and biological component of environment. Technological consideration for selection of type of dredgers is made as maintenance dredging is one of the crucial activities of operational phase which will be continued for app. 8 month every year.

3.12.3.1 Selection of Dredger

Selection of dredgers is important as selection of dredger has environmental implications such as effect of production rate on the project duration, the levels of turbidity and suspended sediment concentrations generated relative to background levels, the proportion of total sediment lost to the environment and the degree of contamination in the sediment.

Typically, CSDs have least effect on turbidity at the dredging site and TSFDs produce similar low turbidity when used without overflow. Grab dredgers and TSGDs when used with overflow, produce significantly high turbidity throughout the water column near the dredging site than do CSDs. However, reverse is true for placement site. CSDs and TSHDs fluidise the sediments by mixing them with water than the mechanical dredgers do. Fluidized sediments by CSDs and TSHDs causes discharged material to cover larger area when unconfined. Comparative analysis of types of dredger and their relative performance related to environmental aspects is given below in **Table 3.24** & **3.25**.

Table 3.24 : Comparative Analysis of Dredgers and Their Relative Performance Related to Environmental Aspects

	Safety	Accuracy	Turbidity	Mixing	Spill	Dilution	Noise
Suction dredger	+	-	+	-	-	0	+
CSDs	+	+	0/+	0/+	0	0	+
TSHD	+/0	-	-/0	-	0	-	+
Bucket Ladder Dredger	-	+	-/0	0/+	+	+	-
Backhoe Dredger	-	+	-/0	+	+	+	+
Grab Dredger	-	-	-/0	0	+	+	+

+ is better than average, 0 is average and – is below average

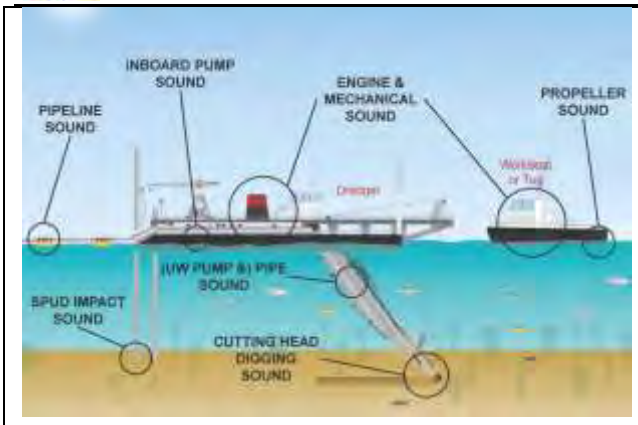
Table 3.25 : Comparative Analysis of Different Type of Dredgers Related to Environmental Aspects

Attributes	CSD	Hopper Dredgers	Grab/Bucket Dredger	Back hoe Dredger
Type	Hydraulic	Hydraulic	Mechanical	Mechanical
Strata	All type-soil, sandy, silty and	Silty and gravel	Silty, gravel, mud and soft rock	Clay & Gravel

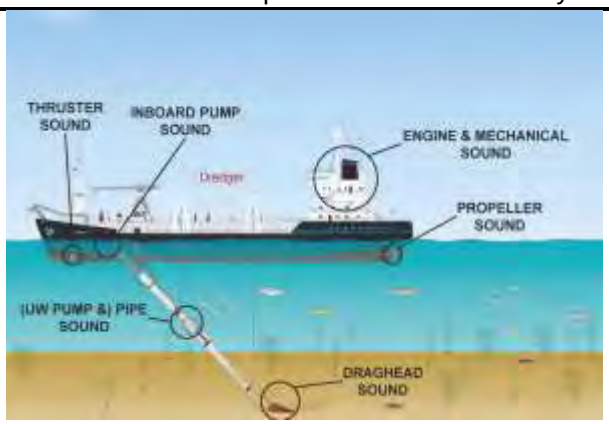
	rocky			
Usage	Inland waters	Coastal areas	Coastal waters and inland waters	Shallow waters and confined places
Underwater Noise levels at 1 m- underwater at 1 µPa2m2	172-185 d B	186-188 dB	Less	186-188 dB
Ambient Air Noise Level dB(A)	100-115dB (A)	100-112dB (A)	115dB (A)	110-118 dB(A)
Suspended Sediment Generation during dredging (kg/cum)[17]- Annexure 3.1	Ordinary 4,000 PS1/- 2.2 – 4.5 Ordinary 2,000 PS-0.1 – 0.3	2.4-5.2	0.4-5	--
Suspended Sediment Generation during placement of dredged material (kg/cum)[18]- Annexure 3.1	Ordinary 4,000 PS1/- 1.2 – 1.4 Ordinary 2,000 PS-NA	12-203	NA	--
Schematic diagram showing noise sources	**Figure 3.11**			

[17] *Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992*

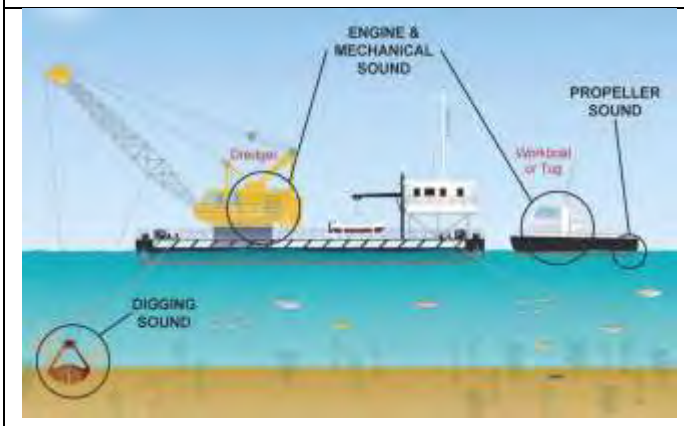
[18] *Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992*



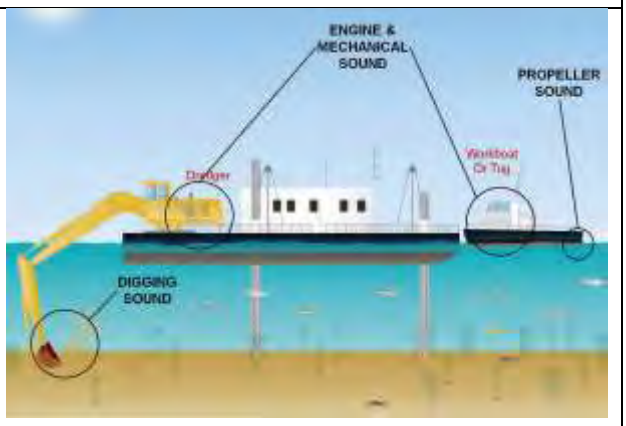
Cutter Section Dredger



TSHD



Grab Dredger



Back Hoe Dredger

Figure 3.11 : Diagrammatic Presentation of Different Type of Dredgers Showing Different Noise Source

Conclusion for Selection of Dredgers

The CSD was considered as most preferred option due to least associated environmental Impact and operational feasibility. As per experience of KoPT[19] and IWT CSD has proved to be the best option and is considered for maintenance dredging planning and environmental impact assessment. Technical brief of the CSDs is given in **Annexure 3.2.**

C: DEVELOPMENT OF NAVIGATION CHANNEL, PLANNED AND PROPOSED PROJECT COMPONENTS

The developmental activities include maintenance of Navigational Channel (Least Available Depth for Navigation), Barge operations, and Physical interventions (Such as construction of Terminals, Navigation Lock, River training structures, RO-Ro Jetties). Details of these interventions are described below.

3.13. Least Available Depth for Navigation in NW-1

For navigation purpose, it is essential that minimum depth of the water is maintained in the river all the time of navigation. IWAI is currently maintaining LAD for managing the

[19] KOPT is using CSD dregeres. According to KoPT it is impractical to use trailer suction hopper dredger (TSFDs) for shallow draught dredging. TSFD is practically a barge mounted and in no way a viable option for inland waterways due to high cost, larger sailing distance and shallow waters.

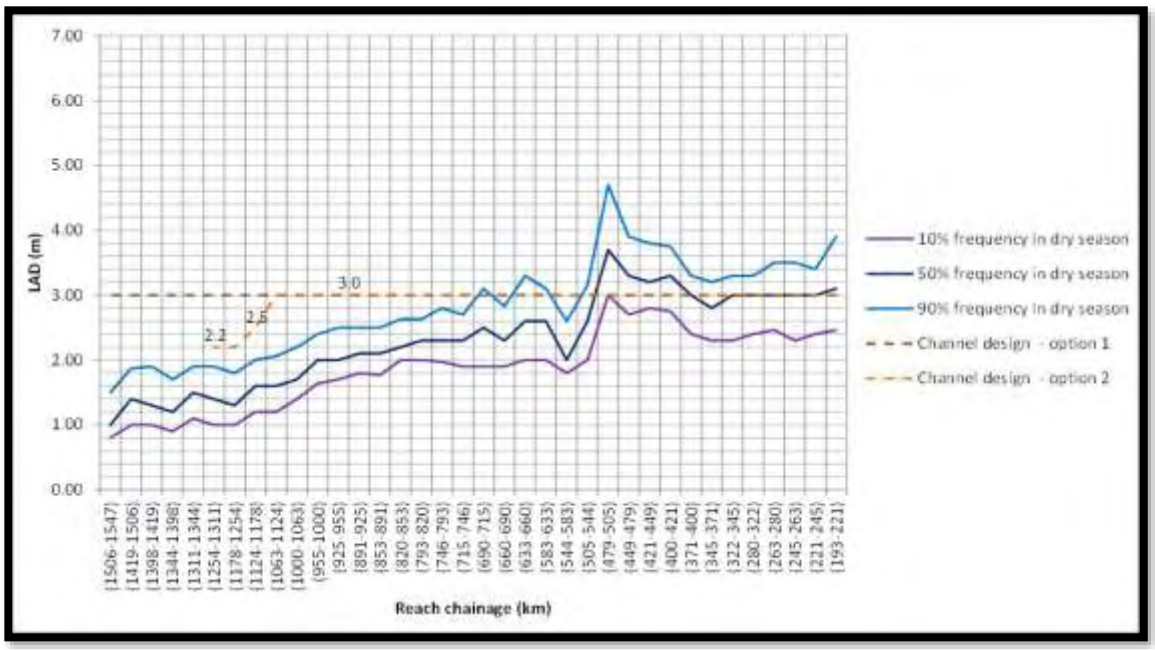
navigation in NW-1 through dredging and bandalling. Depths[20] maintained by IWAI in different stretches currently is given below

- Haldia (Sagar) - Farakka (560 km)-2.8-3.0 m
- Farakka - Barh (400 km)-2.1-2.5 m
- Barh - Ghazipur (290 km)-1.6-2 m
- Ghazipur – Chunar/Allahabad (124 km)-1.2-1.5m
- Chuna-Allahabad (246 km)-No maintenance

However, "Jal Vikas Marg" Project aims at maintenance of LAD to 3 m in entire NW-1. But to optimize the cost, deployment of dredgers, manage man-power and minimize environmental impacts, IWAI is focussing on different depths in different stretches at present.

- Haldia to Farakka (544 km)-3 m
- Farakka to Barh (347 km)-3 m
- Barh to Buxar (233 km)-2.5 m
- Buxar to Varanasi (187 km)-2.2 m

Varanasi to Allahabad (236 km)- no maintenance The above consideration also takes into account assessment of 10%, 50% and 90% frequency of occurrence of LAD during the dry season (Nov-June) for 2010-2015 carried out by design consultant which is shown at Figure **3.12**.



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.12 : LAD Along the waterway for the 10, 50 & 90% frequency value

3.14. Maintenance Dredging in NW-1

[20] As per the surveys carried out by IWAI, depths available in NW-1 naturally are as follows:.

- Haldia to Tribeni (196 km)- LAD of 3m- throughout the year
- Tribeni to Farakka (364 km)- LAD of 2.5 m – 320 days
- Farakka to Ghazipur (690 km)- LAD of 2 m- 200 days
- Ghazipur to Allahabad (370 km)-LAD of 1.5 m-170 days

Dredging is required to be carried out so as to maintain the length and width of the channel and maintain LAD near the berths/jetty. At present dredging of 0.7 million cum is being undertaken by IWAI between Farakka to Barh & Barh to Patna. However, for year I maintenance dredging is planned as per required minimum LAD. Two options are opted for LAD. Option 1: 3m LAD thought NW-1(Haldia to Allahabad), Option 2: varied LAD between different sections between Haldia to Varanasi i.e. 3 m LAD from Haldia to Barh, 2.5 m from Barh to Buxar, 2.2 m from Buxar to Varanasi, and naturally available LAD between Varanasi to Allahabad (no dredging between Varanasi to Allahabad). Dredging quantity is estimated for achieving both the options in different sections. Dredging quantity is calculated for channel width of 64 m, and 1:10 side slope. Estimated dredging quantity will be as low as 50% in average flow conditions in option 2 compared to option1. Reach wise detail of the tentative dredging quantity in both the options is given in **Table 3.26** and summary of the tentative dredging quantity in different stretches is given in **Table 3.27.** For purpose of environmental impact assessment study, preferred option 2 is being considered. However, impacts of both option 1 & 2 are assessed in the impact assessment chapter.

Table 3.26 : Reach Wise Detail of Dredging Quantity (Option1 & option 2)

S. No.	Start	End	Option 1		Option 2	
			Average Flow (December) cum	Average Flow (Dry) cum	Average Flow (December) cum	Average Flow (Dry) cum
1.	Haldia	Tribeni	--	--	--	--
2.	Tribeni	Balagarh	208,500	208,500	208,500	208,500
3.	Balagarh	Kalna	193,002	193,002	193,002	193,002
4.	Kalna	Samudragarh	140,031	140,031	140,031	140,031
5.	Samudragarh	Nabadwip	51,855	51,855	51,855	51,855
6.	Nabadwip	Patuli	168,416	168,416	168,416	168,416
7.	Patuli	Katwa	133,483	133,483	133,483	133,483
8.	Katwa	Plassey	306,265	306,265	306,265	306,265
9.	Plassey	Chumarigacha	115,304	115,304	115,304	115,304
10.	Chumarigacha	Berhampore	76,121	76,121	76,121	76,121
11.	Berhampore	Mahammadpur	104,598	104,598	104,598	104,598
12.	Mahammadpur	Nasipur	148,823	148,823	148,823	148,823
13.	Nasipur	Jangipur	8,009	8,009	8,009	8,009
14.	Jangipur	Farrakka	8,185	8,185	8,185	8,185
15.	Farrakka	Rajmahal	84,676	174,321	84,676	174,321
16.	Rajmahal	Manihari	114,824	332,797	114,824	332,797
17.	Manihari	Karagola	430,541	945,924	430,541	945,924
18.	Karagola	Kahalgaon	193,914	685,960	193,914	685,960
19.	Kahalgaon	Bhagalpur	73,621	346,174	73,621	346,174
20.	Bhagalpur	Sultanganj	74,578	335,109	74,578	335,109
21.	Sultanganj	Munger	320,194	636,630	320,194	636,630
22.	Munger	Mahendrapur	183,846	364,106	183,846	364,106
23.	Mahendrapur	Semaria	487,580	702,489	487,580	702,489
24.	Semaria	Barh	641,884	1,094,622	641,884	1,094,622
25.	Barh	Mehnar	852,786	1,128,642	585,661	811,907

26.	Mehnar	Patna	1,566,955	2,060,893	1,072,193	1,475,192
27.	Patna	Doriganj	877,707	1,345,685	510,806	880,303
28.	Doriganj	Ballia	1,635,429	2,826,940	1,041,072	1,896,619
29.	Ballia	Buxar	284,847	826,628	112,731	485,201
30.	Buxar	Ghazipur	433,521	1,282,515	88,582	456,523
31.	Ghazipur	Saidpur	989,081	1,934,918	395,416	924,991
32.	Saidpur	Varanasi	1,717,726	2,575,922	930,815	1,549,137
33.	Varanasi	Chunar	1,163,500	1,436,199	5,000	5,000
34.	Chunar	Mirzapur	2,085,582	2,991,955	--	--
35.	Mirzapur	Rampur Ghat	1,173,041	1,589,645	--	--
36.	Rampur Ghat	Sirsa	357,143	830,872	--	--
37.	Sirsa	Allahabad	2,144,355	2,968,038	--	--

Source: HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant) India

Note: No dredging is at present planned to be undertaken between Varanasi & Allahabad stretch of NW-1.

Table 3.27 : Dredging Volumes in different Stretches for Maintaining LAD

Stretch	Stretch Length (km)	Average Annual Dredge Volume (cum)		
		Present Day 2013-2014	LAD of 3 m	LAD of 3 m from Farakka to Barh, 2.5 to Buxar & 2.2 m to Varanasi
Haldia to Farakka	544	--	1,662,592	1,662,592
Farakka to Barh	347	3,70,000	5,618,132	5,618,132
Barh to Patna	64	3,30,000	3,189,534	2,287,099
Patna to Buxar	169	--	4,999,253	3,262,123
Buxar to Varanasi	187	--	5,793,355	2,930,650
Varanasi to Allahabad	236	--	9,816,710	n/a
Total	1547	7,00,000	31,079,576	1,57,60,596

Source: HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant) India

Apart from dredging requirement for maintain LAD in navigation channel, maintenance dredging is required to be carried out at proposed Haldia Terminal. To provide 24X7 accesses to Haldia terminal, it is required to carry out dredging of 0.10-0.20 million cum/year at the Haldia terminal. Some maintenance dredging will also be required to be carried out at other proposed development sites like Sahibganj but that is not significant and thus not quantified here. To carry out these dredging operations, various equipment like cutting section dredgers, along with plough dredgers, agitation dredgers and Backhoe Dredgers are proposed to be used.

Requirement of Dredgers for Maintaining LAD in Navigation Channels: Maximum capacity of one dredger in one month is to dredge 50,000 cum of sand if there are 25 working days in month of 8 hours each. If dredger works at its maximum capacity for 6 months, then dredging volume per dredger of 3,00,000 cum can be achieved. Average volume to be dredged to maintain LAD in navigation channel as per option 2 is 1,57,60,596 cum/year thus it would require 53 dredgers working at their maximum capacity for 6 months. To optimize the nos.of dredgers, it is proposed to extend daily operation hours from 8 to 10 hrs so as nos. of dredgers required will be 43. If dredger works for 10 hrs in a day for 8 months, then dredgers required will be 32 nos. only. If dredgers work this way in 2 shifts,

then no. of dredgers required will be 16 only. However excess dredging may be required when water levels are lower than average water levels during dry season. Dredging should be supplemented by bandalling works so as to increase effectiveness of dredging and reducing requirement of dredging.

Type of Dredgers:

CSD (cutter section dredgers) is proposed to be used for Jal Marg Vikas Project along with the agitation (plough dredger) dredgers and Backhoe Dredgers (BHDs). The dredging plant will require support vessels, including bunkering, survey, accommodation and tugs. Plough/agitation dredgers could be used to dredge shallow waters or removing high spots (dredge cut <0.5 m). Channel width is 64 m and CSDs used by IWAI have swing width of 35-40 m thus two CSDs can be deployed in pairs leaving the off-set to prevent overlap to dredge the channel. Dredging depth varies from 0.5-3 m, means about 1-4 cuts will be required to achieve the required depth (dredge cut <0.5 m).

Water levels start reducing from mid-October and dredging operation would be required to be started during this period. Plough/agitation dredgers can be used in initial period to dredge shallow waters/ high spots. When depth reduces significantly by November CSDs will be used for dredging. Dredging operations will continue from mid-October to June. During monsoon season, i.e. July-mid October repair & maintenance of dredgers can be taken up.

Dredge Disposal:

Disposal of dredged material through CSDs will be done through pipeline into the free stream of the river in a way to avoid material working its way back to dredged channel. This can be achieved by disposing in faster flowing water, downstream and to the side of the working dredgers and disposal of material into secondary channels or redundant channels. Material dredged by BHD will need to be placed in a barge and disposed of away from the channel as the reach of the BHD is unlikely to be sufficient enough to reach the faster flow for dispersion of the material. Therefore, it is required to find potential disposal sites for this material.

3.15. Physical Intervention

3.15.1. *Navigation Aids*

3.15.1.1 Existing Navigation Aids on NW-1

- Temporary channel marks for day navigation maintained between Tribeni and Allahabad all-round the year.
- Night navigation aids were maintained between Tribeni and Varanasi (1187km) with country boats/ MS poles fitted with navigational lights and beacons
- DGPS stations at Bhagalpur, Patna and Swaroopganj.
- 12 Nos. survey vessels. Thalweg surveys conducted fortnightly during low water period and on monthly basis in flood season
- 77 Cargo vessels deployed in operations between Haldia & Kolkata
- 3 nos. cargo vessels on voyage charter basis and 3 nos. cargo vessels on bare boat charter basis on NW-1, NW-2 and Indo-Bangladesh Protocol route
- Eight Cutter Suction Dredgers (CSD) one Hydraulic Surface Dredger (HSD) and one Amphibian Dredger (AD) for maintain LAD in NW-1
- River Information System Development for Haldia to Farakka stretch which is 545 km in length. The project has 7 base stations, 2 control stations and has 30 vessel

stations. Project costs app. INR 26.3 Cr. River information system is a form of vessel traffic management system using combination of modern technologies like automatic identification system, Radar, Meteorological & hydrological equipment and software information technology related services designed to optimize traffic and transport processes in inland navigation. The system enhances swift electronic data transfer between mobile vessels and shore stations through advance and real time exchange of information. RIS aims to streamline the exchange of information between various stakeholders of Inland Water Transport. The system facilitates exchange of real time information like, wind speed, fog conditions, danger areas, depth information, route details between operators and vessel masters. This system will enhance the inland navigation safety in ports and rivers and optimize the resource management of the waterborne transport chain which will enhance the efficiency of inland navigation and help in providing traffic and transport information to the operators for an efficient & optimal navigation on Ganga. This immensely helps in optimization of navigation and minimizes collision risks in the waterway thus benefitting the users greatly.

3.15.1.2 Planned/Proposed Navigation Aids on NW-1 under Jal Marg Vikas Project

It is planned to develop navigation aids all along the NW-1 so as to ensure better navigation both during day and night. Navigation aids to be provided includes the following as per IWAI planning

- Upgrade the physical aids to navigation like channel marks, navigation lights, and signals between Haldia to Farakka
- Install comprehensive physical aids to navigation including navigation lights between Farakka and Allahabad
- Extending the NW-1 River Information System (RIS) to cover Farakka to Allahabad section also. Farakka to Allahabad stretch is further divided into Farakka to Patna and Patna to Varanasi stretch. Work on Farakka to Patna has already been started which is 410 km in length and the section Patna to Varanasi which measures 356 km is under tendering process. Farakka to Patna stretch will comprise of 6 base stations and 1 control station and cost for this stretch will cost INR 15.89 Cr. Patna to Varanasi stretch will comprise of 4 base stations and 1 control station and will cost INR 14.56 Cr.
- Communicating the key navigation data to users in real time e.g. detailed LAD, water levels, flow speeds, visibility, vessel congestion, operational status (one way/two traffic) etc.

Other planned development to build better understanding of the waterway performance and sharing knowledge with the waterway users are detailed below.

- Target and prioritise immediate/short-term physical intervention measures based on feedback and reports of experience from waterway users.
- Collect comprehensive data on all navigation incidents, and near-misses. Analyse these data, and take appropriate actions to prevent similar occurrences in the future.
- Collect detailed waterway performance data e.g. vessel congestion bottlenecks, incident hotspots, and effectiveness of dredging/bandalling activities. Continuously monitor and analyse the performance to identify and prioritise waterway management activities, and report to users.
- Publish detailed navigational guidance information for key navigation challenges and bottlenecks.

- Update and upgrade the pilotage information available in the NW-1 River Pilot (particularly for middle and upper sections of the waterway)
- Introduce immediate- to short-term skills training programme for IWT vessel masters and crews
- Establish and enforce minimum competency levels and qualifications for all IWT commercial masters and crews.
- Establish a long-term training and apprentice scheme/system for all IWT commercial users.
- Build engagement with local waterway users (fishermen, ferrymen and sand miners). Establish an information feedback mechanism with these users.
- Raise awareness of risks (to all waterway users) and opportunities associated with additional IWT traffic on the waterway.

3.15.2. *Navigations Infrastructure*

3.15.2.1 Existing Navigation Infrastructure

Navigation infrastructure existing at NW-1 which facilitates the cargo transportation are listed below

- Low & High level jetties at Patna
- GR jetty in Kolkata
- Fixed Jetty at Farakka & Pakur
- Floating terminals at Haldia, BISN & Botanical Garden in Kolkata, Tribeni, Shantipur, Swaroopganj, Katwa, Hazardwari, d/s Farakka, u/s Farakka, Manglahaat (Rajmahal), Samdaghat (sahebganj), Bateshwarsthan, Bhagalpur, Munger, Semaria, Buxar, Ghazipur, Ramnagar (Varanasi) and Allahabad.

Details of the location, Chainage, capacity, area, facilities of these above mentioned existing facilities in NW-1 are given below in **Table 3.28**. Map showing location of the existing developments in NW-1 is given in **Figure 3.13** below. Photographs of some of existing facilities along NW-1 are given in **Figure 3.14.**

Table 3.28 : Details of Existing Infrastructure in NW-1

A. Floating Terminals

Sl. No.	Name of terminal with chainage (In km)	Land area (in Sq. m)	Size of berth, water front (In metre)	No. of Pontoon Barge & Gangway	Cargo Handling equipment	Storage area	Link approach road	Security (in each shift)	Water/ Lighting facility	Remarks
1	Allahabad (Ch. 1535)	8.759 Hectare Land	35 m berth & 300 WF	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land 5000 Sq. m	Pucca Rasta (Concreted road)500 m and metalled road 2 kmconnected with NH 76	01 no. armed 01 no.unarmed	Drinking Water facility available	Generator could be provided for lighting if required
2	Ramnagar (Varanasi) (Ch. 1315)	5.586 Hectare Land	35 m berth & 300 WF	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land 2000 Sq. m	Land acquisition in process for approach road of about 700m connecting with NH 07	01 no. armed 01 no. unarmed	-	Being developed under Jal Marg Vikas Project
3	Ghazipur (Ch. 1177 Km) / Rajghat (Varanasi)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon. Private land could be made available if required	Kachcha Rasta(Earthen Road) 100m and Pucca road 100 m connected with NH 19	-	Drinking Water facility available	Generator could be provided for lighting if required
4	Buxar (Ch. 1124 Km)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon. Private land could be made available if required	KachchaRasta100m and Pucca road 400 m connected with NH 84	-	Drinking Water facility available and Street Lights available as provided by Local Administration	
4	Semaria (Ch. 850 Km)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Crane on Pontoon available	To be stored on Pontoon. Private land could be made available if required	Kachcha Rasta 200m and Pucca road 300 m connected with NH 31	-	Drinking Water facility available	
5	Munger (Ch.793Km.)	3.40 Acre Land	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land 1000 Sq. m	Pucca Rasta 100 m and metalled road 5 km connected with NH 80	01 no. armed 01 no. unarmed	Drinking Water facility available and Street Lights available provided by Local Administration	Generator could be provided for lighting whenever required
6	Bhagalpur (Ch715Km.)	3.86 Acre Land	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land 1000 Sq. m	Pucca Rasta 300 m and metalled road 2 km connected with NH 80	01 no. armed 02 nos unarmed	Drinking Water Sodium Vapour Lamps (Full Illumination)	DGPS Station is operational and being utilized since 2010.

7	Bateshwarsthan (Ch. 683Km.)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon.	Kachcha Rasta 200m and Pucca road 5km connected with NH 80	-	Drinking Water facility available	Generator could be provided for lighting whenever required
8	Samdaghat (Sahebganj) (Ch.617Km.)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Crane on pontoon	To be stored on Pontoon. Private land could be made available if required	Kachcha Rasta300m and Pucca road 1km connected with NH 80	-	Drinking Water facility available	Generator could be provided for lighting whenever required
9	Manglahat (Rajmahal) (Ch. 588Km.)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon. Private land could be made available if required	Kachcha Rasta 100m and connected with NH 80	-	Drinking Water facility available	Generator could be provided for lighting whenever required
10	U/s Farakka (Ch. 545.0)	4800	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon & land of FBP	100 m	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps	Land belongs to FBP being used by IWAI.
11	D/s Farakka (Ch. 542.0)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon.	Along the road	NIL	Street Lights provided by Local Administration	Land not available pontoon placed on water front
12	Hazardwari (Ch. 439.0)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon.	100 m	NIL	Street Lights provided by Local Administration	Land not available pontoon placed on water front
13	Katwa (Ch. 334.50)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon.	1.5 km	NIL	NIL	Land not available pontoon placed on water front
14	Swaroopganj (Ch. 280)	2337	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	One Godown of size 4.5 x 5 m and Open space 290 m^2	500 m	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps	Land taken from KoPT on lease basis
15	Shantipur (Ch. 241.0)	8000	35 m berth & 100 WF	01 Pontoon 06 Modular Pontoons Gangway	NIL	To be stored on Pontoon and open space of IWAI's land 2000 Sq. m	3 km	03 nos. unarmed	NIL	Land belongs to State Govt. of W.B. being used by IWAI.
16	Tribeni (Ch. 196.0)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon	Along the road	01 nos. armed 02 no. unarmed	NIL	Land not available pontoon placed on water front
17	BISN Jetty & G.R. Jetty-1 (Ch. 135.0)	30409.64	70 m berth & 100 WF	03 Pontoons 01 Steel Gangway	NIL	Open Space area 6000 m^2	1 km	01 nos. armed 03 no. unarmed	Sodium Vapour Lamps (Full Illumination)	Land taken from KoPT on lease basis
18	Botanical Garden Jetty (Ch. 134.5)	996	35 m berth & 50 m WF	01 Pontoon 01 Steel Gangway	NIL	To be stored on Pontoon	150 m	03 nos. unarmed	Sodium Vapour Lamps (Full Illumination)	Land belongs to KoPT being used by IWAI.
19	Haldia (Ch. 35.0)	10930	70 m berth & 200 m WF	04 Pontoons 01 Gangway	NIL	One Godown of size 12 x 30 m and Open space 1630 m^2	3.5 km via HDC	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps	Land taken from Haldia Dock Complex (HDC) on lease basis.
B. Fixed RCC Jetties										

Sl No	Name of terminal with chainage (In km)	Land area (in Sq. m)	Size of berth, water front (In mtr.)	No of Pontoon Barge & Gangway	Cargo Handling equipment	Storage area	Link approach road	Security	Water/ Lighting facility	Remarks
1	G.R.Jetty-2 (Ch. 134.5)	14,557	70 m berth	-	-	One Transit shed of size 25 x 46 m and Open space 4000 m^2	500 m.	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps (Full Illumination)	Land taken from KoPT on long term lease basis. RCC Jetty completed and being operational since Nov., 2013.
2	Farakka RCC Jetty (Ch. 542 km)	-	115 m berth	-	-	-	Along the road	-	Drinking Water Sodium Vapour Lamps	Owned by FBP this can be used by the common users.
3	Pakur RCC Jetty (Ch. 522 km)	-	60 m berth	-	-	-	1 km	-	-	Owned by FBP this can be used by the common users.
4	Patna (Gaighat) (Ch. 955Km.)	2.93 Acre	46.0 m berth 100 m WF	Nil	Shore Crane-2 with capacity of 01 - 20 tonnes subject to radius	45m x 14m Transit shed and open space of IWAI's land 1000 Sq. m	Pucca Rasta 500 m and metalled road 2 km connected with NH 30	01 no. armed 03 no.unarmed	Drinking Water Sodium Vapour Lamps (Full Illumination)	Permanent High level Jetty and DGPS Station is operational and being utilised since 2012.

(Source: Howe Engineering -Detailed Feasibility Report)

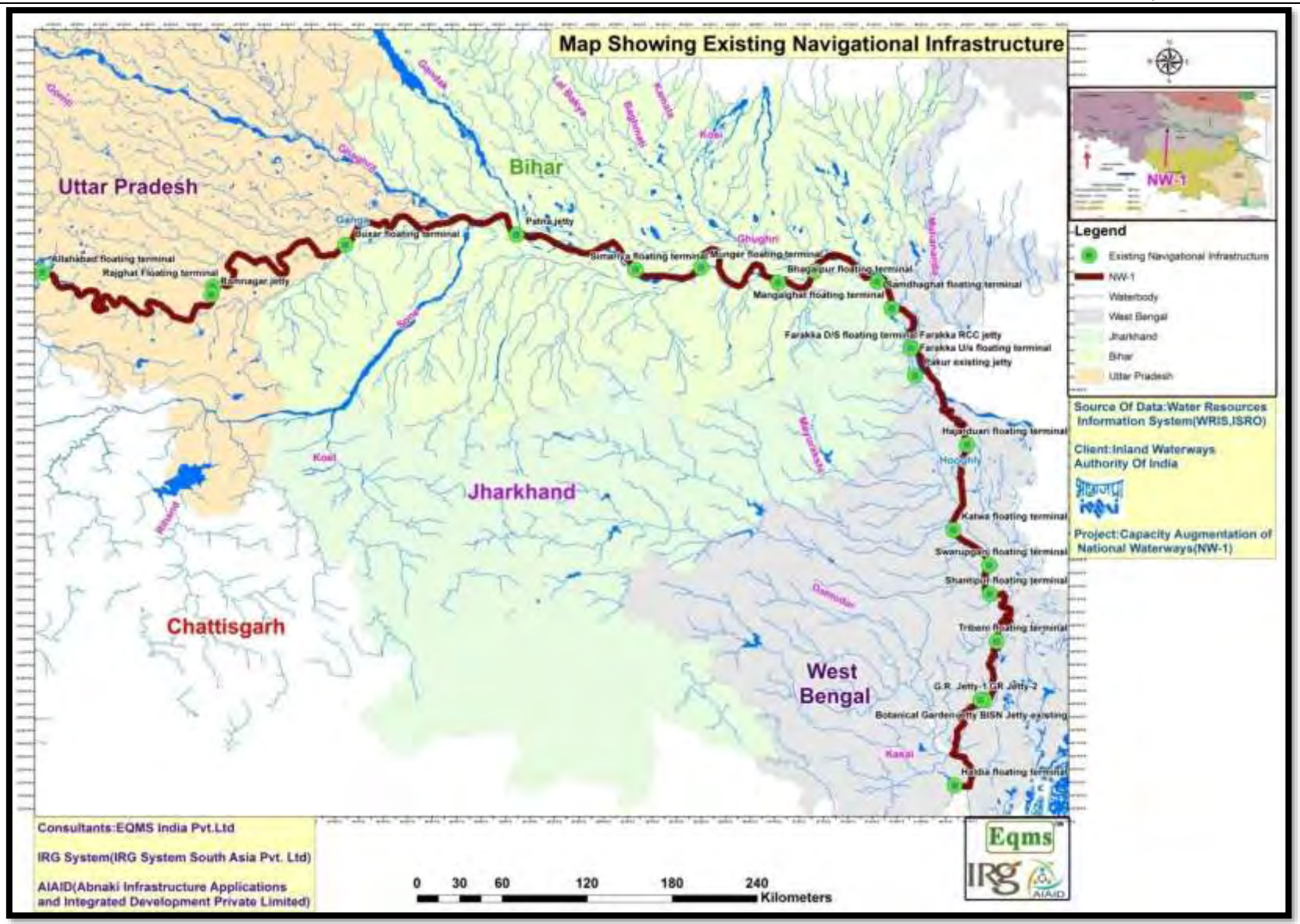


Figure 3.13 : Existing Navigation Infrastructure Facilities in NW-1

Mangal Haat, Jhakhand	Pakur Jetty
Farakka Lock	Existing Patna Terminal

Figure 3.14 : Photographs of Existing Infrastructure along NW-1

3.15.2.2 Planned/Proposed Infrastructure on NW-1 under Jal Marg Vikas Project

Jal Marg Vikas project involves development of various components for capacity augmentation of NW-1. Some of these components are already planned and being implemented, some are at initial stage of planning and some are yet to be planned. Details of all such components is given below

Planned Infrastructure

1. Terminal sites at Haldia, Sahibganj & Varanasi
2. New Lock at Farakka
3. Bank Protection and River Training Works at existing and planned civil interventions
4. Maintenance dredging for maintenance of waterways and proposed civil interventions/navigation infrastructure

Infrastructure Facilities at Initial Planning Stage

1. Terminals at Ghazipur and Tribeni (Kalyani)

Facilities yet to be planned

1. One similar terminal site
2. 10 Nos. Ro-Ro Jetty and Passenger Ferry Jetties
3. Development of low draught cargo
4. River Training Works at Critical Locations like bends and civil interventions under planning
5. Bank/slope & scour protection works

6. Equipment of tow barges, inland vessels, survey vessels including rescue boats and survey equipment
7. Barge maintenance and repair facility

Location of existing and proposed navigation infrastructure facilities for NW-1 under Jal Marg Vikas Project are shown at **Figure 3.15.**

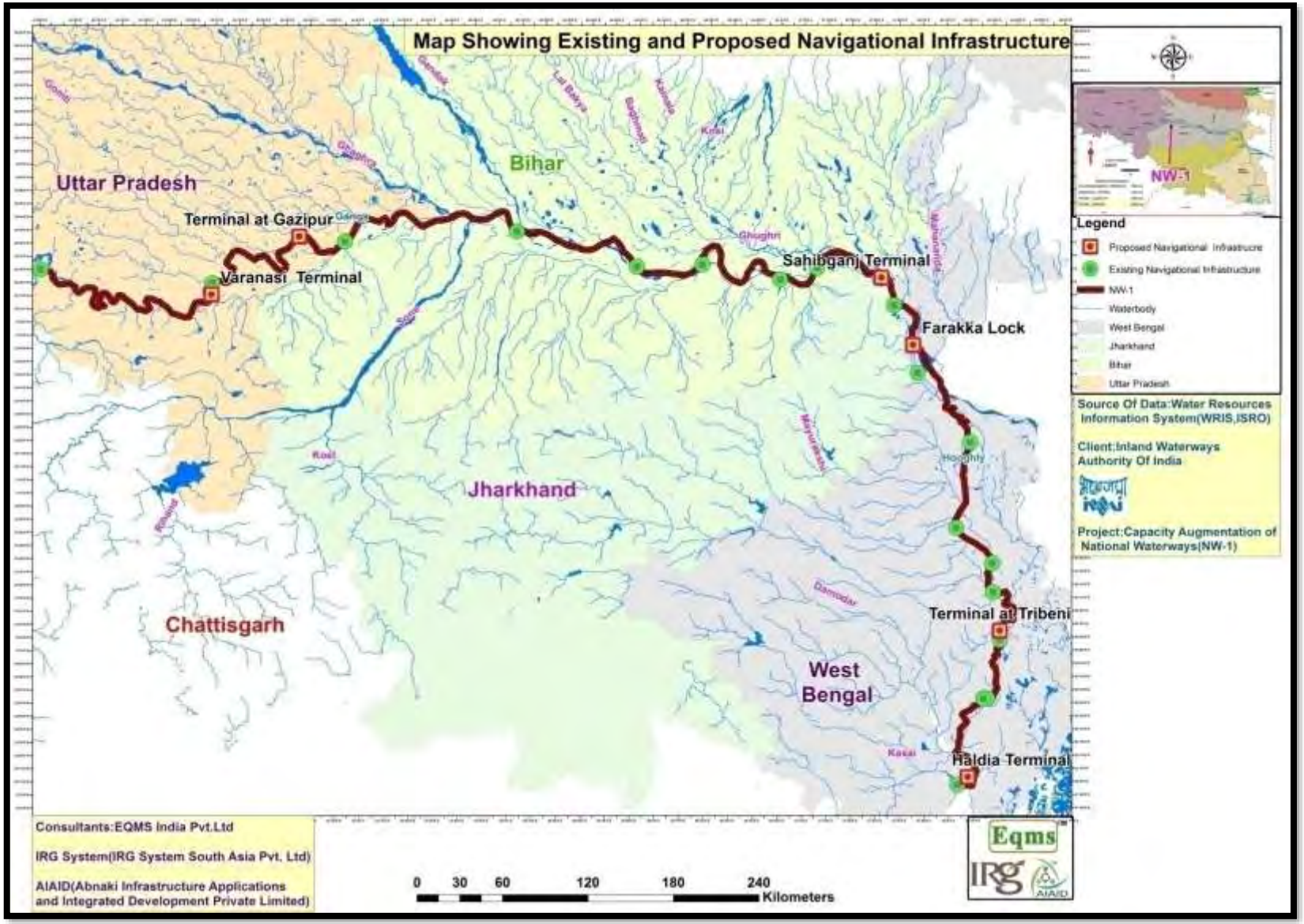


Figure 3.15 : Planned Navigation Infrastructure Facilities in NW-1 Under Jal Marg Vikas project

3.15.2.2.1 Terminal at Haldia

Haldia inland water terminal at River Hooghly (NW-1) is proposed to be located at River Hooghly at Industrial Zone of Haldia dock Complex near Durga Chak (J.L. No-135, Barmurchak-138 & Jagat Chak J.L. No-140), Haldia, District Purbi Medinipur, West Bengal. River Hooghly flows in South direction of the terminal site. Map showing location of Terminal at Haldia is given in **Figure 3.16.**

Figure 3.16 : Location Map of Haldia Terminal

Total area of terminal site is 61.0 acres. The identified land belongs to Haldia Dock Complex. Site is low lying area with elevation ranging from 4-9 m amsl. Photographs of the site are given in **Figure 3.17**. It is required to fill the site to achieve finished level of 7 m, i.e. 2.54 m above HFL. Soil required for filling is 3.3 lakhs cum. At present site is well connected with 7 m wide paved road (Haldia-Macheda Road) connecting the site with NH-41 as well as Haldia town. The NH-41 (Haldia-Kolaghat road) is located towards west direction at about 6.0 km from the site.

Figure 3.17 : Photographs of Haldia Terminal Site

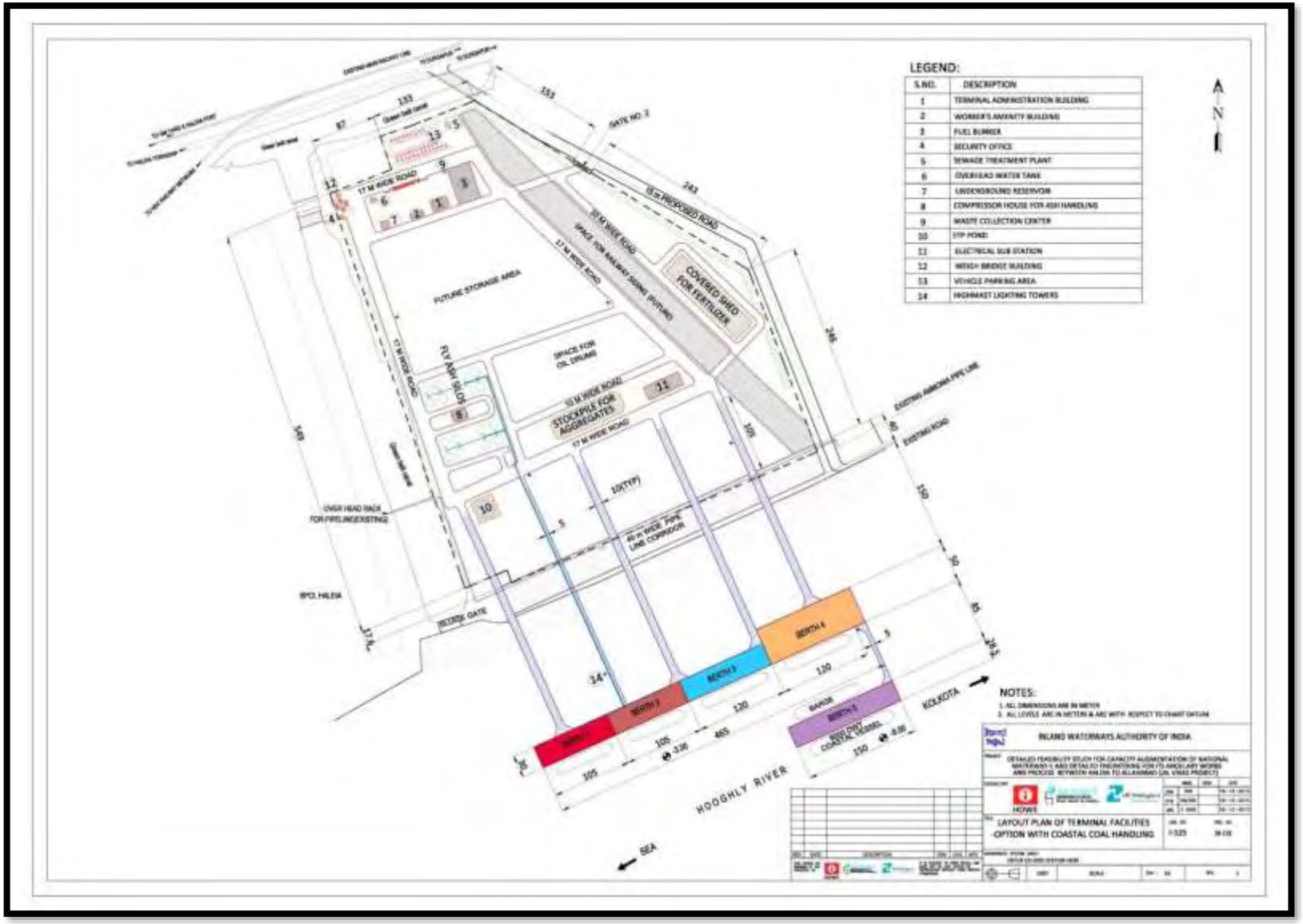
Terminal facility is designed to handle 4.07 MTPA of cargo. Out of 4.07 MTPA of cargo, 1.57 MTPA of cargo comprises of fly ash, fertilizer, stone aggregate, edible oil & POL. These materials will be stored, loaded, unloaded and transported from the terminal site. In addition to this transhipment of 2.5 MTPA of coal is involved. It is proposed to develop administrative building, worker's amenity building, fuel bunkers, security office, overhead water tank, STP, underground water reservoir, compressor house for ash handing etc. The proposed terminal project will be developed in phases, i.e. phase 1A & 1 B. Phase 1 A will comprises of all the proposed developments except berth proposed for transhipment of coal and 8 nos. of fly ash storage silos and its conveyors out of proposed 16 nos. of silos and stockyard development area (future storage). Salient features of the project are given at **Table 3.29** and layout plan of the terminal site at Haldia is given in **Figure 3.18.**

Table 3.29 : Salient Features of the Haldia Terminal

S. No.	Salient Feature	Capacity/Quantity/Nos.
1.	Location	Haldia Industrial Complex area, Haldia, District Purbi Medinipur, West Bengal.
2.	Geographical Coordinates	22°03'38.34"N & 88°08'29.49"E
3.	Capacity of Cargo Handling	4.07 million MTPA 1.57 MTPA for Stone aggregates, fertilizers, Fly ash and edible oil & POL and 2.5 MTPA for coal transhipment
4.	Connectivity	Site connected to NH-41 through 7 m wide road along western boundary of site. Nearest railway station is Durgachak Railway Station at 600 m in NE direction. Railway connectivity is not proposed.
5.	Topography of terminal site	Site is almost flat in topography and elevation ranges of 4-9 m amsl. Site requires levelling and filling (3.3 lakhs cum) to achieve finished level of 7 m
6.	Facilities Proposed for HaldiaTerminal (Phase 1A & 1 B)	• Storage sheds (future storage area will be developed in phase 1B) • 8 Nos. of Silos in phase 1A & 8 nos. of silos in phase 1B for flyash storage and pipeline conveyor system • Unloading & Loading Areas • Internal Roads • Berths (5 Nos.) (berth for coal transhipment in phase 1 B) • Water area & approach channel • Administration Building • Workers Amenity Building • Fuel bunker • Security office • Weigh bridge building • Lighting Towers • Railway siding (future development) • Other associated facilities like sewerage system, STP, dump pond, drainage system, RWH pond, fire-fighting facilities, communication system, water supply, ESS & power supply.
7.	Facilities to be shifted	Existing underground ammonia pipeline of Tata chemicals further towards the bank (above ground) and Existing Road to Mitsubishi Plant in South to Eastern Boundary of the site
8.	Shore Protection Works	The existing river bank protection works is adequate
9.	LAD (Least Available Draft)	3 m for barge vessels (4 nos. berths) and 8 m for large vessel (coal transhipment berth)
10.	Extension of Off-shore structure in River	Offshore structure | Extension of off-shore | Length of approach trestle | Length of Berth | Width of Berth

			structure (berth + approach trestle) inside the river	inside river		
		2 Nos of berths for barges	200	170	30	105
		1 Nos of berths for barges	200	170	30	120
		1 No of berth for barges/Berth No. 4	200	150	50	120
		1 No of berth for coal transhipment attached to Berth No. 4	313.5	85 + 50 m (length of berth no. 4)	28.5	150
		* length of 4 nos. approach trestle at terminal site is 145 m				
11.	HFL of the River	4.46 m amsl				
12.	Finished level of site	7 m				
13.	Top level of berth & approach trestle	14 m				
14.	Dredging During Construction Phase	7 lakhs cum				
15.	Material Transportation System	Trucks, Pay loaders, Barge loaders, mobile harbour cranes &gantry cranes. Flyash will be transported by trucks and loaded to the silos pneumatically by pumps and then it will be loaded to barge by pipe conveyor system. 16 Nos. silos of 1200 Tonne capacity will be provided for ash storage				
16.	Maintenance Dredging during operation phase	8.5 lakhs cum/year				
17.	Water Requirement-construction phase	90 KLD				
18.	Water Requirement-operation phase	70 KLD 20 KLD-Raw water requirement and 50 KLD potable water requirement				
19.	Power Requirement	Connected load-5500 KW Demand Load-2400 KW				
20.	Storm Water System	Open Storm water drains of total length 6 km Stock yard, parking area & roads –dump pond Buildings- Rain water storage sump				
21.	STP Capacity-Operation Phase	30 KLD				
22.	Dust Suppression Methods	Fly Ash-Dust extraction system on top of silos Aggregate & fertilizers stockyards- Swivelling plain water sprinklers for abatement of aggregate dust generation along the length of the stockpile.				

Source: Site visit &HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant) India



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.18 : Layout of Haldia Terminal Site

3.15.2.2.2 Terminal at Sahibganj

Sahibganj terminal will be developed along River Ganga, Village Samdha Nala & Rampura, Tehsil & District Sahibganj, Jharkhand. Map showing location of Terminal at Sahibganj is given in **Figure 3.19.**

Figure 3.19 : Location Map of Sahibganj Terminal Site

The total land required for the proposed project is estimated to be 78.91 ha (195 acres) including land for rail and road connectivity, land for resettlement colony and the construction of an ROB. Total estimated land for phase I is approximately 18 ha. Land is currently under residential and agricultural use, orchards (mango trees) and settlements. Land is undulating with level variation of 30-56 m amsl. Photographs of the site are given in **Figure 3.20**. At present site is not connected with any paved road. Nearest highway to the site is NH-80 (Sahibganj-Rajmahal road) located at 1.0 km from site in Southern direction. PWD is to construct a road to connect the terminal site with NH-80.

Figure 3.20 : Photographs of Sahibganj Terminal Site

Terminal will be developed in phases. Phase 1 of terminal is designed for handling cargo of 2.24 million MT per annum. Ultimate cargo handling from the terminal is estimated to be 9.00 million MT per annum. Salient features of project are given at **Table 3.30** and layout plan of the terminal site at Sahibganj for phase I is given in **Figure 3.21** below.

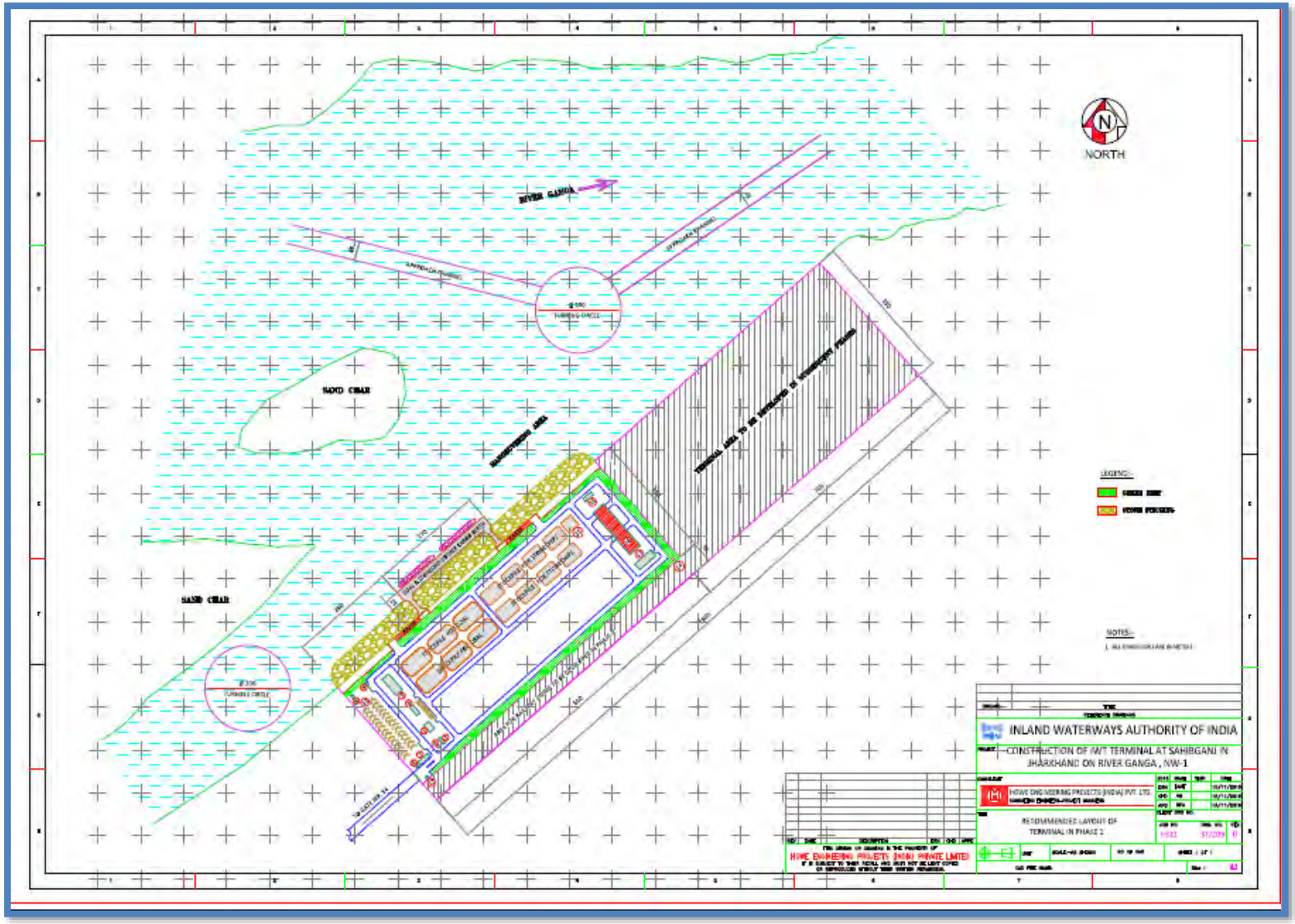
Table 3.30 : Salient Features of the Sahibganj Terminal

S. No.	Salient Feature	Capacity/Quantity/Nos.
1.	Location	River Ganga, Village Samdha Nala & Rampura, Tehsil & District Sahibganj, Jharkhand
2.	Geographical coordinates	25°15'0.73"N & 25°15'0.73"N
3.	Cargo Handling Capacity	Phase I-2.24 million MTPA Phase II-4.39 million MTPA Phase III-9.00 million MTPA
4.	Nature of Cargo to be	Coal, stone chips, food grains, cement, fertilizers &

	handled	sugar
5.	Connectivity	Approach road to be constructed by PWD to connect to NH-80 and Railway connectivity to be developed to link the existing railway line Nearest Railway Station: Sakrigali Railway Station (1.1 km, S) & Sahibganj Railway Station (6 km, W) Nearest Airport: Patna Airport (270 km, NW) Ferry Service: Sahibganj Ghat to Manihari Ghat
6.	Topography of terminal site	Undulating with level variation of 30 m-56 m
7.	On-shore Facilities Proposed for Phase I	• Stockyard for coal (6 stock piles-1.12 ha), for stone chips (8 stock piles-0.875 ha) & 1 covered shed (0.416 ha) • Unloading & Loading Areas • Internal Roads (12 m wide & 3.6 km length) • Administration Building • Workers Amenity Building • Lighting Towers • Other associated facilities like sewerage system, STP, drainage system, fire-fighting facilities, communication system, water supply & power supply (ESS) • Boundary wall of 2.4 m high • Green belt- 15-20 m (2.9 ha) To be developed by PWD/Railways: • Approach Road (1 km connecting to NH-80 crossing LC-54) • Railway Connectivity (through Sagrakali Railway Station) with provision of ROB over LC-54 for approach road to be developed
8.	Off-shore Facilities Proposed for Phase I	• Jetty (1 No.) & Berth (2 Nos.) • Water area & approach channel • Turning Circle (2 Nos. at starting & end of channel) • Shore protection (1.5 km along River Bank, 800 m in Phase I & 700 m in phase II)
9.	Extension of Off-shore structure (jetty & Berths) in River	75 m (50 m-approach trestle & 25 m jetty) length & 270 m width.
10.	Shore Protection Works	Retaining wall and stone pitching (30-50 kg) along the length of bank (1.5 km total, 800 m in phase I & 700 m in phase II) and 40 m apron inside the River.
11.	LAD	1-2.5 m near shoreline 7-11 m at distance of 50 m
12.	Water level fluctuation of River near Terminal Site	10 m
13.	HFL of Site	30.91 m amsl
14.	Finished Level of Site	37 m amsl
15.	Top level of Berth & Jetty	33.5 m
16.	Earthwork Phase I	Cut: 14.25 lakhs cum Fill: 2.15 lakhs cum Muck for disposal: 12.1 lakhs cum
17.	Dredging During Construction Phase	1.5 lakhs cum
18.	Material Transportation System	In Phase-1 of terminal, it is proposed to provide hopper at the coal and stone chips stockyard and the cargo shall be carried through conveyor system to the berth where it shall be discharged to the vessels through barge loader

19.	Maintenance Dredging during operation phase	30,000 cum in lean season
20.	River Water Requirement for dust suppression and horticulture	Phase 1: 162 KLD Phase II: 210 KLD Phase III: 350 KLD
21.	Municipal supply water for domestic purpose (staff & vessels)	Phase 1: 46.5 KLD Phase II: 65 KLD Phase III: 90 KLD
22.	Power Requirement	Phase 1: 588 KW Phase II: 2535 KW Phase III: 1897 KW
23.	Storm Water System	Storm water drain of length 3.05 km Stock yard, parking area & roads –dump pond Buildings- Rain water storage sump
24.	Sewage Generation & STP	Phase 1: 30 KLD Phase II: 36 KLD Phase III: 40 KLD STP: 40 KLD capacity
25.	Dust Suppression Methods	**Barge Loaders-** Plain water fine spray with medium pressure standard hydraulic system using raw water **Coal Stock Yard-**Swivelling plain water sprinklers for abatement of coal dust generation along the length of the stockpile.
26.	Vehicle Parking Area	1 ha
27.	Solid Waste Generation & management	Solid waste to be generated from terminal facility will include majorly the food waste and the garden waste. This waste can be disposed through the local agency in the area responsible for waste handling. Dustbins shall be provided at the site for collection of the waste. Used oils from DG sets/transformers/pumps etc. may also generate at the site. Used/Waste oil will be stored in HDPE containers at the site in isolated location and will be sold to authorized vendors

Source: Site visit &HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant) India



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.21 : Layout of Sahibganj Terminal Site

3.15.2.2.3 Terminal at Varanasi(Ramnagar)

A multimodal terminal is proposed to be developed at Ramnagar, on river Ganga in Varanasi district in Uttar Pradesh. Map showing location of Terminal at Varanasi is given in **Figure 3.22**

Figure 3.22 : Location of Varanasi Terminal Site

Area of 5.586 ha has been acquired for development of the terminal by IWAI. Identified site is open agricultural land. However, no agriculture activity is being carried out at site at present. The proposed terminal project site falls in Ramnagar Municipal Board of Varanasi district. Photographs of the Varanasi terminal site are given in **Figure 3.23**

Figure 3.23 : Photographs of Varanasi Terminal Site

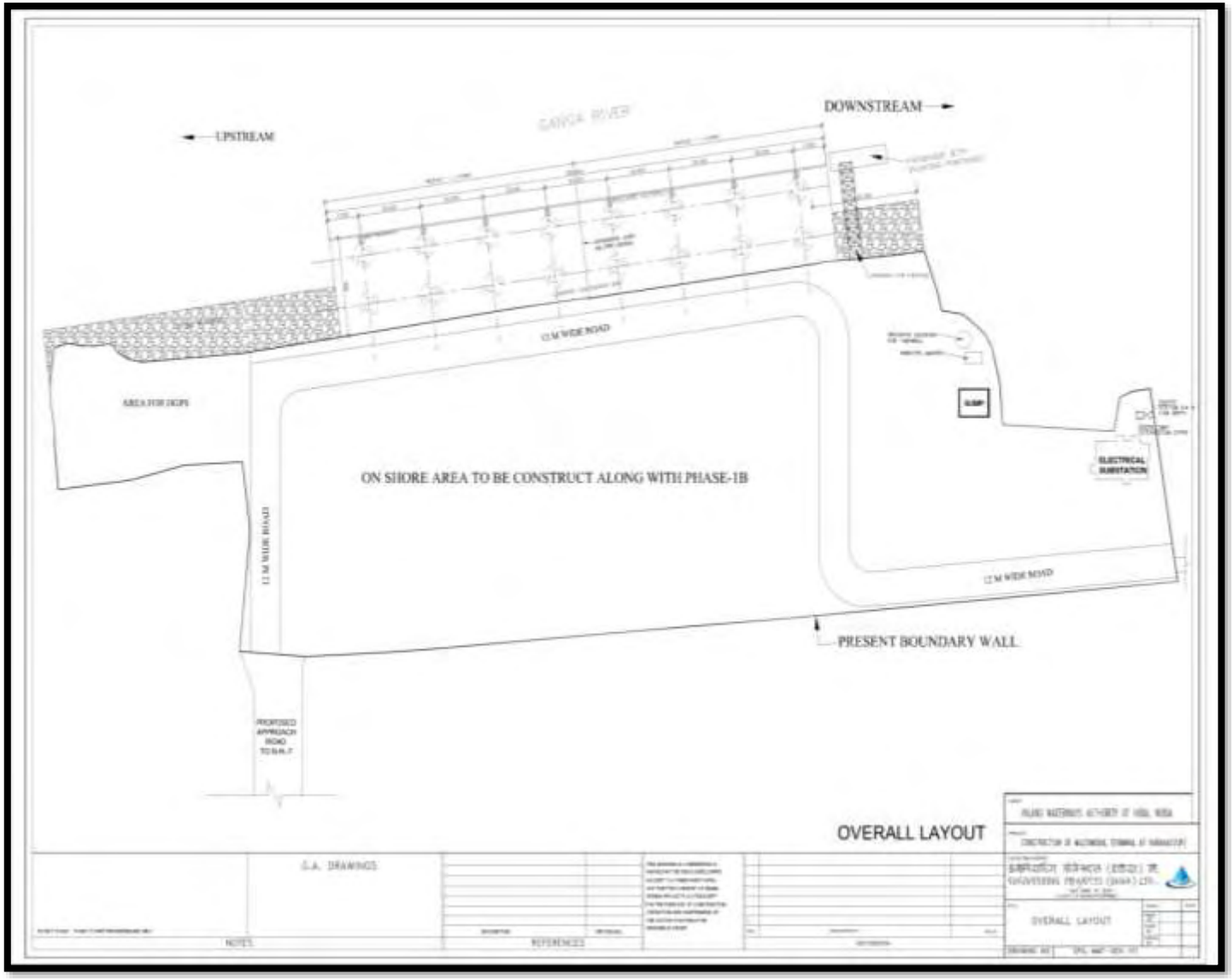
Terminal will be developed in phases and at present phase 1A of terminal is designed. In phase 1 A, terminal shall handle about 0.54 MT per year which is expected to grow to 1.22 MTPA by 2038.Salient features of the development of phase 1A of the Varanasi terminal are listed in **Table 3.31**and **l**ayout plan of the terminal site at Varanasi for phase I is given in **Figure 3.24** below.

Table 3.31 : Salient Features of Varanasi Terminal

S. No.	Salient Feature	Capacity/Quantity/Nos.
1.	**Location**	River Ganga, Ramnagar, Varanasi, U.P.
2.	**Project site Geographical Coordinates**	25°15'7.90"N & 83° 1'55.45"E
3.	**Project Area**	5.685 ha
4.	**Type of Land**	Private Agricultural Land (12 small Khajur (Date) trees and 8 babool shrubs) but no agricultural activity is being undertaken
5.	**Site Surroundings**	River Ganga (abuts site, West) Gurha Nallah (Abuts, East & South)
6.	**Accessibility & Connectivity**	No pucca public road to access site. Site accessible through katcha village road and it connects site to NH-7. Approach road of 700 m is planned to connect the site with NH-7 for which additional area of 0.592 ha will be acquired. Nearest Railway Station – Jeonathpur (4.0 km, SE) Nearest Airport - Lal Bahadur Shastri Airport (30 km, NW)
7.	**Facilities Proposed**	• 2 Nos. berths (100 m length & 36 m width each) so as 2 vessels of 80 m each can be berthed at one time. • 2 mobile cranes for loading & unloading • Open area at site for storage of transportation material (Edible oil tank storage area) • Passenger jetty (floating pontoons-20 m X 10 m) & gangway (1.2 m wide) • Stone pitching upstream & downstream river bank (35 m length downstream & 117 m length upstream) • Area for DGPS • 12 m wide internal roads-365 m & 22 m wide internal road-650 m • Approach road to NH-7 • ESS (400 sq m) building & power back-up • Soak pit & septic tanks-wastewater management system • Workers amenity building (30 sqm) • Water supply system

<table>
<tr><td></td><td></td><td>• Storm water drainage system
• Earthing & lighting protection system for all conducting materials
• Lighting system
• Green area</td></tr>
<tr><td>8.</td><td>Cargo to be handled</td><td>Coal (imported & domestic), cement, fertilizers, wheat & crude edible oil</td></tr>
<tr><td>9.</td><td>Plying vessel</td><td><table>
<tr><th>Multimodal jetty</th><th>DWT</th><th>LOA (m)</th><th>Beam (m)</th><th>Loaded Draft (m)</th></tr>
<tr><td>Maximum Ship Size</td><td>2000</td><td>80</td><td>11</td><td>3.5</td></tr>
<tr><td>Minimum Ship Size</td><td>200</td><td>18</td><td>5</td><td>1.0</td></tr>
</table></td></tr>
<tr><td>10.</td><td>LAD at jetty</td><td>+3.5 m</td></tr>
<tr><td>11.</td><td>Eco-sensitivity</td><td>Kashi Turtle Sanctuary at 2.3 km in North direction (downstream)

No national park, reserved/protected forest, reserves, zoological parks, migratory bird route, protected wetland under Ramsar convention etc. are present within the 10 km radius area</td></tr>
<tr><td>12.</td><td>Water Supply System</td><td>Municipal Corporation, Varanasi</td></tr>
<tr><td>13.</td><td>Power Requirement</td><td>State grid (Purvanchal Vidyut Vitran Nigam Ltd).</td></tr>
</table>



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.24 : Layout of Varanasi Terminal Site

3.15.2.2.4 Lock at Farakka

A new lock is proposed to be developed in Farakka on the Feeder Canal of Farakka Barrage adjacent to the existing lock at Farakka in Murshidabad district of West Bengal. New lock will be further West to the existing lock and will share its right bank with the left bank of the existing lock. Site is located in village Goraipada, Grampanchayat Bewa, Farakka in Murshidabad district of West Bengal. The Ganga River is flowing about 1.2 km East of the proposed lock gate site. Map showing location of Lock at Farakka is given in **Figure 3.25**

Figure 3.25 : Location Map of Farakka Lock

The proposed project would be set up in the 14.86 ha transferred land of Farakka Barrage Project (FBP) and the land revenue area demarked by Beoa Mouza`s,JL No. 31, Sheet No.3. As per the topographic survey carried out at site by IWAI, ground levels vary from RL+13 to RL+29 m which indicate the site is almost flat with gentle slope. The lock gate site is well connected with road & rail. This road at presently passes through the site and thus will be realigned to Western boundary of the proposed lock gate site. This road connects the NH-80 is located about 1.6 km West of the proposed Lock gate site and is connected. Photographs of the Varanasi terminal site are given in **Figure 3.26.**

Existing lock of Farakka is not working at optimal efficiency and it takes 2-3 hours to complete one operation there by reducing the possible nos. of ships which can cross through and ultimately the freight transportation efficiency. Renovation of the existing lock would keep the lock in non-operational condition for entire period, i.e. 6-31 months (WAPCOS, IWAI and FBP) thereby stopping the movement of barges/vessels in most of this period. Although this upper estimate could be reduced if parallel working is

assumed. To overcome this problem and to ensure uninterrupted and efficient movement of vessels/barges in NW-1, IWAI has proposed to construct a new lock at Farakka parallel to existing lock.

Figure 3.26 : Photographs of Farakka Lock Site

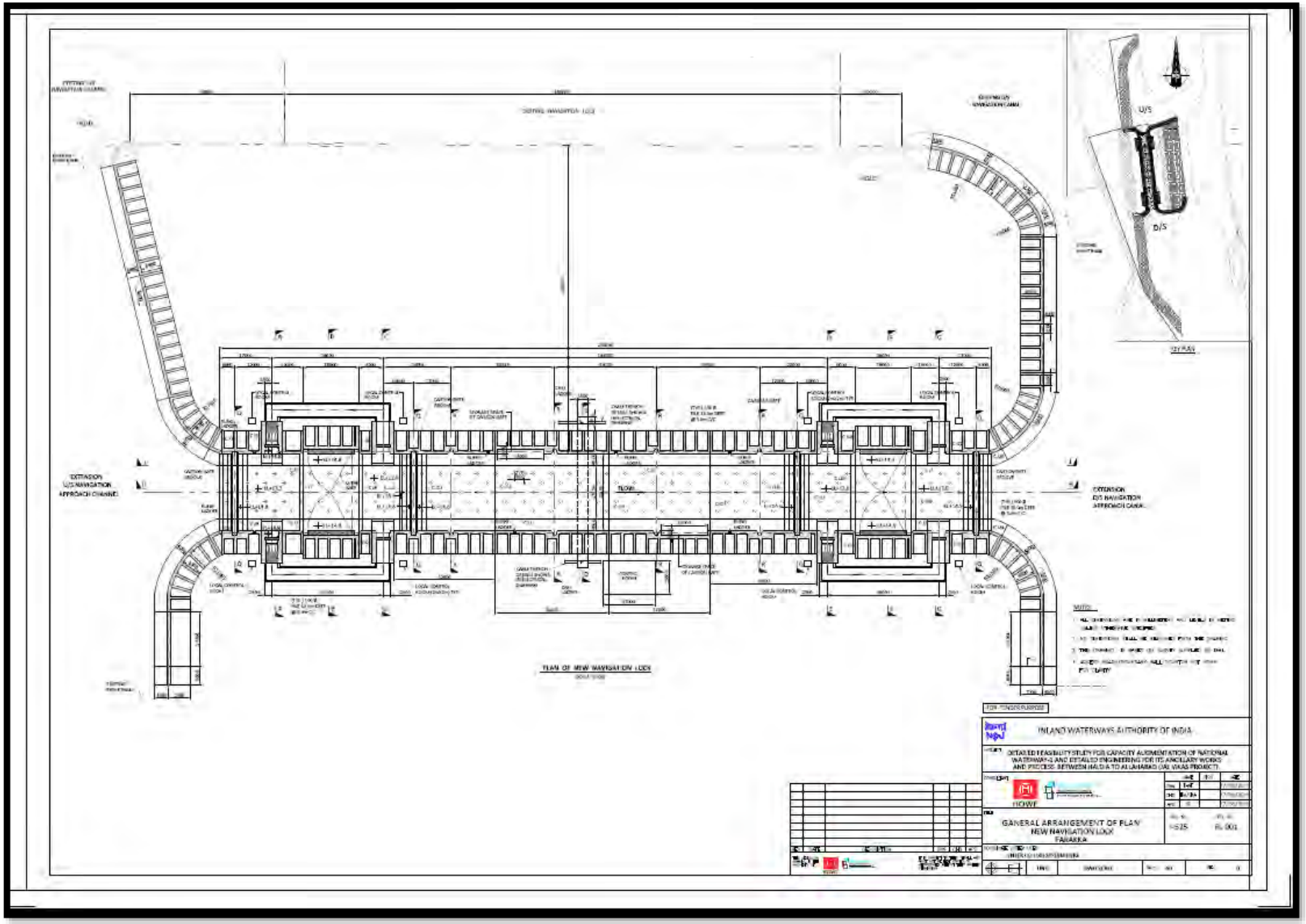
The new lock like the existing lock will facilitate the movement of vessels/barges from main River Ganga upstream to River Bhagirathi-Hooghly downstream through feeder canal negotiating the significant difference in water level existing in main River Ganga and feeder canal. Water level in the River Ganga and feeder canal varies according to the flow in River Ganga & the feeder canal. New lock is required as the existing lock is not functioning adequately and obstructs the movement of the vessels. The length and width (size) of the proposed lock is similar to the existing lock. Length & width of new lock will be 179.0 m & 25.148 m respectively. Lock is designed to handle four vessels of size 85 m (length) X 12 m, (width) so as two vessels are moored lengthwise and two sidewise like existing lock. The salient features of the existing lock site are given in **Table 3.32** and layout plan of the lock site at Farakka for phase I is given in **Figure 3.27.**

Table 3.32 : Salient Features of New Lock

S. No.	Parameters	Value
1	Location	Feeder Canal, village Goraipada, Grampanchayat Bewa, Farakka in Murshidabad district of West Bengal.
2	Geographical Coordinates	24°48'32.38"N to 24°49'02.23"N & 87°54' 05.63"E to 87°54' 17.18"E.
3	Land Required	14.86 ha
4	Topography	RL+13 to RL+29m
5	Finished Level of Site	28.44 m
6	High Water Level U/S High Water Level D/S	RL + 26.30 m RL +24.38 m
7	Length of Lock	179 m
8	Width of Lock	25.148 m
9	Av. Depth of Lock	13.10 m

10	Capacity of Lock to handle no. of vessels of size 85 m (length) X 12 m (width)	four vessels of size 85 m (length) X 12 m, (width) so as two vessels are moored lengthwise and two sidewise like existing lock
11	Seismic Risk Design Consideration	Site lies in Zone III and design is calculated as per IS:1893:2002
12	Length of extension of U/S Approach Channel (m)	190
13	Length of extension of D/S Approach Channel (m)	310
14	Dredging required in upstream and downstream of approach channel to achieve water depth of 3 m	0.05 + 0.08 = 0.13
15	Counter Fort Retaining wall • Top wall level • Bottom wall level • Slope	 28.44 m 12.8-14.8 m 1V:370 H
16	Slope of Excavation along River Bank	1.5 H :1 V
17	Inlet & Outlet water Structures	4 Nos. feeder culverts (2 U/s & 2 D/s) of length 60 m each.
18	Base Slab Thickness	1.2 m
19	Main Units other than the lock	• Mitre Gates- 2 sets (two leaves per set) • Radial Valve Gates- 4 sets (2 for U/S and 2 for D/S) • Mooring Bits (Floating)- 8 sets (4 sets per bank) • Caisson Gates/Stoplogs- 2 Nos (Used for U/S or D/S) • Bulkhead Gates- 4 sets (2 sets for U/S or D/S) • Control Rooms for remote control-1 each for U/S or D/S
20	Length of FBP Inspection Road to be realigned (m)	675
21	Length of Boundary Wall to be constructed (m)	1180
22	Scour Protection • River Bank Slopes U/s & D/s of approach channel • Guide wall	 2 layers of back pitching with PCC blocks of size 1 X 1 X 0.6 m and 6 m wide launching apron consisting of two layers of concrete blocks of size 1.5 X 1.5 X 0.9 m Tied to existing lock and cut-offs to a depth of 5 m
23	Flood Protection	Filling site to 28.44 m + RL, i.e. above HFL, strengthening of existing levees and banks to prevent erosion & flooding
24	Other facilities	Water supply system, soak pit & septic tanks, storm water drainage system, green belt (1 ha & 900 trees) and office building
25	Water Requirement	Construction Phase-16.5 KLD Operation Phase-6.5 KLD for domestic, 7.3 KLD for dust suppression & 2.7 KLD for horticulture
26	Power Requirement	557 KW
	Green Area	10000 m^2 (1000 m X 10 m). 900 trees to be planted

Source: HOWE Engineering Projects (India) Pvt. Ltd. (Design Consultant) India



Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Figure 3.27 : Layout of Farakka Lock Site

3.15.2.2.5 Bank Protection and River Training Works

Erosion of banks is natural phenomenon in the alluvial rivers. However, erosion is aggravated due to construction of any structure like bridge, terminal and jetty on the river. Thus river training works includes the engineering works carried out in river to prevent the erosion of the banks, control and guide the river. It is proposed to carry out bank protection works in the areas where civil interventions are planned to be carried out and details of the same are given at **Table 3.33**. Bank protection additionally also be carried out at other interventions yet to be finalised.

Table 3.33 : Bank Protection Works as per Current Planning

S. No.	Location	App. Length (km)
1.	Varanasi	0.35
2.	Sahibganj	1.1
3.	Farakka Navigation Lock	0.75
4.	Three new terminal	2.5
5.	Farakka Feeder Canal	39
6.	Barge Repair and maintenance facility	2
7.	Existing Terminals & Jetties	4.6

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

Bends are navigational hazard which requires straitening. Crucial bends likely to be considered for straightening are Bend near Mirzapur, bend near Patauli & Agradwip, bend near Sanudragrah, bend near Chumariagacha, bend near Digibaraj and sharp bend just u/s of Farakka navigation lock. These task will be taken up after detailed study on a later date.

3.15.2.2.6 Terminal at Tribeni -Kalyani (Tentative Location)

It is planned to develop terminal at Tribeni. Planning is at initial stage and site selection & finalization is undergoing at present. Two locations are considered for development of terminal. First site is located on left bank of River Hoogly upstream of Road Bridge on SH-6 at Tribeni, west Bengal. Site is well connected with road & railways. Kalyani Samanta is nearest railway station. App. 40 ha of agricultural land is identified for development of terminal at this site. Some brick kilns also exist at the site. One more site is considered for development of the terminal. Site is located on the right bank of the River downstream of the road bridge at SH-6. This site is located near the thickly populated area. Out of both the options alternative 1, i.e. site located upstream if SH-6 is considered for development of terminal. Google map showing the site considered for development of terminal at Tribeni is given in **Figure 3.28.**

Figure 3.28 : Google Map Showing Proposed Terminal Site at Tribeni

3.15.2.2.7 Terminal at Ghazipur (Tentative Location)

It is planned to develop terminal at Ghazipur, U.P. Planning is at initial stage for this terminal. Site identification and alternative site analysis are undergoing at present. Two sites have been identified at present for development of project. Out of the two sites, preferable site is located at Village Chaukiya, Ghazipur. This site is located on left bank of River Ganga (main channel) and downstream of NH-97. The site is agricultural land with no development or facilities or settlements on it. Area of the site identified is app. 22 ha. Site is well connected with road & railway. Depth of the channel is more than 2.5 m close to the shoreline. However, approach road will be required to be constructed for connecting the terminal site to NH-19. Google map showing the site considered for development of terminal at Ghazipur is given in **Figure 3.29.**

Figure 3.29 : Google Map Showing Proposed Terminal Site at Ghazipur

3.15.2.2.8 Barge Maintenance & Repair Facility

Barge maintenance and repair facility is essential component of Jal Marg Vikas Project. At present no location has been finalized for the purpose but this development is under planning. Barge maintenance and repair facility will comprise of the following

- Slipway: It is a ramp, which helps in moving the barge/ship to and fro from water to land. Slipway will be provided in deeper water conditions so as design vessels can be taken in docking conditions.
- Winch House: It should be provided in straight-line to mail slipway. It is generally a single room like structure and should have adequate space for winch and electrical equipment
- Repair bay for large & small vessels: Repair bay for vessels should be inclined so as the vessels can slide towards the river on its own after repair under control of winch.
- Transfer bays: To transfer small vessels between slipway and repair bay
- Winches and trolleys. Winches should be provided at winch house and at transfer bay. Trolleys should be provided to receive the vessels on main slipway.
- Workshops and buildings with all basic utilities like water, electricity, storm water management system and waste management system.

3.16. Material Handling, Transportation and Storage

Material handling including transportation, storage, loading and unloading will be involved at terminals and jetty sites. Material handling at some planned site is manual, i.e. is through pay loaders, barge loaders, dumpers, trucks and at some sites is mechanical through

conveyor belts and pneumatically depending on type and quantum of cargo to be transported. Considering the environmental effect, it is strongly suggested to adopt mechanical mode of material handling only for loading & unloading of barges and pneumatic transportation of the fly ash to minimize dust generation.

3.17. Construction material Sourcing

Construction materials required majorly for the project development are bricks, steel, cement, timbers, sand etc. It is preferred that construction material will be sourced from nearby areas preferably. Details for construction material sourcing for the planned infrastructure under Jal Marg Vikas Project are given as a reference in **Table 3.34** below.

Table 3.34 : Construction Material Sourcing for already Planned Interventions

S. No.	Location	Construction Material Sourcing
1	Haldia Terminal	Stone chips- Pakur quarry in Jharkhand (370 km from site) Sand- Villages Kasthakbali and Barsundra (20 km) and Damodar River (100 km)
2	Farakka Lock	Stone and aggregates- Rajmahal hills (Sahibganj) at app.100 km from site
3	Sahibganj Terminal	Stone and aggregates- Rajmahal hills (Sahibganj) near the site
4	Varanasi Terminal	Stone and aggregates- Sirsa, Mirzapur at app. 45 km from site

3.18. Waste Disposal

It is likely that waste and sewage will be generated due to anticipated human activities at major intervention locations (terminal, locks & jetties). Details of waste generation and its management is given below

3.18.1. *Sewage & Effluent*

It is likely that sewage will be generated at the locations where interventions are proposed only. For management of sewage measures like provision of mobile toilet with anaerobic digester, provision of toilets with septic tank & soak pits are proposed during construction phase. It is proposed that soak pits should be provided in the locations away from river. During operation phase sewage should be managed by provision of well-developed sewage collection system and the collected sewage should be treated in STP (if sewage generation >5-10 KLD) and should be disposed in septic tank/soak pit if <5-10 KLD.

No vessels will be allowed to discharge its waste in river during navigation or berthing. Vessels should follow MARPOL guidelines for management of sewage.

3.18.2. *Solid Waste*

Solid waste will be generated due to project activities at the locations where interventions are expected majorly. Expected solid waste to be generated from the site is mainly municipal in nature. Some quantity of hazardous waste in form of used oil from operation of DG sets, cleaning operations etc. is expected to be generated from the intervention sites.

No vessels will be allowed to discharge its waste in river during navigation or berthing. Vessels should follow MARPOL guidelines for management of solid waste. No maintenance or repair work of ships/vessels and related facilities shall be undertaken at the proposed intervention sites. Site will be identified for development of workshops/maintenance hubs.

Adequate waste management system shall be designed for such sites for prevention of soil and water pollution.

3.19. Dust Suppression

Activities like vehicular movement, material loading, unloading from trucks, material loading and unloading from barge, storage of material etc. will generate the dust during the operation phase of the project. Materials like coal, fly ash, stone aggregates, stone chips, sand etc. are likely to generate more dust as compared to other commodities like fertilizers, oil, textiles etc. Adequate dust suppression measures shall be undertaken depending on the potential of dust generation. Dust suppression measures include development of green belt, provision of dust sprinklers, mechanical transportation system for loading/unloading of barges, pneumatically transportation of fly ash, and transportation of material in covered vehicles and storage of material under covered sheds. Such provisions are already incorporated under the planned navigation infrastructures (terminals at Varanasi, Sahibganj & Haldia) such as material loading/unloading through mechanical conveyor system at Sahibganj, provision of pneumatic transportation system at Haldia for fly ash, provision of water sprinklers, green belt and transportation of material in covered conditions in all the terminal sites. Similar provision will be made for remaining proposed facilities under planning stage.

3.20. Green Belt

Project development includes various intervention measures which will lead to change in land use, removal of vegetation etc. But the interventions are planned in a way so as to maintain the aesthetic value of the area by providing the adequate greens and also wherever tree cutting is associated necessary and additional compensatory plantation works are proposed. At all the proposed interventions, it will be ensured that adequate peripheral green belts and organized greens are provided. Details of the green area and trees proposed at the identified intervention locations are given in **Table 3.35** below.

Table 3.35 : Green Area and Tree Details for the Planned Intervention Sites

S. No.	Location	Green Area (Acres)	Nos. of trees
1	Haldia Terminal	3 acres (1.214 ha) 10 m wide tree belt all along the periphery and avenue tree plantation along roads	1200
2	Farakka Lock	2.47 acres (1 ha) 10 m wide tree belt all along the periphery and avenue tree plantation along roads	900
3	Sahibganj Terminal	7.166 acres (2.9 ha) 15-20 m wide tree belt all along the periphery and avenue tree plantation along roads	3500 (1000 as compensatory plantation & 2500 additional)

3.21. Accident Prevention

Associated hazards which may lead to accidents are fires, earthquakes, collision of vessels/barges/ships, floods, cyclones, spillage of material etc. These hazards are proposed to be managed by planning the proposed interventions considering these hazards. This planning will help in minimizing the chances of occurrence of accidents and impact of these hazards on developed infrastructure, human population and surroundings. Some of the stretches prone to the accident along the NW-1 are listed below

- **Haldia to Howrah:** Tidal section of Hugli estuary/river shared with ocean-going vessel traffic, that is subject at times to strong tidal conditions, strong seasonal winds and occasionally adverse wave conditions
- **Howrah to Nabadwip:** Tidal section of the Hugli river, shared with local commercial traffic. Subject to strong tidal conditions at times
- **Nabadwip to Jangipur:** Non-tidal section of natural river (Bhagirathi River). This section of the waterway is challenging to navigate due to sequences of sharp river bends.
- **Section of Farakka Feeder Canal Around Bagmari Syphon:** This siphon is significant navigation hazard

River information system developed and being developed by IWAI will help the vessels to judge the tides, tide level, meteorological condition, LAD, traffic and other vital information required for navigating safely and will help in prevention of accidents and collisions.

3.22. Project Cost

Overall cost of the Jal Marg Vikas Project will depend on finalization of various components proposed under the project. However, fund allotted by World Bank to GOI for development of Jal Marg Vikas is about 650 million USD (~4200 Cr). Tentative capital cost for each component planned or under planning stage of Jal Marg Vikas Project is given below in **Table 3.36** below. Cost considered for the terminals include land cost, development and cost of R & R (if applicable)

Table 3.36 : Component Wise Tentative Project Cost of Components (Planned & Under Planning) of Jal Marg Vikas Project

S. No.	Capital Cost	Project Cost-Phase-1 (in Millions INR)
1.	Varanasi Terminal	2567
2.	Sahibganj Terminal	5773
3.	Haldia Terminal	7496
4.	Terminal-4*(Tribeni Terminal)	4500
5.	Terminal-5*	4500
6.	Terminal-6* (Ghazipur terminal)	2500
7.	New Farakka Navigational Lock	3735
8.	Dredging	6844
9.	Shore Protection Work	10000
10.	River Training Works	500
11.	Vessel Management System	500
12.	Disaster Management System	1400
Total		50,315

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)
**** Site yet to be finalized. Thus cost estimated is lump sum development cost***

3.23. Project Schedule

The NW-1 project activities will be developed in phases. The phase I development is likely to starting in mid-2016 and expected to be completed in 5years period by 2019. The project life is considered as 30 years. Time required for construction of the various planned infrastructure in Phase-I is given below in **Table 3.37** below.

Table 3.37 : Implementation Time for Planned Interventions under Jal Marg Vikas Project (Phase-1)

Component	Construction Time from Start (months)
Start	Mid 2016
Varanasi Terminal	26
Sahibganj Terminal	30
Haldia Terminal	30
Terminal-4* (Tribeni Terminal)	30
Terminal-5*	30
Terminal-6 * (Ghazipur terminal)	30
Farakka Navigation Lock	30
NW-1 Dredging	8
Shore Protection Works	18
River Training Works	24
Vessel Management System	12
Disaster Management System	12
Project Life Considered	30
End Date	Year 2045

Source: HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

CHAPTER 4. DESCRIPTION OF THE ENVIRONMENT

4.1. General

NW-1 traverse through the state of West Bengal, Jharkhand, Bihar and Uttar Pradesh. The terrain throughout the stretch of NW-1 is flat with primarily agriculture land use in the surrounding area.

The natural environment comprises of physical (air, noise, water, topographical, geological, land, soil and climate aspects), biological (terrestrial and aquatic floral and faunal aspects) and socio-economic aspects. It is sensitive to any developmental activity adequate preventive measures are taken and environmental conditions are maintained within defined environmental parameters. Thus, it is imperative to study the existing environmental conditions not only to establish the present physical, biological and socio-economic conditions but also in order to predict future impacts owing to construction and operation of the project. The baselines conditions have been studied based on secondary and primary data collection and analysis.

4.2. Baseline Analysis, Study Area and Salient Environmental Features

4.2.1. *Baseline Data Collection and Study Area*

Analysis of environmental baseline of the project area is an important phase of Environmental Assessment process for understanding the prevailing environmental conditions in and around project area/alignment. The environmental conditions of NW-1 and its intervention areas were established through extensive literature search, field monitoring, laboratory analysis, stakeholder consultation and data interpretation.

Secondary data from literature search were obtained from various Government and non-government sources such as Meteorological Departments, CPCB publications, National River Ganga Basin Authority, IIT consortium reports and other agencies as listed at **Table 1.2.**

The primary data generation was carried out between:15th September 2015 to 28th February 2016 for different period and frequency at different locations covering the entire stretch of NW-1, finalised intervention areas[21], likely intervention areas, likely maintenance dredging areas[22], select existing RO-RO jetty locations, Select existing passenger ferry locations and environmental sensitive areas. Being a liner project, the 500m radius[23] on either side of the bank is considered as core zone, 2 Km radius as immediate buffer zone and 10 Km radius as extended buffer zone all along the NW-1 stretch and intervention areas. (refer **Figure 4.1** for study area map).

[21]The finalised intervention areas include terminals at Varanasi, Sahibganj and Haldia and navigation lock at Farakkha.

[22]River bed sampling (dredge sampling) has been carried out upto the depth of 3 m below river bed level at varying location depending on the intensity of the dredging in a particular stretch for assessing contamination level if any in the dredge material

[23]Being a liner project impacts are likely to be confined to within 100m but we have considered 500m as core zone. Focus of primary data collection has been more on this core zone and immediate buffer zone of 2Km.

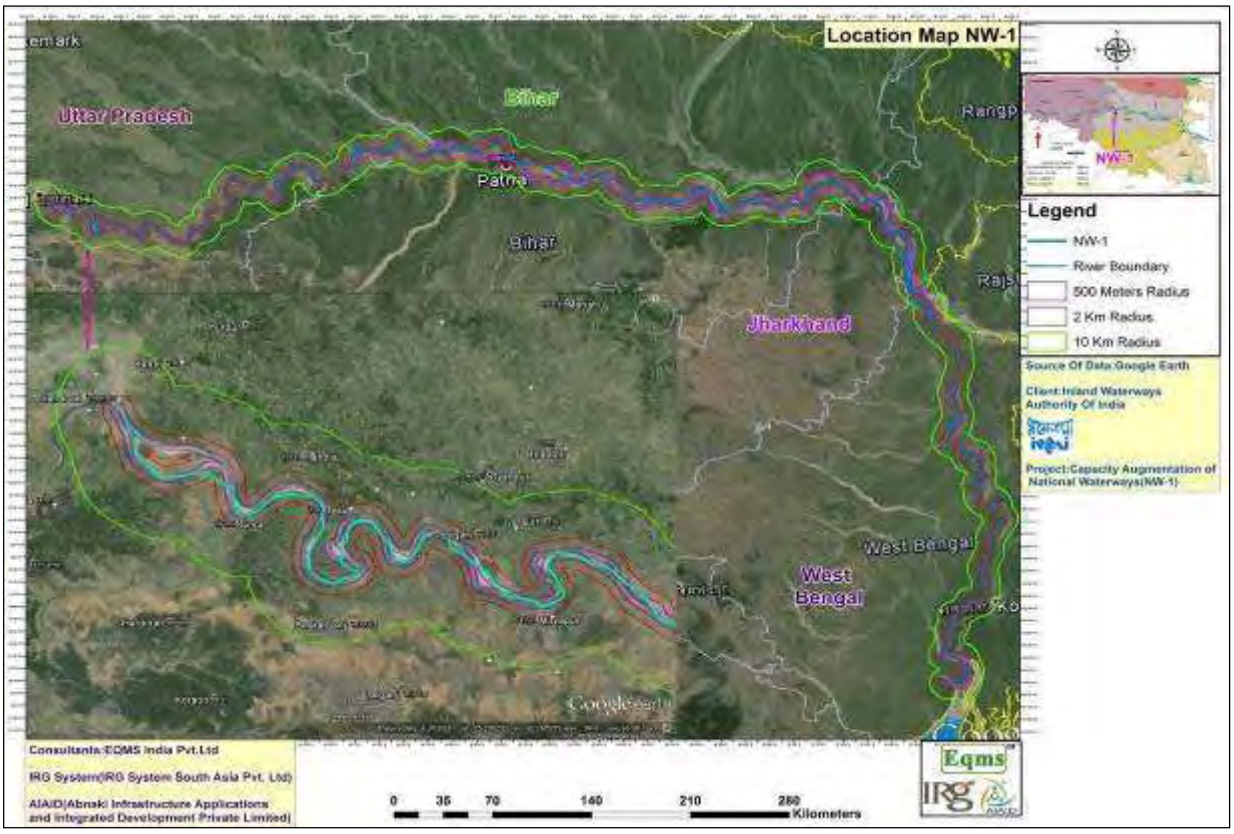


Figure 4.1 : Study Area Map (NW-1)

4.2.2. *Environmental Setting and Salient Environmental Features of the Project Area*

The NW-1 stretch starts from Haldia (Sagar) to Allahabad (1620 KM long) on Ganga - Bhagirathi - Hooghly river system. The Hooghly river portion of the waterway from Haldia to Nabadwip is under tidal influence. From Nabadwip to Jangipur the NW1 stretch is formed by Bhagirathi river. Bhagirathi river flow is regulated through barges at Farakka and Jangipur. From Farakka upstream the navigable route depends upon the main Ganga river flow. The Feeder Canal and the navigation lock at Farakka become the link between the Bhagirathi and main Ganga upstream of Farakka Barrage. NW-1 is passing through four states namely UP, Bihar, Jharkhand and West Bengal. Location map, alignment map of NW-1 is shown at **Figure 1.1**, and **Figure 3.1** respectively.

The salient environmental features around NW-1 within,500m, 2km and 10km stretches are summarised in **Table 4.1**.

Table 4.1 : Salient Environmental Features along NW-1 Alignment

S. No.	Environmental Features	Within NW-1 (500 M)	Within 2 km area around NW-1	Within 10 km area around NW-1
1	**Ecological Environment**			
A	Presence of National Park/Biosphere	None	None	None

	Reserves, Tiger reserve etc.			
	Presence of Wildlife Sanctuary	Yes 1. Kashi Turtle Sanctuary at Varanasi 2. Vikramshila Dolphin Sanctuary Kahalgaon to Sultanganj 3. Hilsa Sanctuary stretch in west Bengal	None	Yes Udhwa lake sanctuary in Jharkhand (about 9 km away from NW-1
B	Reserved /Protected Forests	None	None	Yes (Bethuadahari RF, Bahadurpur RF & RF near Rajmahal Hills)
C	Wetland of state and national interest	None	None	Yes (Udhwa Bird sanctuary)
D	Migratory route for wild terrestrial animals	None	None	None
E	Presence of Schedule-I Terrestrial Fauna	None	Yes Migratory birds near Farakka Barrage and surrounding	Yes Migratory birds at important birds' areas
F	Presence of Schedule-I Aquatic Fauna	Yes Dolphin, and Turtle	None	None
G	Important Bird Area	Vikramshila sanctuary area	Yes 1. Danapur Cantonment area 2. Mokama tal 3. Kurseala river course and diyara flood plain. 4. Farakka Barrage and surround area	Yes Udhwa lake sanctuary
H	Seismicity	NW-1 falls in Zone-III (moderate risk) and zone IV (high damage risk zone) as per Seismic Zoning Map of India		
B.	**Social Environment**			
I	Physical Setting	Rural, Industrial and Urban		
	Densely populated area	Allahabad, Sirsa, Mirzapur, Chunar, Varanasi, Zamania, Ghazipur, Gahmar, Buxar, Ballia, Chappra, Patna, Barh, Bihat, Munger, Bhgalpur, Kahalgaon, Sahibganj, Farakka, Berhampore, Katwa, Kalna, Kolkatta and Haldia are densely populated areas.		
J	Physical Sensitive	Yes		

	Receptors	Ghats at Varanasi, Patna, Temples, Schools, College and Hospital. Details are provided at section 4.7
K	Archaeological Monuments	Yes There are 9 archaeological sites located within 300 m area of the NW-1 and these are Kardmeshwar Mahadeva Mandir, Ramnagar fort, archaeological excavation site, Varanasi, Manmahal and observatory, St. John's Church, Temple of Gour Chandra and Krishnachandra at Chatra (Gaur Chandra Ghat), Hazardwari Palace, Sindhi Dalan and Jami Masjid Details provided in Section 4.7.

4.2.3. Primary Data Collection: Monitoring Plan and Quality Assurance Procedures

The study period and methodology for primary data collection is followed as per the monitoring plan approved by IWAI and World Bank. Summary of monitoring plan and sampling, testing methodology followed is given at **Table 4.2**.

Table 4.2 : Summary of Monitoring Plan and Methodologies Adopted for Primary Data Collection

Parameters	**No. Of sampling locations**	**Frequency**	**Remark**
Ambient Air Quality			
$PM_{(10)}$, $PM_{(2.5)}$, SO_2, NOx CO	3 locations and 8 sample per terminal and lock One location and 2 samples per Ro-Ro jetty	Twice a Week (within 2 km area)	AAQ monitoring was carried out representing upwind, downwind and crosswind directions of the site. 24 hours sampling at each location was carried out as per CPCB guide lines (CPCB Gazette notification dated 18.11.2009 on AAQ).
Meteorology			
Temperature, Humidity, Wind speed, Direction, storm, barometric pressure, Strom, Rainfall etc.	-	--	Meteorological status of the impact zone has been established by analysing the IMD secondary data for 30 years' period.
Ground Water Quality			
pH, Temp., Conductivity, Turbidity, TSS, TDS, DO, BOD, COD, oil & grease, chloride, NO_3, PO_4, Cl, SO_4, Na, K, Ca, Mg, Silica, Hg, Pb, Cd, Total Cr, Cu, Zn, Se, Fe, Total Coliform (MPN/100 mL), Presence and absence of pesticides in water samples	3 locations per terminal, lock One location per Ro-Ro jetty	Once	Samples were preserved, transported and analysed for different parameters based on APHA methods. Temp, conductivity and pH which were measured instantly at site itself.
Surface Water Quality			

pH, Temperature, Conductivity, Turbidity, TDS, Aluminium, Calcium, Chlorides, Copper, Fluoride, Free residual chlorine, Iron, Magnesium, Manganese, Nitrate, Phenolic compounds, Sulphate, Sulphide, Total Alkalinity, Total Hardness, Zinc, Cadmium, Cyanide, Lead, Mercury, Nickel, Total Arsenic, Total Chromium **Biological Parameter:** Total coliform Fecal Coliform	2 locations per terminals, lock, 3 locations in Sensitive Ecosystem and one location per Ro-Ro jetty	Once	Samples were preserved, transported and analysed for different parameters based on APHA methods. Temp, conductivity and pH, DO which were measured instantly at site itself.
Soil Analysis			
Texture, bulk density, pH, conductivity, cation exchange capacity, organic matter, Total N, P, K, and Heavy metals etc.	2 locations per terminal/lock One location per Ro-Ro jetty	Once	Soil samples were collected at two locations and analysed as per IARI method
River bed Sampling			
Texture, bulk density, pH, conductivity, cation exchange capacity, organic matter, Chromium, Arsenic, Mercury, Lead, Zinc, Iron, Cupper, ∞, β- γ-Endosulphan, Methyl Parathion, and Lindane	34 dredge sampling location (total 102 nos. of sample at different depth) along NW-1	Once in season	Top layer, (composite sample of 0 to 1.0 m depth), Middle Layer (composite sample 1.0 to 2.0 m depth) & Bottom layer (composite sample of 2.0 to 2.5 m depth) at each proposed dredging and borehole location. For the sampling location of first seven locations sampling of 2.5 to 3 m sample will also be drawn and tested. Sedimentation sampling was collected and analysed as per IARI method.
Noise Environment			
Noise profiling for 24 hrs	3 locations per terminal and lock One location per Ro-Ro jetty and six locations per sensitive ecosystem	Once in season	Noise monitoring was conducted within the 2 km area of terminal/lock/ro-ro jetty and sensitive ecosystem for noise profiling for 24 hrs using integrated sound level meter, as per CPCB guidelines.
Aquatic Ecology			
Phytoplankton, Zooplankton, benthos	3 locations per terminal and lock/sensitive ecosystem One location per Ro-Ro jetty	Once in season	River water sampling was also carried out for aquatic ecology and analysed as per APHA method.
Terrestrial Ecology			
Flora & Fauna	Along NW-1	Once	Primary survey/ Secondary sources
Terrestrial Ecology			
Demography & Socioeconomic	Along NW-1	Once	Primary survey/ Secondary sources

Standard methods and procedures (QA/QC procedures) were strictly followed covering all components of in-situ base line surveys include sample collection, handling, laboratory analyses, data coding, statistical analyses, presentation and communication of results. All sample analysis was carried out by NABL/MoEF&CC accredited/recognized laboratory.

4.3. Physical Environment

4.3.1. *Topography*

The whole NW-1 (Allahabad to Haldia) falls within a relatively flat terrain. Physiographically, it constitutes a part of the Indo-Gangatic plain, which is largely flat, featureless and is formed of recent alluvial deposits of the river Ganga and its tributaries. River erosions, change in course of rivers and human activities of recent times have played an important role in shaping the relief of the river terrain. Based on the contour of the NW-1, the Digital Elevation Model has been prepared for 10 km area around the NW-1. The Nearest Neighbour method has been used to interpolate the elevation data to develop the elevation model. The elevation within this stretch ranges between 321 m to 1 m. Highest elevation was observed at Sahibganj area (Jharkhand), because of presence of hillocks in this area. This map depicts clearly that the elevation of waterways declines from western to eastern part towards Haldia. Digital Elevation Model of study area is shown in **Figure 4.2.**

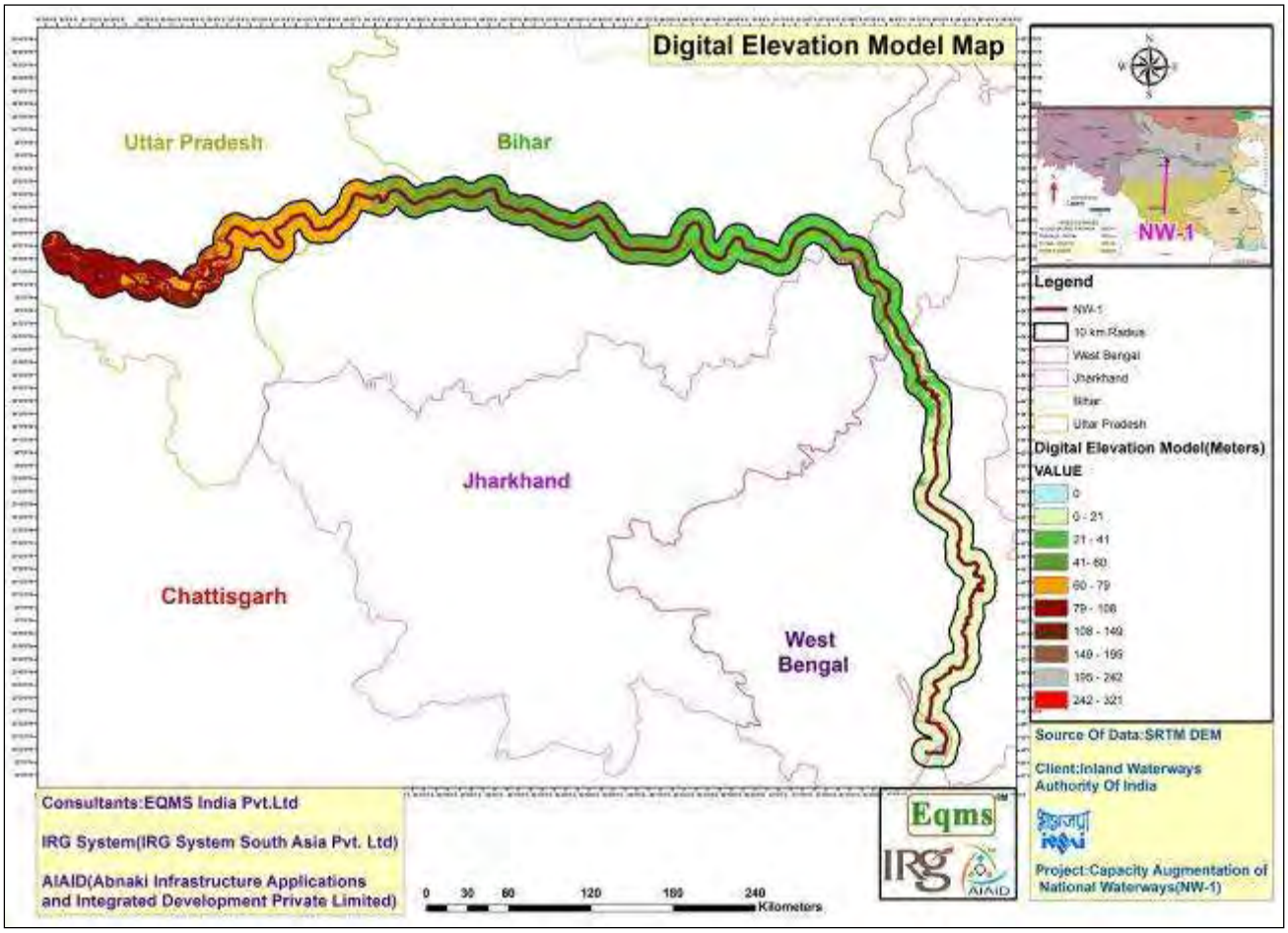


Figure 4.2 : DEM of NW-1

4.3.1.2 Drainage Pattern (Ganga River)

The Ganga River (about 2525 km long) is fed by runoff from a vast catchment area bounded by the snow peaks of the Himalaya on one side in the north and the peninsular highlands and the Vindhya Range on the other side in the south. The basin encompasses an area of more than a million square kilometres (1,186,000 Sq. km) spread over four countries: India, Nepal, Bangladesh and China. With 861,404 Sq.km within India itself, the Ganga basin is the largest river basin in India and covers approximately 25 per cent of India ‘s total geographical area. The catchment area, length, total utilizable water of Ganga river basins within India and the states that they cover is given in **Table 4.3.** State wise distribution of drainage area of Ganga river is given in **Table 4.4**.

Table 4.3 : Ganga river Basin Catchment Area

S. No.	Length (km.)	Catchment Area (Sq. km.)	Total utilizable water
2	2525	861404 (1186000)	420.99

Source: *Status paper on river Ganga, NERD, MoEF, 2009*

Table 4.4 Distribution of the Drainage Area of Ganga River in India

S. No.	State	Total Geographical Area (Sq. Km)	Drainage area as Percent of Total Geographical Area
1	Uttar Pradesh & Uttarakhand	294364	34.2
2	Madhya Pradesh	198962	23.1
3	Bihar & Jharkhand	143961	16.7
4	Rajasthan	112490	13.1
5	West Bengal	71485	8.3
6	Haryana	34341	4.0
7	Himachal Pradesh	4317	0.5
8	Delhi	1484	0.2
	Ganga Basin (Total)	**861404**	**100.0**

Source: *Status paper on river Ganga, NRCD, MoEF, 2009*

4.3.1.3 Drainage pattern NW-1

Many tributaries of Ganga namely, the Tons, Son, Gomati, Ghaghara, Gandak, Burhi Gandak and Kosi. meets NW-1 after Allahabad. Drainage pattern of the NW-1 is controlled by these rivers. By the time Ganga reach the head of its delta at Farakka (after Rajmahal) in the state of Jharkhand, its water flow and volumes increases substantially due the contribution from these tributaries. Its water quality and sediment load also fluctuate depending on the composition of the contributing stream. Beyond Farakka, the Ganga river bifurcates into the Padma and the original channel of the Ganga, known as the Bhagirathi. Therefore, the Bhagirathi is treated as the main Ganga for all purposes in West Bengal.

The Padma, carries the majority of Ganga river flow, eventually turns south-eastwards into Bangladesh, while the Bhagirathi (Ganga) winds southwards down the deltaic plain of West Bengal and ultimately empties into the Bay of Bengal under the name of Hugli. Nearly

halfway between Farakka and Sagar Island, the hydraulic character of the Bhagirathi (Ganga) changes upon its entry into the tidal zone of the Gangetic delta. The speed and direction of water in the estuarine streams and creeks are in continual flux due to the ebb and flow of the tides. Drainage Map of Ganga River in NW-1 stretch is shown in **Figure 4.3.** Line diagram of the River Ganga and its major tributaries meeting in NW-1is shown in **Figure 4.4**.

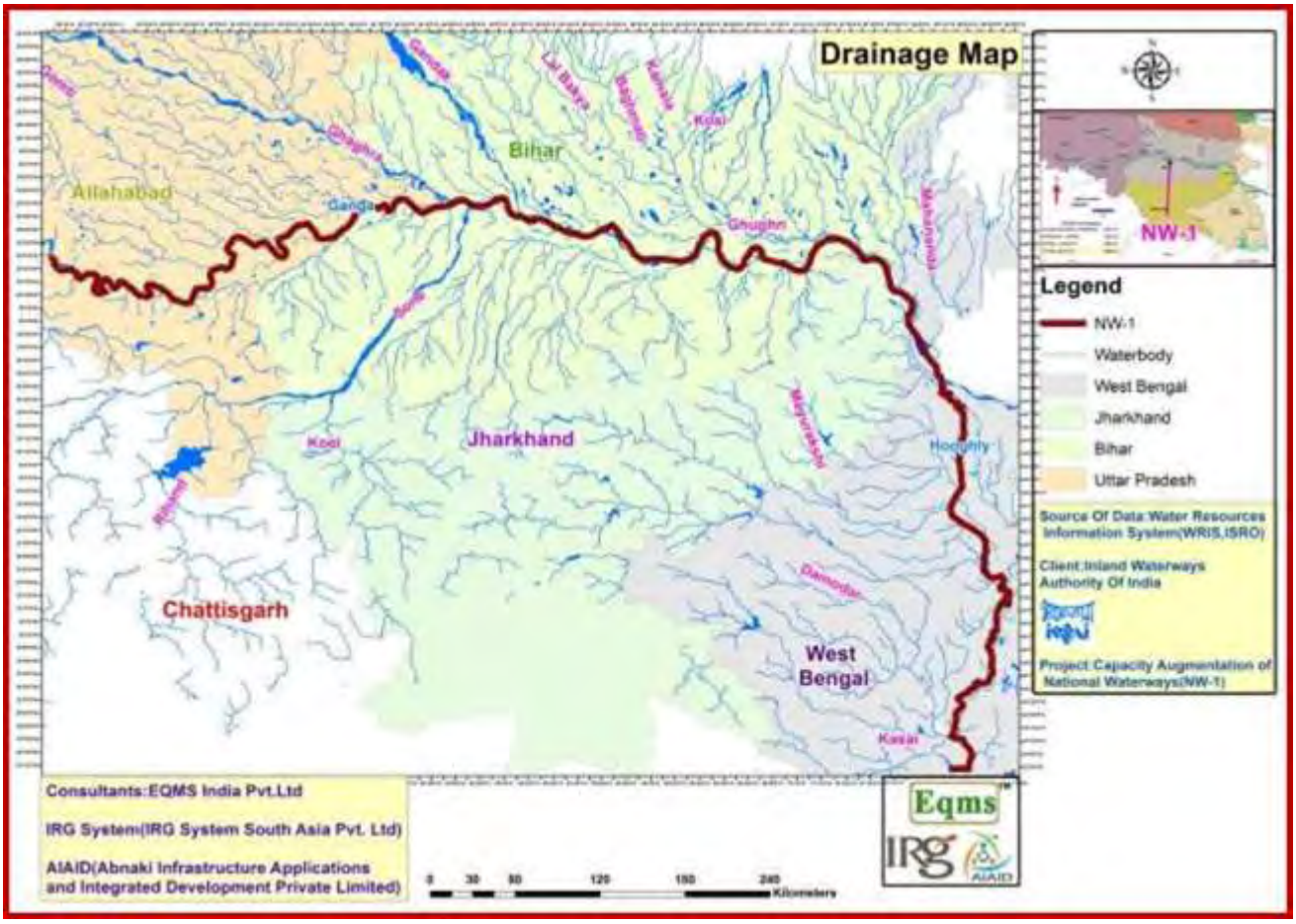
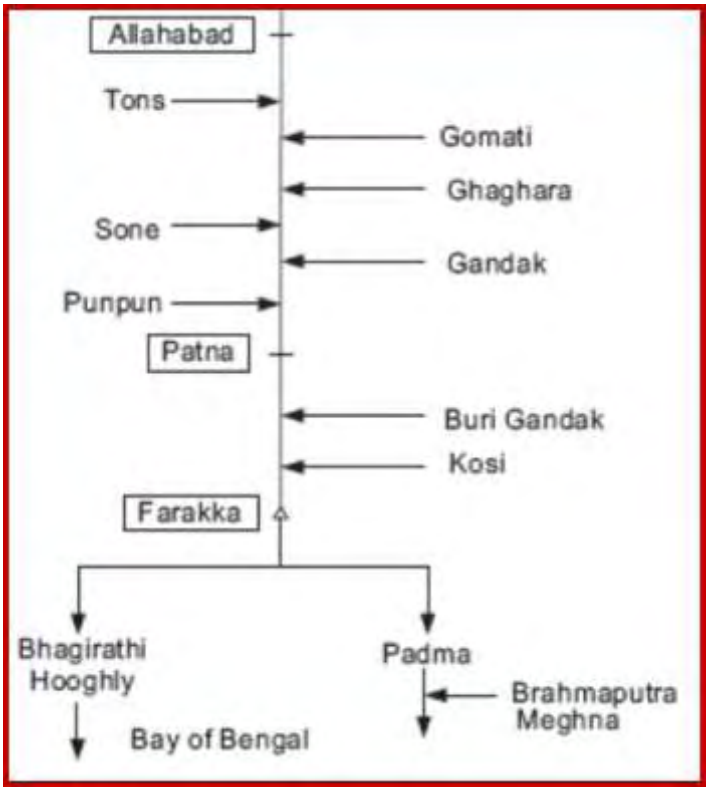


Figure 4.3 : Drainage Map of 2 Km radius of NW-1



(Source: NMCG report)

Figure 4.4 : Line Diagram of Ganga and its tributaries

4.3.1.4 Land use Pattern

NW-1 passes through states of Uttar Pradesh, Bihar, Jharkhand and West Bengal which are extensively cultivated, constituting about 10 per cent of the total area of the India. About 11 per cent of total land of NW-1 states is fallow land and 52% percent as net sown area. The cropping intensity is highest in west Bengal with 184.1 per cent followed by Jharkhand, Uttar Pradesh and Bihar. The overview of land use pattern of the sates traversed by NW-1 is given in **Table 4.5**.

Table 4.5 : Overview of Land use in the States traversed by NW-1

Land use	West Bengal	Jharkhand	Bihar	Uttar Pradesh	*Total NW-1 States*	India
Geographical Area	88750	79720	94160	240930	503560	3287260
Reporting Area for Land Utilization Statistics	86840	79700	93600	241700	501840	3056740
Forest	11740	22390	6220	16580	56930	696260
Land not Available for Cultivation	17830	13190	20830	32680	84530	432180
Total Fallow land	3310	23410	6860	19480	53060	251480
Net Area Sown	52960	15360	56650	164170	289140	1408610
Total Cropped Area	97520	23910	79100	249270	449800	1958350
Cropping Intensity (%)	184.1	155.7	139.6	151.8	157.8	139

(Source: Directorate of Economics and Statistics, Department of Agriculture 2008; indiastat.com

4.3.1.5 Land use pattern along NW-1

The land use analysis of study area (10 km area around NW-1) was carried out using remote sensing data. Systematic interpretation was carried out using a set of digitized images with color coding for delineating the land use classes. By integrating the areas demarcated under different land use/land cover as different colours are assigned to different land use/land cover types of satellite imagery[24] .

The land use classes in 10 km area of the NW-1 are agricultural land, settlement, water body, forest, barren land and vegetation. Land use within the 10 km Radius of the NW-1 is majorly dominated by agricultural land. Both sides of the NW-1 are occupied by Agricultural land and about 78.9 % of the land is under cultivation. NW-1 also passes through many urban areas. About 7.18% land is under settlement. As per the land use data analysis about 7.21% of the land is under water bodies, about 3.59% land is under vegetation, 2.82% land is under dry river bed and rest of the land falls under other uses (refer **Table 4.6**).

Table 4.6 : Land use of the Study Area

Sl. No.	Class	Area(KM^2)	Percent
1	Agricultural Land	19767.57	78.90
2	Water body	1805.8	7.21
3	Vegetation	899.94	3.59
4	Settlement	1799.93	7.18
5	Dry River Bed	705.76	2.82
6	Open Land (Non Agri. Land)	76.01	0.30
Total		**25055.01**	100.00

Source: Satellite Image Analysis

The land use map of different sections of the NW-1 is shown in **Figure 4.5 to 4.7**.

[24]The satellite Imagery of Indian Remote Sensing Satellite (IRS- ID, sensor P6, LISS III) of 24 m resolution was used. The Swath of the imagery is 141 Km x 141 Km. Band used are 4, 3, 2 and 5. LANDSAT imagery of 30 m resolution and 185 x 185 km swath is also used for the comparative and overall analysis of the area. LISS III imagery and LANDSAT 4-5 TM imagery were used for the complete coverage of the study area

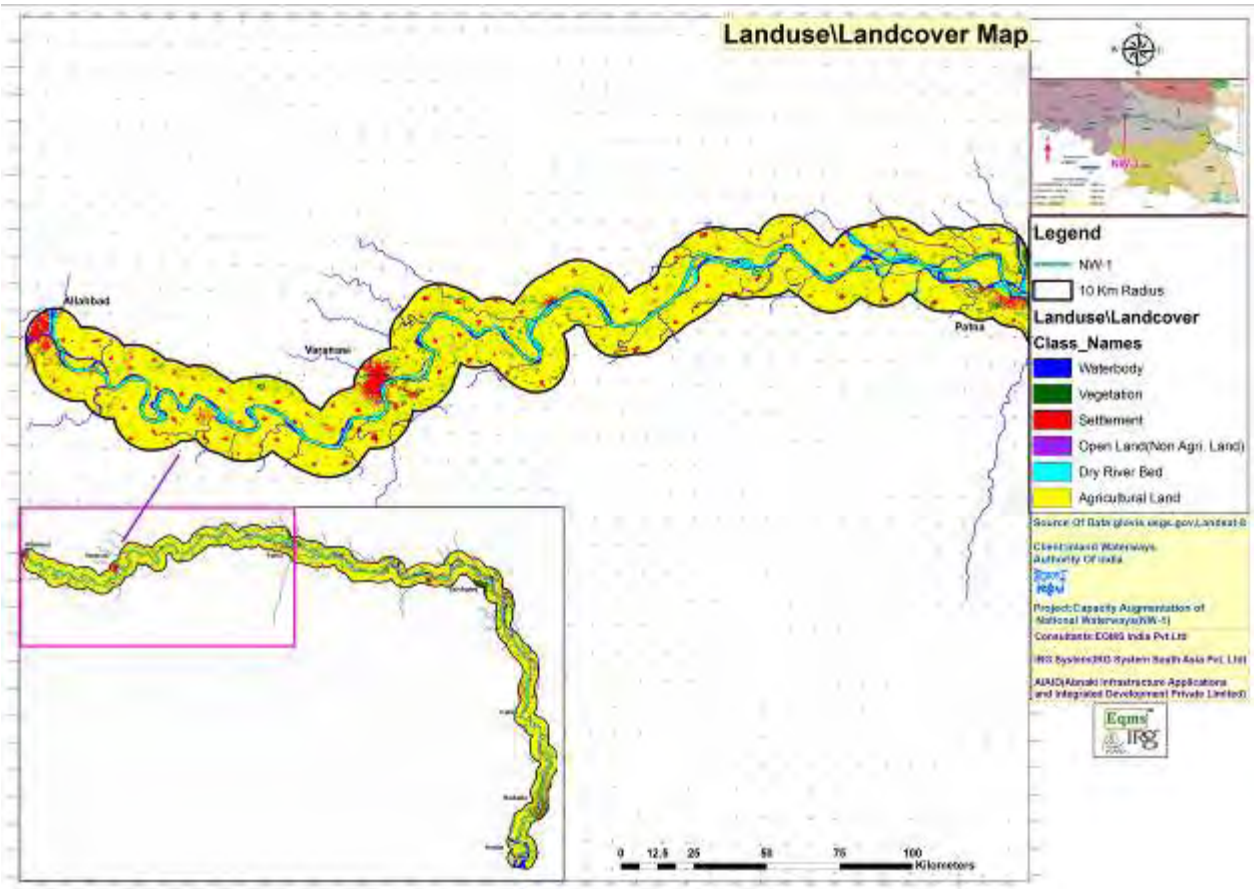


Figure 4.5 : Land use Map (Allahabad to Patna)

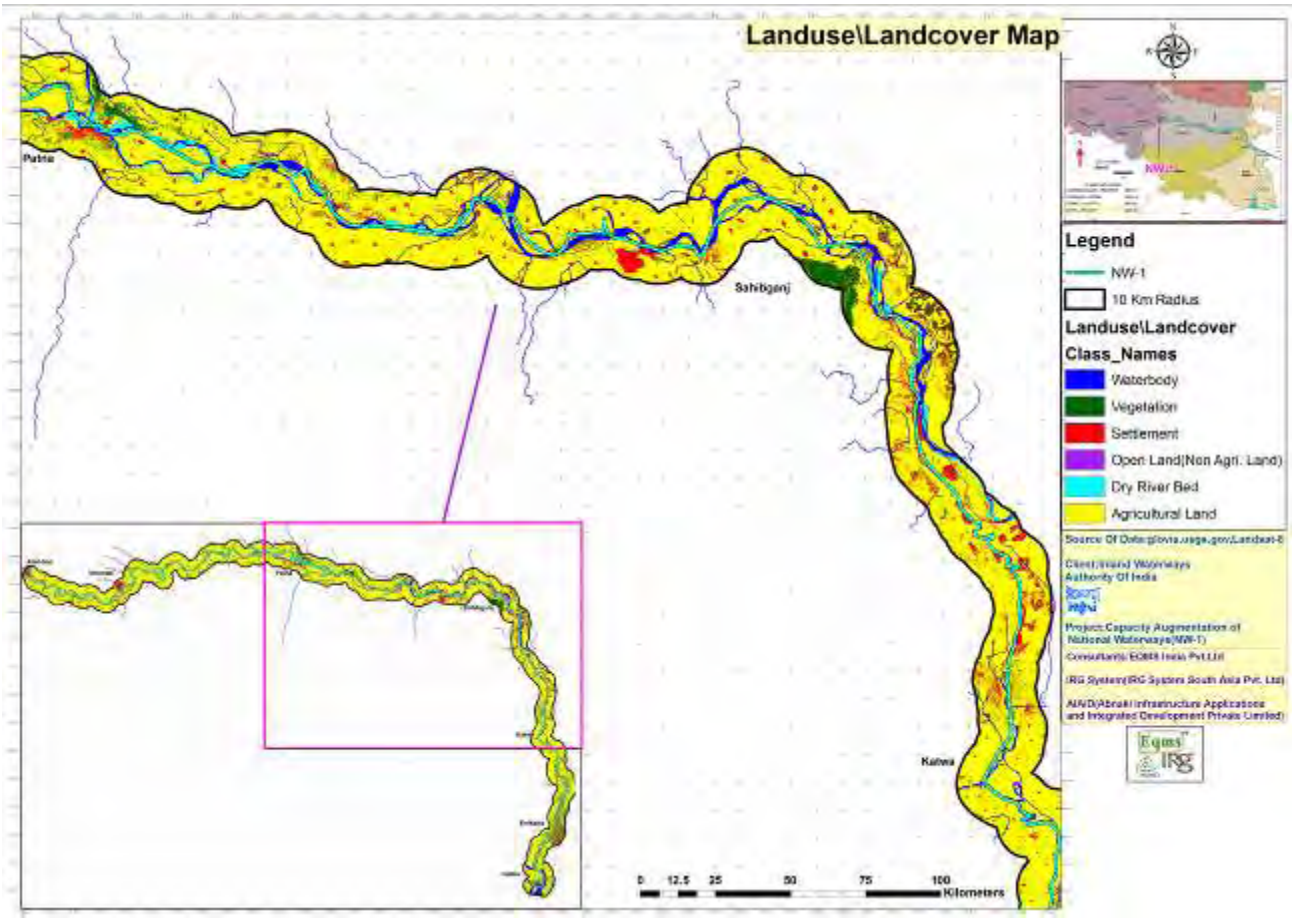


Figure 4.6 : Land use Map (Patna to Katwa)

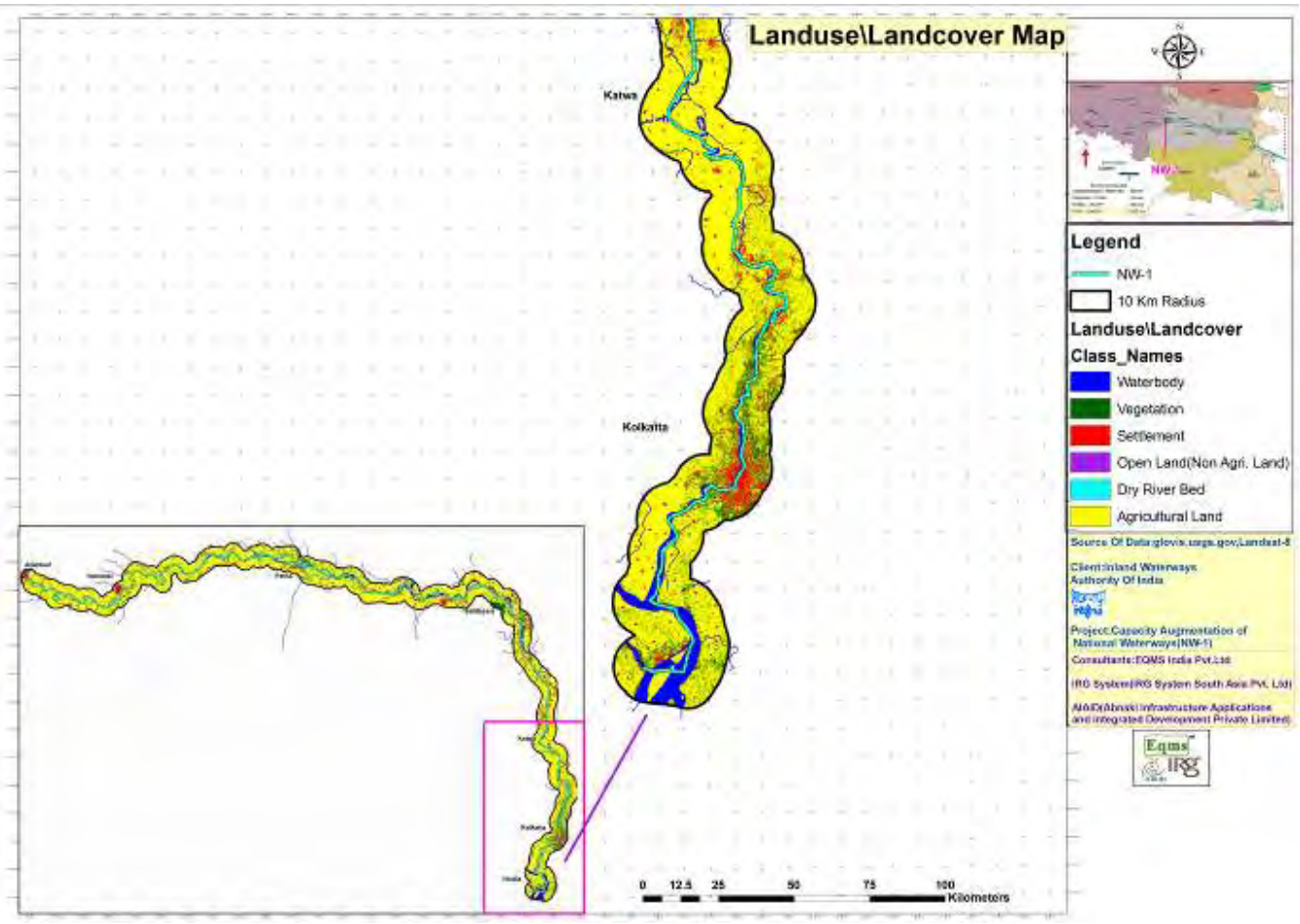


Figure 4.7 : Land use Map (Katwa to Haldia)

4.3.1.6 Cropping Pattern

The Ganga river with its fertile soil is having a great influence to the agricultural economies of adjoining district along the NW-1. The Ganges and its tributaries provide a constant source of irrigation water catering to the agricultural needs of an extensive area along the NW-1. The major crops cultivated in that area include rice, lentils, sugarcane, potatoes, oil seeds and wheat. Along the banks of the river, the existence of swamps and lakes also provide a rich fertile soil for crops like legumes, chilies, sesame, mustard, sugarcane, and jute.

4.3.1.7 Major Habitation along the NW-1

The major habitation located along NW-1 are Allahabad, Sirsa, Mirzapur, Chunar, Varanasi, Zamania, Ghazipur, Gahmar, Buxar, Ballia, Chappra, Patna, Barh, Bihat, Munger, Bhgalpur, Kahalgaon, Sahibganj, Farakka, Berhampore, Katwa, Kalna, Kolkata and Haldia.

4.3.2. *Geology*

Ganga river basin is part of the tectonically active foreland basin of the Himalayan mountain range formed by collision of the Indian tectonic plate with the Eurasian plate more than fifty million years ago. Thus, most of the area of NW-1 consists of alluvial plains formed during the Tertiary and Quaternary periods by flood deposits of Himalayan rivers. The Ganga river

network not only conveys water, but also transfers enormous amounts of eroded Himalayan sediments to the sea. The alluvial deposits on the plain area constitute large and highly productive multi-aquifer systems in the area, which are a major storehouse of ground water. The soils of the area are also largely alluvial. Geological map of NW-1 is provided in **Figure 4.8.**

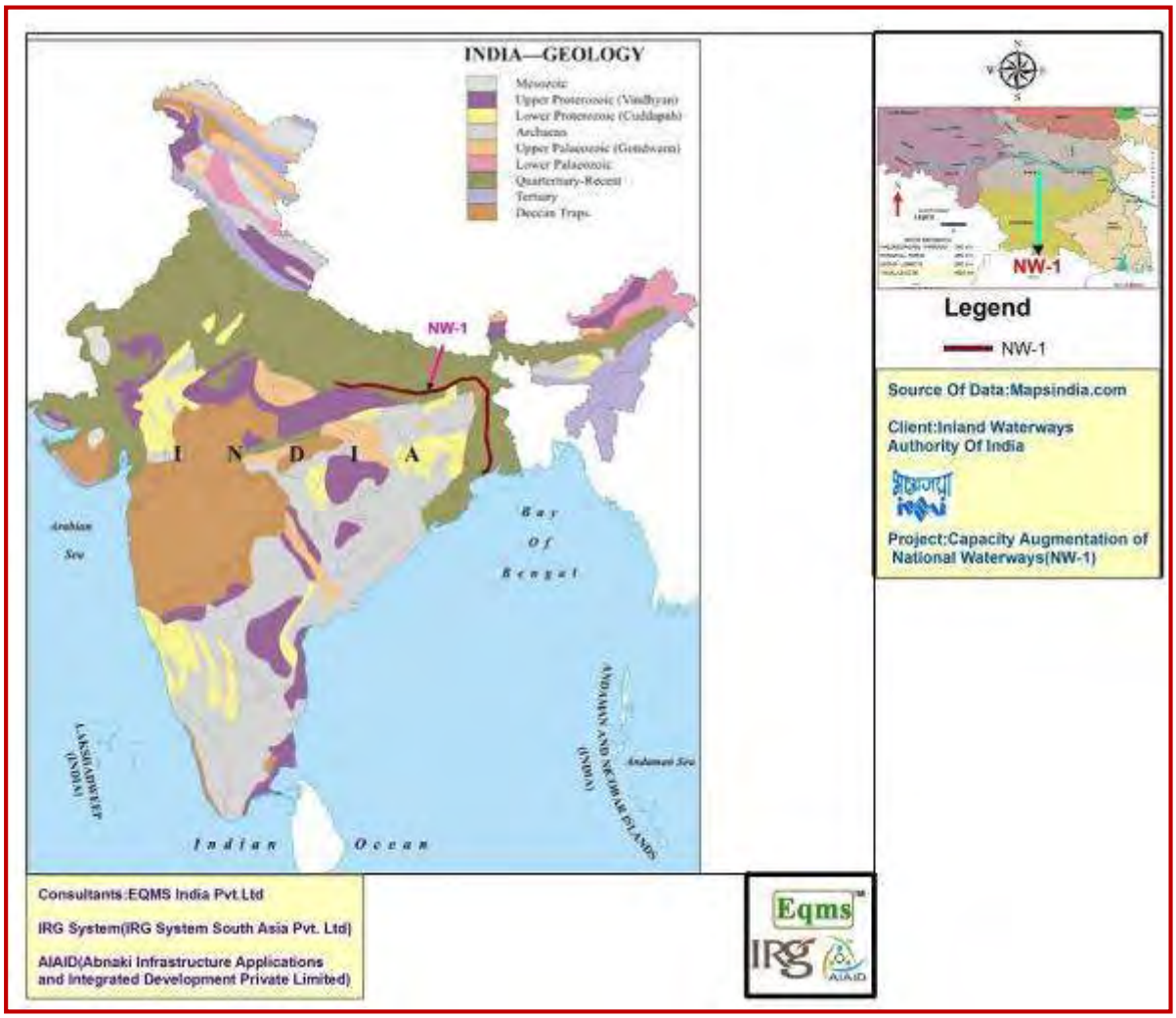


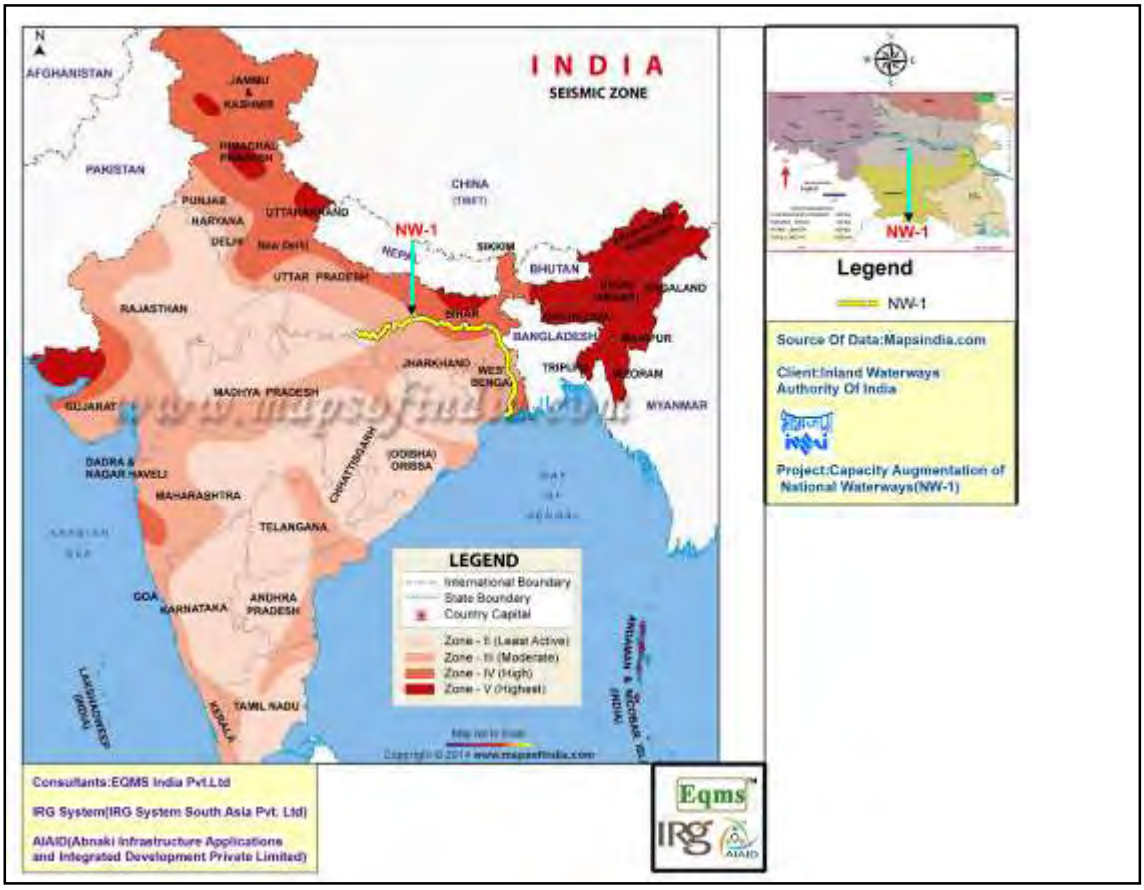
Figure 4.8 : Geological Map of India

4.3.2.2 Volcanic activity

There were no records of any volcanic eruption in NW-1 region or even in its surrounding areas.

4.3.2.3 Seismicity

As per seismic classification of India most of the NW-1stretch falls under zone-III which mean moderate seismic risk. Some stretch in Bihar state falls under zone IV which means high seismic risk. The seismic zoning map of India is shown at **Figure 4.9**.



(Source: As per IS:1893 Part I 2002)

Figure 4.9 : Seismic of Zones Map of India

4.3.3. *Soil*

Soils may be defined as a thin layer of earth's crust that serves as a natural medium for the growth of plants wherein root zone develops. It is the unconsolidated mineral matter that has been subjected to and influenced by genetic and environmental factors. Soils serve as a reservoir of nutrients for plants and crops and also provide mechanical anchorage and favourable tilts. Soil is the seat of many macro and micro flora like algae, fungi, earthworms, bacteria etc. These are very beneficial in promoting soil reactions and decomposing the organic matter by which essential nutrients for plants are liberated.

4.3.3.1 Regional Soil Types

The NW-1 stretch is characterized by a wide variety of soils. The soils of the high Himalayas in the north are subject to continued erosion and the Gangetic trough provides a huge receptacle into which thousands of metres of thick sediment layers are deposited to form a wide valley plain. The Deccan plateau in the south has a mantle of residual soils of varying thickness arising due to the weathering of the ancient rocks of the peninsular shield. Three classes of soils have been developed in the states of NW-1 under different Lithological, and climatic conditions. Among the soil types alluvial soil, red soil and red and yellow soil are found in the NW-1 stretch. The soil of four states of NW-1reflects a variety of soils. Some of the soils are highly susceptible to erosion. The alluvial soils, covering maximum area of the NW-1, have very high erodibility; red soils covering of the study area have high erodibility, red & yellow soils have moderate erodibility, Broadly, it can be said that soils in Uttar

Pradesh, Bihar, Jharkhand and West Bengal, through which the main stem of Ganga and all its tributaries flow, have very high erodibility.

Most of the NW-1 stretch is dominated by alluvial soil type. The entire alluvial formation is endowed with rich soil nutrients. The alluvial deposits of the Ganga and its tributaries, coming down the Himalaya and the peninsular foreland, have yielded annual harvests of crops for the past thousands of years with little significant deterioration. Besides paddy, this tract produces a wide variety of crops including wheat, jowar, bajra, small millets, pulses of different kinds, maize, cotton, jute and many other food and commercial crops.

4.3.3.2 Study, Sampling and Analysis

The physicochemical characteristics of soils within the study area, soil sample were also collected from proposed interventions along the NW-1. The physicochemical characteristics of the soils in the study area, as established from the analysis of the soil samples are presented in **Table 4.7** and **4.8.**

Table 4.7 : Soil Quality along NW-1 (near Proposed Terminal Locations)

S. No.	Parameter	Unit	West Bengal			Jharkhand	Uttar Pradesh	
			Haldia Terminal	Farakka (LockGate)	Tribeni Terminal	Sahibganj Terminal (Samdanala)	Ghazipur Terminal	Varanasi Terminal
Physical Characteristics								
1.	Texture	USDA System	Sandy Clay	Clay Loam	Sandy Clay	Clay Loam	Clay Loam	Clay Loam
2.	Water Holding Capacity	%	30.6	30.2	29.5	30.2	31.4	36.0
3.	Bulk Density	gm/cc	1.39	1.29	1.35	1.32	1.26	1.30
4.	Porosity	%	47.6	51.3	49.1	50.2	52.5	50.9
Chemical Characteristics								
5.	pH	20 % Slurry	7.86	6.85	7.25	6.58	7.72	7.40
6.	Conductivity (EC)	µmhos/cm	235.4	135.4	279.2	272.0	305.6	360.5
7.	CEC	meq /100-gm	20.5	16.8	22.5	19.5	21.5	18.0
8.	Organic Matter (OM)	%	1.34	1.69	1.29	1.55	1.14	0.9
9.	Organic Carbon (OC)	%	0.78	0.98	0.75	0.90	0.66	0.52
10.	**Primary Nutrients**							
i)	Nitrogen as N	Kg/ha	245.8	325.8	281.5	298.6	345.5	280.2
ii)	Phosphorous as P	Kg/ha	20.5	24.3	25.2	19.6	16.8	16.2
iii)	Potassium as K	Kg/ha	139.5	116.5	128.2	225.7	245.2	168.8
Micronutrients								
11.	Manganese as Mn	mg/kg	18.2	565.2	26.5	26.8	14.5	11.8
12.	Chromium as Cr	mg/kg	76.5	26.7	2.16	<0.01	5.7	10.5
13.	Arsenic as	mg/kg	<0.01	2.65	<0.01	<0.01	<0.01	<0.01
14.	Mercury as Hg	mg/kg	<0.01	0.12	<0.01	<0.01	<0.01	<0.01
15.	Lead as Pb	mg/kg	11.8	35.6	28.5	<0.01	6.4	5.8
16.	Zinc as Zn	mg/kg	31.9	38.5	<0.01	1.28	1.16	1.04
17.	Iron as Fe	mg/kg	31.2	2.44	2.68	42.2	24.3	12.9
18.	Copper as Cu	mg/kg	16.8	15.6	13.8	3.56	2.24	2.45
19.	Cadmium as Cd	mg/kg	1.25	0.35	0.88	<0.01	0.85	0.75
20.	Nickel as Ni	mg/kg	<0.01	16.5	<0.01	0.89	2.15	1.88

Source: Data sampling & Analysis by JV and NABL accredited Lab

Table 4.8 : Soil Quality along NW-1 (Near Existing Ro-Ro / Jetty / Floating Terminal Locations)

S. No.	Parameter	Unit	West Bengal						Jharkhand	Bihar		
			Diamond Harbor	Howrah	Shantipur Ghat	Hazardwari	Katwa	Pakur	Mangal Hat	Munger	Patna	Buxer
Physical Characteristics												
1.	Texture	USDA System	Sandy Clay	Clay Loam	Sandy Clay	Sandy Clay	Clay Loam	Sandy Clay	Sandy Clay	Sandy Loam	Sandy Loam	Clay Loam
2.	Water Holding Capacity (WHC)	%	32.6	30.5	31.8	30.5	29.7	30.5	29.4	28.9	29.6	33.8
3.	Bulk Density (BD)	gm/cc	1.37	1.28	1.35	1.39	1.36	1.35	1.30	1.42	1.48	1.25
4.	Porosity	%	48.3	51.7	49.1	47.6	48.7	49.1	50.9	46.4	44.2	52.8
Chemical Characteristics												
5.	pH	20 % Slurry	7.66	7.01	7.72	7.35	6.62	7.56	7.08	7.68	7.46	7.36
6.	Conductivity (EC)	µmhos/cm	224.4	235.6	298.5	228.3	261.5	278.5	220.6	244.8	224.2	272.9
7.	CEC	meq /100-gm	18.8	16.5	20.6	22.8	24.4	18.2	21.5	10.5	9.6	18.5
8.	Organic Matter (OM)	%	1.17	1.34	1.07	1.24	1.66	0.88	1.02	1.10	1.12	0.83
9.	Organic Carbon (OC)	%	0.68	0.78	0.62	0.72	0.96	0.51	0.59	0.64	0.65	0.48
10.	**Primary Nutrients**											
i)	Nitrogen as N	Kg/ha	245.8	264.3	278.5	229.7	272.8	255.4	226.4	238.5	227.5	255.1
ii)	Phosphorous as P	Kg/ha	22.5	29.7	26.2	20.6	32.4	28.5	25.6	28.2	26.8	31.5
iii)	Potassium as K	Kg/ha	128.5	124.9	123.4	246.6	185.5	142.6	252.8	267.9	252.7	236.8
Micronutrients												
11.	Manganese as Mn	mg/kg	10.2	18.7	16.8	15.9	18.6	16.2	19.6	15.8	17.1	13.7
12.	Chromium as Cr	mg/kg	32.4	17.6	6.58	20.3	8.4	14.8	22.8	<0.01	<0.01	<0.01
13.	Arsenic as	mg/kg	1.22	1.12	0.95	<0.01	<0.01	8.5	<0.01	<0.01	<0.01	<0.01
14.	Mercury as Hg	mg/kg	0.16	0.12	0.27	<0.01	<0.01	0.85	<0.01	<0.01	<0.01	<0.01
15.	Lead as Pb	mg/kg	14.2	16.8	11.6	5.2	6.8	4.6	6.5	<0.01	<0.01	<0.01
16.	Zinc as Zn	mg/kg	24.5	1.88	1.15	0.76	0.44	0.95	0.82	2.62	2.06	1.16
17.	Iron as Fe	mg/kg	2.45	28.4	30.8	28.5	33.8	24.8	37.5	24.2	32.4	28.2
18.	Copper as Cu	mg/kg	12.8	8.6	12.4	2.25	2.66	2.55	1.95	2.11	2.07	2.15

19.	Cadmium as Cd	mg/kg	0.67	<0.01	<0.01	1.18	<0.01	0.24	1.14	<0.01	<0.01	<0.01
20.	Nickel as Ni	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	12.8	<0.01	<0.01	<0.01	<0.01

Source: Data sampling & Analysis by JV and NABL accredited Lab

4.3.3.3 Soil Characteristics

Physical Properties

The physical characteristics examined include colour, texture, bulk density, porosity and water holding capacity. The soil along the NW-1 is alluvial type. As per 'USDA' Triangular Classification System, overall soils of all the sampling locations along NW-1 can be described as Sandy Clay, Sandy Loam and Clay Loam type. Soils having larger particles usually have higher Bulk Density than those of smaller particles. Bulk Density of soils along NW-1 was found in the range of 1.25 to 1.48-gm/cc. Porosity of soils was observed between 44.2 to 52.8%. Water Holding Capacity (WHC) of the soils varied between 28.9-33.8%.

Chemical Characteristics

The analysis reflected that the soils are generally neutral to slightly alkaline nature with pH ranging from 6.62-7.86 at all locations along with NW-1". Electrical Conductivity (EC) was found varying between 135.4-360.5-µmhos/cm and found with acceptable range.

Nitrogen is an integral component of many compounds including chlorophyll and enzyme essential for plant growth. Available nitrogen content in the surface soils along NW-1 stretch ranges between 244.48 & 345.5-kg/ha thereby, indicates that soils are low to medium for available nitrogen content.

Phosphorous take part in important functions like photosynthesis, nitrogen fixation, crop maturation, root development, strengthening straw in cereal crops etc. Available phosphorus content ranged between 16.2-32.4-kg/ha thereby indicating that soils are low in phosphorus in Jharkhand zone, medium in Uttar Pradesh and is on higher side in the soils of West Bengal.

Potassium is an activator of various enzymes responsible for plant processes like energy metabolism, starch synthesis, nitrate reduction and sugar degradation. It is also important in grain formation and tuber development and encourages crop resistance for certain fungal and bacterial diseases. Available potassium content in these soils at sampling locations ranged between 116.5-267.9-kg/ha thereby indicating that the all sampled soils were medium category of available potassium.

Cation Exchange Capacity (CEC) was found in the range of 9.6 to 24.4-meq/100-gm at all locations along with NW-1. Range of copper, zinc, Chromium, Lead and other micronutrients were observed in normal range.

Thus, the overall soil along the NW-1 area is of moderately fertile and not expected to be detrimental to the growth of agricultural and forest crops. Above description based on physicochemical properties reveals that the soils fall within medium fertility levels in the entire stretch of NW-1 (Haldia to Allahabad).

4.3.4. *Meteorological Data (30 years avg.)*

The main climatic factors of concern are temperature, sunlight and precipitation. In India, has four temperature zones namely tropical, sub-tropical, temperate and alpine. Among

these, the tropical zone (Humid, sub-tropical and Tropical wet and dry) is most predominant in the entire NW-1 stretch.

The meteorological parameters also play a vital role in transport and dispersion of pollutants in the atmosphere. Historical meteorological data were obtained from climatological tables pertaining to different IMD stations all along the NW-1. The met data of the nearest representative IMD stations all along the NW-1(period 1961-1990) is summarized in in **Table 4.9 and 4.10**.

Table 4.9 : Meteorological Data (Period 1961-1990)

Month	Kolkata, IMD					Malda, IMD					Bhagalpur, IMD					Patna, IMD					Varanasi, IMD				
	Temp (^{O}C) daily		Relative Humidity, %		Rain Fall	Temp (^{O}C) daily		Relative Humidity %		Rain fall	Temp (^{O}C) daily		Relative Humidity, %		Rain Fall	Temp (^{O}C) daily		Relative Humidity, %		Rain fall	Temp (^{O}C) daily		Relative Humidity, %		Rain fall
	Max	Min	Max	Min	mm	Max	Min	Max	Min	mm	Max	Min	Max	Min	mm	Max	Min	Max	Min	mm	Max	Min	Max	Min	mm
Jan	26.4	13.8	71	55	15.0	25.1	11.8	67	56	10.1	24.6	11.9	78	65	11.9	23.3	9.1	78	59	13.2	23.2	9.2	77	53	17.7
Feb	29.4	17.0	65	48	24.4	28.0	13.9	61	47	10.1	27.4	14.1	69	56	11.2	26.0	11.3	69	48	13.1	26.4	11.6	67	42	17.1
Mar	33.8	21.8	66	47	32.9	33.3	18.0	53	40	12.0	33.6	19.3	57	43	9.3	32.3	16.2	53	33	11.7	32.8	16.4	51	29	9.3
April	35.7	25.0	69	59	57.0	36.9	22.1	57	43	36.9	37.5	23.8	58	41	26.0	37.1	22.0	48	27	10.1	38.5	22.1	42	25	5.4
May	35.6	26.1	71	65	120.7	36.0	24.0	65	54	120.3	37.5	24.8	68	51	63.6	38.0	24.9	59	37	40.0	40.4	25.5	49	29	13.2
June	34.0	26.5	78	75	291.2	34.5	25.6	72	66	189.4	36.0	26.4	77	68	188.7	36.5	26.6	70	55	123	38.5	27.2	62	47	91.3
July	32.4	26.1	82	81	375.7	32.6	25.7	76	74	332.8	33.1	26.2	84	79	293.5	32.9	26.0	83	75	360	33.7	25.8	81	72	309.3
Aug	32.1	26.0	83	82	348.4	32.7	25.9	77	73	248.8	32.9	26.3	84	79	235.9	32.5	26.0	83	76	269	32.9	25.4	84	76	286.5
Sept	32.4	25.8	80	81	291.4	32.8	25.5	75	73	229.7	33.1	25.9	82	78	204.0	32.3	25.2	82	76	213	32.9	24.4	81	72	203.5
Oct	32.2	23.8	73	72	137.7	31.8	22.9	72	68	107.6	32.4	23.1	77	71	97.4	31.6	21.4	76	69	93	32.8	20.5	72	59	27.3
Nov	30.1	19.1	66	64	22.2	29.5	17.7	66	61	11.4	30.0	17.8	72	65	4.2	28.9	14.9	73	64	8.1	29.5	14.3	68	54	13.8
Dec	26.9	14.3	70	61	11.9	26.3	13.1	67	60	6.2	25.8	12.9	77	67	5.4	24.5	9.8	77	62	5.5	24.7	9.9	75	55	5.9

(Source-IMD)

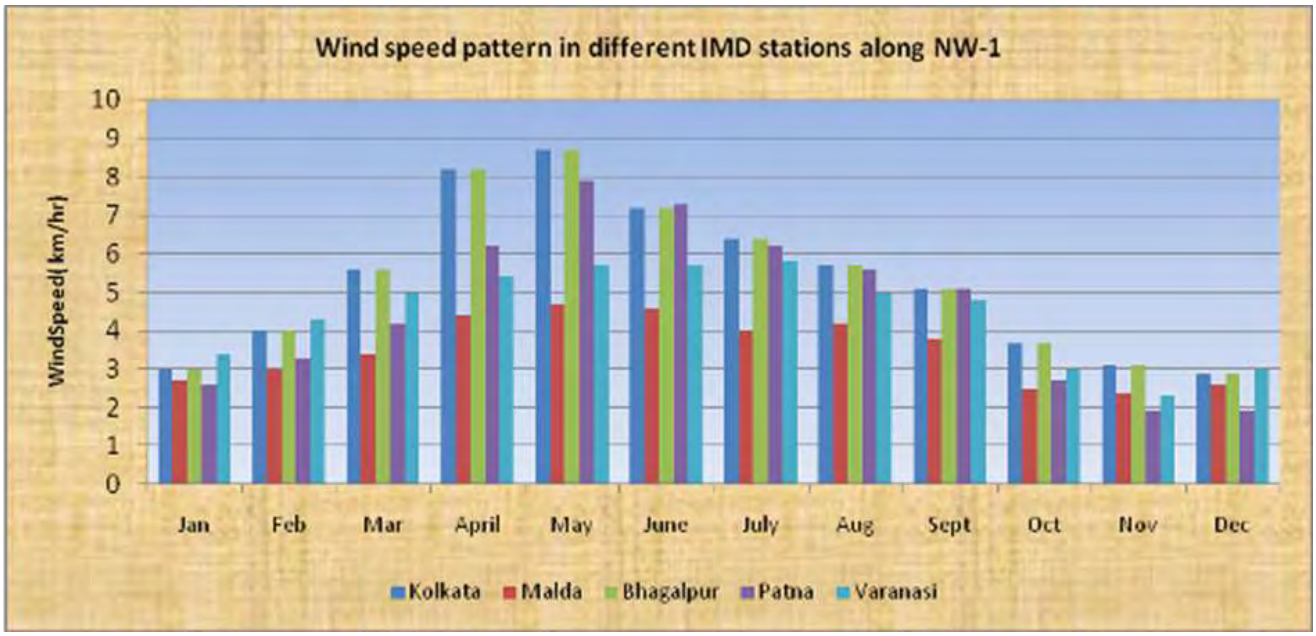
Table 4.10 : Meteorological Data (Period 1961-1990)

	Kolkata, IMD			Malda, IMD			Bhagalpur, IMD			Patna, IMD			Varanasi, IMD		
	Wind speed	Pre-dominant wind direction	Pressure	Wind speed	Pre-dominant wind direction	Pressure	Wind speed	Pre-dominant wind direction	Pressure	Wind speed	Pre-dominant wind direction	Pressure	Wind speed	Pre-dominant wind direction	Pressure
	Kmph	From	hpa	Kmph	From	hpa	Kmph	From	hpa	Kmph	From	hpa	Kmph	From	hpa
Jan	3.0	NW, N	1014.8	2.7	N,NW	1013.7	3.0	SW,W	1012.3	2.6	W,SW	1006	3.4	W, NW	NA
Feb	4.0	NW, N	1014.2	3.0	W,NW	1011.3	4.0	SW,W	1009.8	3.3	W,SW	1007	4.3	W, NW	NA
Mar	5.6	S, SW	1011.2	3.4	W,NW	1008.3	5.6	SW,W	1006.6	4.2	W,SW	1004	5.0	W, NW	NA
April	8.2	S, SW	1007.6	4.4	E,SE	1004.4	8.2	E,W	1002.7	6.2	E,W	1000	5.4	W, NW	NA
May	8.7	S, SW	1004.1	4.7	E,SE	1001.6	8.7	NE,E	999.4	7.9	E, NE	996	5.7	W,NW	NA
June	7.2	S, SE	999.6	4.6	E,SE	997.9	7.2	E,SE	995.3	7.3	E, NE	992	5.7	W, NW	NA
July	6.4	S, SE	1000.0	4.0	E,SE	997.7	6.4	E,SE	995.7	6.2	E, NE	992	5.8	W, E	NA
Aug	5.7	S, SE	1001.0	4.2	E,SE	998.6	5.7	E,SE	996.7	5.6	E, NE	994	5.0	W, E	NA
Sept	5.1	S, SE	1005.1	3.8	E,SE	1002.7	5.1	E,SE	1000.9	5.1	E, NE	998	4.8	W, E	NA
Oct	3.7	NW, S	1010.4	2.5	N,NE	1007.2	3.7	E,W	1006.5	2.7	E	1004	3.0	W, NW	NA
Nov	3.1	NW, N	1014.2	2.4	N,NW	1011.6	3.1	SW,W	1010.6	1.9	W,SW	1008	2.3	W, NW	NA
Dec	2.9	NW, N	1016.6	2.6	N,NW	1013.7	2.9	SW,W	1012.7	1.9	W,SW	1010	3.0	W, NW	NA

(Source-IMD)

4.3.4.2 Wind Speed and Direction

The wind speed in the area was mostly between 1.9 km/hour at Patna IMD and maximum of 8.7 km/hour at Kolkata IMD for all the months of a year (**Figure 4.10**). The predominant wind direction is from North and Northwest direction in winters and South and Southeast direction during rest of the season.

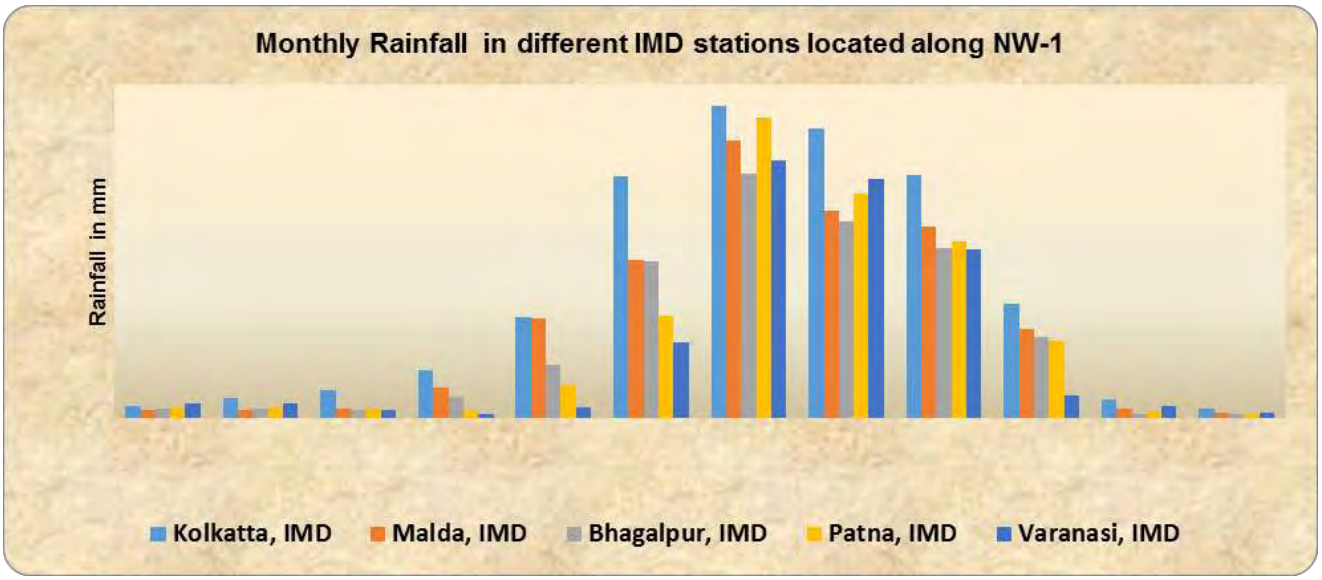


(Source: Analysis of IMD data)

Figure 4.10 : Wind Speed at different IMD stations along NW-1

4.3.4.3 Rainfall

The annual total rainfall in all IMD stations (representing respective city/towns) ranges between 1000.3mm at Varanasi and 1728.5 mm at Kolkata. Over 80% of the total annual rainfall at all locations is received during the monsoon period between June to September (**Figure 4.11**).

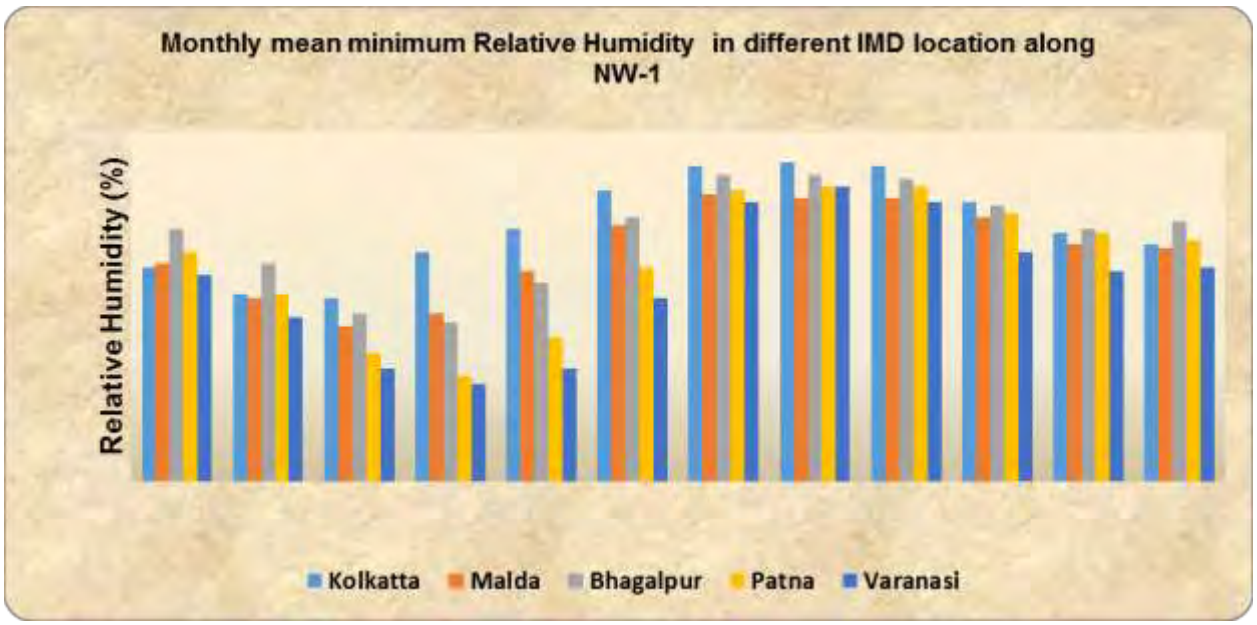


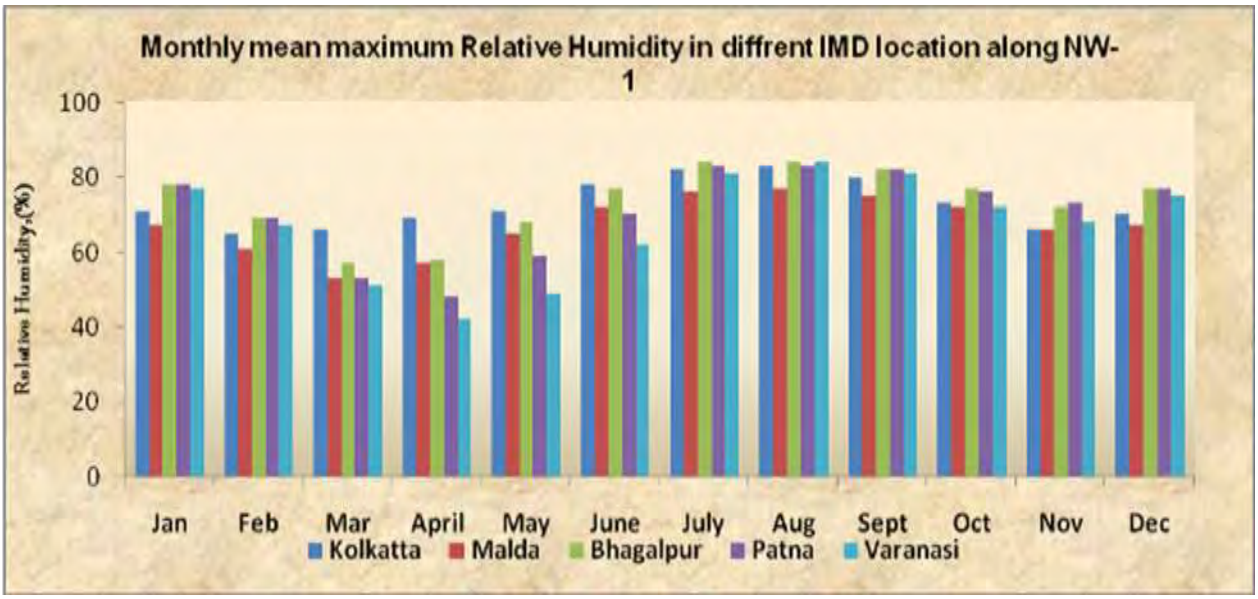
(Source: Analysis of IMD data)

Figure 4.11 : Monthly Rainfall

4.3.4.4 Relative Humidity

The air is generally dry in the region except during monsoon. March and April are the driest months with relative humidity ranging between 25-84%. Lowest humidity was observed in Varanasi (as per IMD records) which slightly increased with decreasing altitude. The maximum humidity was observed during rainy season as reflected in data base of all IMD stations along NW1. **(Figure 4.12)**.





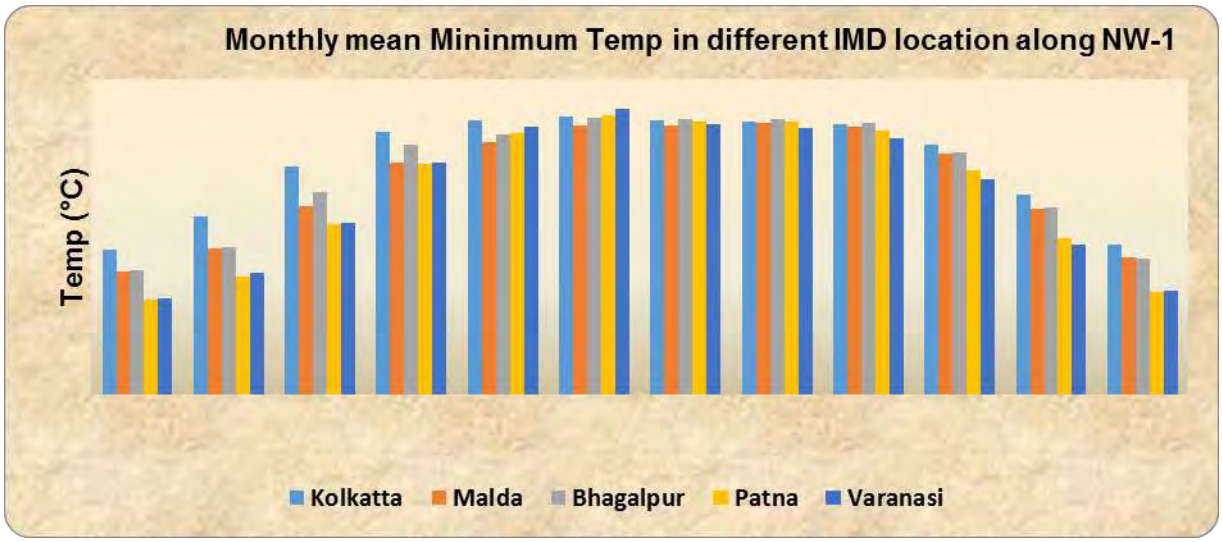
(Source: Analysis of IMD data)

Figure 4.12 : Monthly Relative Humidity

4.3.4.5 Temperature

December and January constitutes winter months with daily mean minimum temperature of around 9.1ºC at Patna (IMD Station) and daily mean maximum temperature of around 26.9ºC at Kolkata. April and May are the hottest months with daily mean maximum

temperature varying around 40.4°C at Varanasi and daily mean minimum temperature around 24°C at Malda (IMD records) **(Figure 4.13)**.



(Source: Analysis of IMD data)

Figure 4.13 : Monthly Temperature

4.3.4.6 Barometric Pressures

The station level barometric pressure at all IMD sites ranged between 997 to 1016.8 h Pa. The station level pressure is highest in winter months and low in during rainy season.

4.3.4.7 Day Time Length:

At Allahabad, the longest day of the year (falling in June) is of 13 hours 35 minutes of daylight. The shortest day (falling in December) is only of 10 hours 24 minutes long. Similarly, at Haldia (which is farther towards South, and closer to the equator), the longest day of the year is of 13 hours 29 minutes, and the shortest day is of 10 hours 47 minutes.

4.3.4.8 Visibility

Visibility is of key concern for safe navigation all along NW1. A review of climate data for a few key locations along the NW-1 route suggests that there are occasions with reduced visibility (characterised by the average number of days affected by fog). The time period over which fog is likely to affect the NW-1 route extends from October to March inclusive. There is a subtle difference in the period of the year when fog is more likely to affect navigation on different locations particularly the locations falling nearer the coast (Haldia and Kolkata) are having a larger window over which fog could occur (October to March). Berhampur is having the narrowest window (January to March). The greatest probability of fog occurring at locations along the NW-1 route is during January, the potential inland locations (Patna and Varanasi) to be affected by fog on more than 50% of days during December and January. Visibility may also be reduced significantly during periods of heavy rain. During such conditions, the performance of vessel-mounted navigation aids, such as radar, may also be affected.

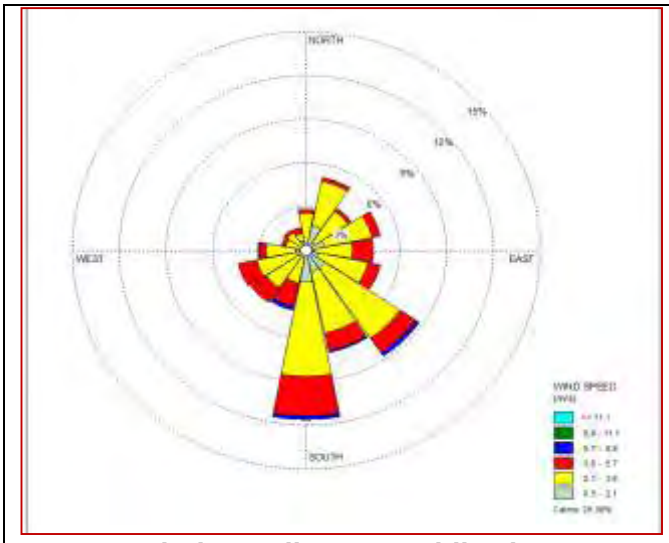
4.3.4.9 Site specific Met Data at proposed terminals

Secondary one-month data was collated for terminal and Lock locations at Haldia, Farakka lock, Sahibganj and Varanasi. The analysis reflected that predominant wind direction all along NW-1 is from NW, WNW, E, S and SE direction. The prevalence of calm period ranges between 26 to 31%. Site specific met data and wind roses are given at **Table 4.11** and **Figure 4.14**.

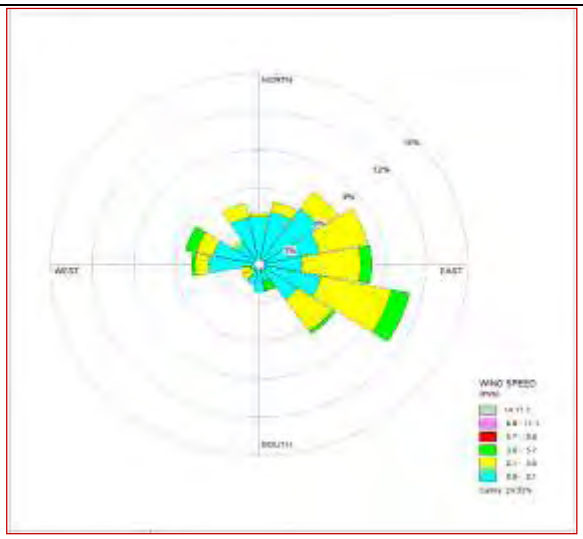
Table 4.11 : Meteorological Data

IMD	Temperature (deg C)		Relative Humidity, %		Wind speed Range m/s		Predominant wind Direction	Calm Period
	Max	**Min**	Max	Min	**Min**	**Max**	**(from)**	**%**
Haldia Site	38.5	25.6	94	34	0.5	8.8	S, SE	26.06
Farakka site	38.6	22.5	81	56	0.5	5.7	ESE, E	24.3
Sahibganj	39.0	22.0	97	30	0.5	8.8	ESE, E	30.2
Varanasi	35.4	23.4	78	57	0.5	6.5	WNW, NW	31.2

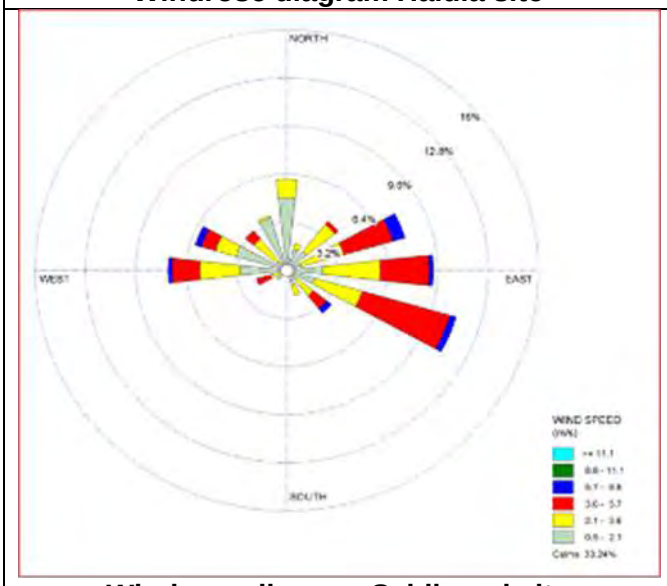
(Source-*World Weather on line.com*)



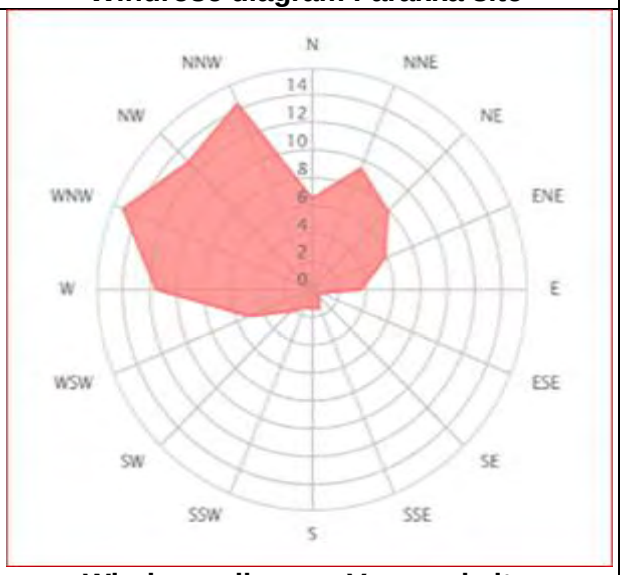
Windrose diagram Haldia site



Windrose diagram Farakka site



Windrose diagram Sahibganj site



Windrose diagram Varanasi site

Figure 4.14 : Wind Rose Diagram

4.3.4.10 History of Cyclones:

As per Cyclone Hazard Prone Map of India some stretch of NW-1 close to Haldia in West Bengal (nearer to sea) falls in Cyclone prone area. Cyclone hazard prone areas of NW-1 are shown at **Figure 4.15.**

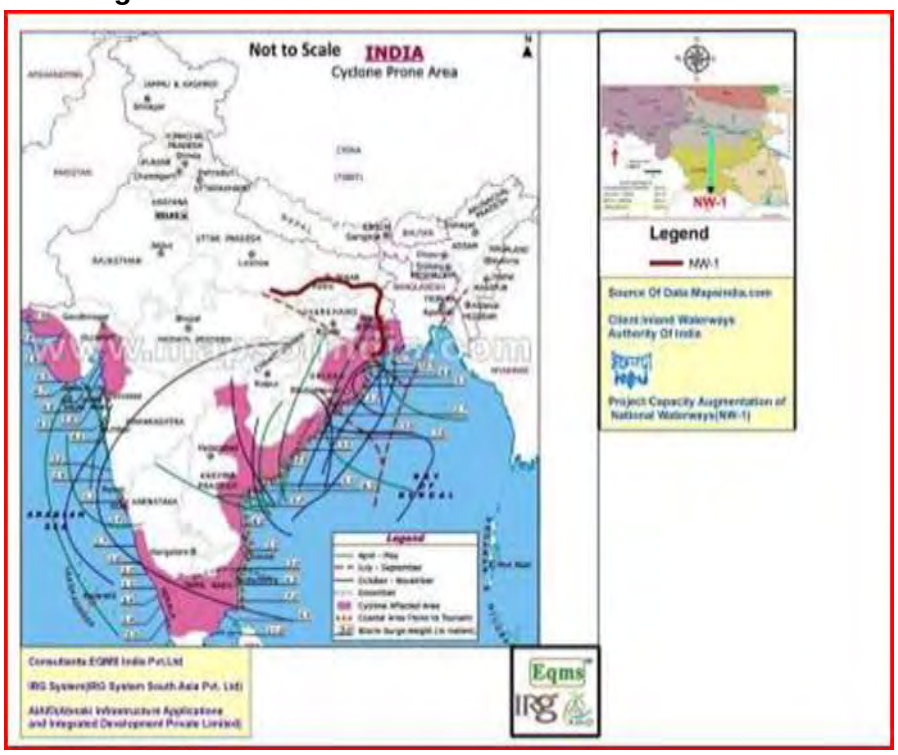


Figure 4.15 : Cyclone Prone Area Map of India showing NW-1

4.3.4.11 Tidal Surges

Tidal surges are also important for navigation ease. There are no tidal surges observed in NW-1 area from Allahabad to Farakka. Nearly halfway between Farakka and Sagar Island, Hoogly(Ganga) enters into the tidal zone of the Gangetic delta. The tide runs rapidly on the Hoogly, and tidal effect upto Kolkata (about 175 Km).

4.4. Water Environment

4.4.1. *Ground Water Use pattern*

Groundwater is the water present beneath Earth's surface in soil pore spaces and in the fractures of rock formations. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers. The major land use type around the NW-1 is agriculture. The NW-1 area has a vast reservoir of groundwater, replenished every year at a very high rate. The conjunctive use of groundwater for irrigation, even within the canal command areas, not only ensures steady supply to the cultivated fields on time but also helps reduce water logging and salinization due to consequent downward movement of subsurface moisture.

The groundwater usage pattern in the states traversed by NW-1 is given in **Table 4.12.** The extent of groundwater utilization for irrigation is highest in Uttar Pradesh (45.36 BCM per year), followed by West Bengal (10.84 BCM per year), Bihar (9.39 BCM per year) and Jharkhand (0.7 BCM per year).

Table 4.12 : Overview of Ground water uses Pattern in States Traversed by NW-1

S. No.	State	Annual Groundwater Draft (BCM per year)			Net annual Groundwater availability (BCM/year)	Projected Demand for Domestic and Industrial uses up to 2025 (BCM per Year)
		irrigation	Domestic and Industrial uses	Total		
1	Uttar Pradesh	45.36	3.42	48.78	70.18	5.30
2	Bihar	9.39	1.37	10.77	27.42	2.14
3	Jharkhand	0.7	0.38	1.06	5.25	0.56
4	West Bengal	10.84	0.81	11.65	27.46	1.24

(Source: Central Groundwater Board, 2008 and Central water commission 2008)

Apart from irrigation, groundwater resources are also being heavily tapped for industrial and domestic activities in urban as well as in rural areas. Throughout the alluvial area of the NW-1, the most of the urban water supply schemes are dependent upon groundwater resources. Similarly, a large number of industries also withdraw significant amounts of groundwater, especially from the easily accessible aquifers in the alluvial zone. State wise ground water resources in NW-1 state are given in **Table 4.13.**

Table 4.13 : State wise Ground water resources in NW-1 (2008)

S. No.	State	Annual Replenishable Groundwater (BCM per Year)	Annual Groundwater Draft (BCM per Year)	Balance available (BCM per year)	Stage of Groundwater Development (%)
1	Uttar Pradesh	76.35	48.78	27.57	70
2	Bihar	29.19	10.77	18.42	39
3	Jharkhand	5.58	1.06	4.52	20
4	West Bengal	30.36	11.65	18.71	42

Source: CWC 2008

4.4.1.2 Ground Water Quality

Ground water samples were collected from intervention locations and stretches close to populated zones all along the NW-1[25]. The water samples were examined for physico-chemical parameters as well as for bacteriological parameters. The details of sampling locations are presented in **Table 4.14** and **Figure 4.16.** The Analysis results are presented in **Table 4.15 and Table 4.16.**

[25]Samples for chemical analyses and bacteriological analyses were collected in polyethylene carboys and in sterilized bottles (APHA Method) respectively.

Table 4.14 : Ground Water Sampling Locations along NW-1

S. No.	Terminal Location	Ground water sampling Location	Location Code	Source
Proposed and Planned Terminals				
1	Haldia Terminal, WB	Patikhali	GW-1	Hand pump
		Near terminal site	GW-2	Borewell
		Durgachak	GW-3	Borewell
2	Tribeni Terminal, WB	Near Terminal site, Tap water	GW-4	Borewell
		Tribeni, Tap Market	GW-5	Tap water
5.	Farakka Lock, WB	Near Farakka lock site	GW-6	Borewell
		Goraipara Village	GW-7	Hand pump
		Farakka Town	GW-8	Hand pump
6.	Sahibganj Terminal, Kharkhand	Samda Nala Village	GW-9	Hand pump
		Rampur Village	GW-10	Hand pump
		Sakrigali	GW-11	Hand pump
7.	Gazipur Terminal, Uttar Pradesh	Tarighat, Ghazipur	GW-12	Hand pump
			GW-13	Handpump
		Kalupur	GW-14	Handpump
8.	Varanasi Terminal, Uttar Pradesh	Terminal Site	GW-15	Borewell
		Milkipur	GW-16	Hand pump
		Ralhupur	GW-17	Hand pump
		Tahirpur	GW-18	Hand pump
		Bhitti	GW-19	Hand pump
		Madarwa	GW-20	Hand pump
Populated areas along NW-1				
1	West Bengal	Diamond Harbour	GW-21	Hand pump
2	West Bengal	Howrah	GW-22	Hand pump
3	West Bengal	Katwa	GW-23	Hand pump
4	Jharkhand	Magalhat	GW-24	Hand pump
5	Bihar	Bhagalpur	GW-25	Hand pump
6	Bihar	Buxar	GW-26	Hand pump
7	Bihar	Munger,	GW-27	Hand pump
8	Bihar	Patna	GW-28	Hand pump

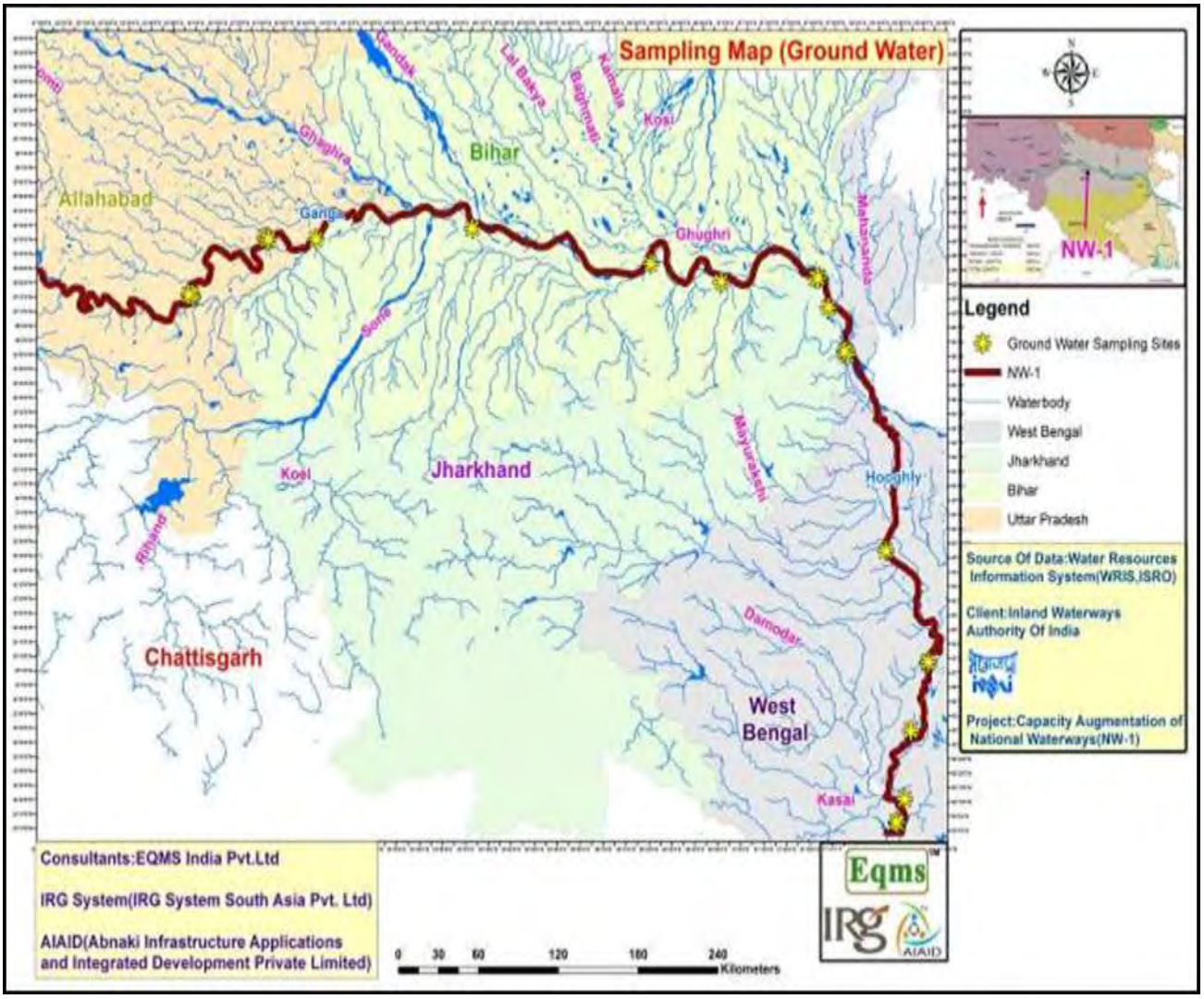


Figure 4.16 : Ground Water Sampling Locations

Table 4.15 : Ground Water Quality at Proposed Terminals/Lock area

S.N.	Parameters	Desirable Limit IS: 10500	Permissible Limit IS: 10500	Haldia Terminal (WB)			Triveni Terminal		Farakka Lock (WB)			Sahibganj Terminal		
				GW-1	GW-2	GW-3	GW4	GW5	GW-6	GW-7	GW-8	GW-9	GW-10	GW-11
1	pH	6.5-8.5	No relaxation	7.24	8.04	7.67	7.38	7.31	6.79	6.96	6.71	7.1	6.85	6.91
2	Temp. 0C	-	-	24	24	24	27.4	26.5	24.6	25	24.8	27	26	27
3	Conductivity, mmhos/cm	-	-	950	1982	1164	474	314	551	549	558	316	632	1303
4	Turbidity,NTU	5	10	0.1	0.1	0.2	0.1	0.4	0.1	0.1	0.2	0.1	0.2	0.2
5	TDS, mg/l	500	2000	612	1372	744	299	201	356	369	377	212	429	886
6	TSS, mg/l	-	-	2	1	1	Nil	Nil	1	2	2	2	1	4
7	T Hardness as CaCO3,mg/l	300	600	268	345	279	264	152	244	252	264	132	225	756
8	Chloride asCl, mg/l	250	1000	236	456	276	26	16	18	20	26	18	39	171
9	Alkalinity, mg/l	200	600	186	268	226	95	75	112	126	116	126	167	133
10	Sulphates as, SO4, mg/l	200	400	8.2	3.98	3.34	15	5	6	9	11	8	13	75
11	Nitrates as NO3, mg/l	45	100	2.9	0.06	0.08	0.9	0.6	0.6	0.8	0.9	0.9	1.2	1.48
12	Fluoride as F, mg/l	1	1.5	0.38	0.46	0.49	0.28	0.22	0.4	0.5	0.23	0.3	0.24	0.19
13	Iron as Fe, mg/l	0.3	1	0.46	0.35	0.32	0.56	0.41	0.22	0.34	0.44	0.12	0.44	0.32
14	Zinc as Zn, mg/l	5	15	0.08	0.7	0.9	1.1	1.0	0.6	0.9	0.9	0.8	1	0.9
15	Calcium as Ca	75	200	72	114	68	53	30	50	51	53	27	70	152
16	Magnesium as Mg	30	100	21	14	28	32	19	29	30	32	16	11	91
17	Cadmium as Cd, mg/l	0.01	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Copper as Cu, mg/l	0.05	1.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Nickel as Ni, mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead as Pb, mg/l	0.05	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Mercury as Hg, mg/l	0.001	No relaxation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Chromium (Total as Cr,mg/l	0.05	No relaxation	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Arsenic as As, mg/l	0.05	No relaxation	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
24	Phenolic compound	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Total coliform MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
26	Fecal Coliform, MPN/100ml	-	-	Nil	Nil	NI	Nil	Nil	Nil	Nil	NI	Nil	Nil	NI

Source: Data sampling & Analysis by JV and NABL accredited Lab

Ground Water Quality at Proposed Terminals/Lock areas (cont..)

S.N.	Parameters	Desirable Limit IS: 10500	Permissible Limit IS: 10500	Ghazipur Terminal				Varanasi Terminal				
				GW-12	GW-13	GW-14	GW-15	GW-16	GW-17	GW-18	GW-19	GW-20
1	pH	6.5-8.5	No relaxation	7.11	7.11	7.34	7.4	7.14	1.17	7.25	7.5	7.4
2	Temp. 0C	-	-	24.6	25.2	25.0	-	-	-	-	-	-
3	Conductivity, mmhos/cm	-	-	749	648	472	462	490	575	887	493	711
4	Turbidity,NTU	5	10	0.1	0.2	0.3	0.5	0.5	0.6	0.8	1.8	1.6
5	TDS, mg/l	500	2000	472	428	320	318	253	274	501	316	440
6	TSS, mg/l	-	-	2	4	1	2	3	4	4	4	4
7	T Hardness as CaCO3, mg/l	300	600	392	310	168	272	212	220	284	172	312
8	Chloride asCl, mg/l	250	1000	30	28	14	14	7	10	50	16	68
9	Alkalinity, mg/l	200	600	143	124	110	NA	NA	NA	NA	NA	NA
10	Sulphates as, SO4, mg/l	200	400	17	15	8.7	15	13	29	35	5	46
11	Nitrates as NO3, mg/l	45	100	0.84	0.78	1.23	0.95	0.07	0.08	0.75	0.7	0.6
12	Fluoride as F, mg/l	1	1.5	0.46	0.38	0.34	0.4	0.03	0.31	0.64	0.34	0.13
13	Iron as Fe, mg/l	0.3	1	0.48	0.38	0.60	0.12	0.02	0.11	0.012	0.12	0.12
14	Zinc as Zn, mg/l	5	15	1.21	1.21	0.87	1	1	0.9	1.1	0.9	0.8
15	Calcium as Ca	75	200	78	62	32	32	39	35	37	44	50
16	Magnesium as Mg	30	100	48	45	21	47	27	32	47	12.2	46
17	Cadmium as Cd, mg/l	0.01	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Copper as Cu, mg/l	0.05	1.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Nickel as Ni, mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead as Pb, mg/l	0.05	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Mercury as Hg, mg/l	0.001	No relaxation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Chromium (Total as Cr, mg/l)	0.05	No relaxation	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Arsenic as As, mg/l	0.05	No relaxation	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
24	Phenolic compound	0.001	0.002	<0.001	<0.001	<0.001	-	-	-	-	-	-
25	Total coliform MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
26	Fecal Coliform, MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Source: Data sampling & Analysis by JV and NABL accredited Lab

Table 4.16 : Ground Water Quality at Major Habitation area along NW-1

S.N.	Parameters	Desirable Limit IS: 10500	Permissible Limit IS: 10500	Daimond Harbour	Hoorah	Katwa	Mangalhat	Bhagalpur	Buxer	Munger	Patna
1	pH			7.50	7.36	7.29	7.67	7.56	7.34	6.94	7.23
2	Temp. 0C	-	-	24.0	24.2	24.5	24.8	24.8	23.6	23.8	25.1
3	Conductivity, mmhos/cm	-	-	1148	1240	322	626	637	342	862	674
4	Turbidity,NTU	5	10	1.0	2	1	Nil	2	1	3	1
5	TDS, mg/l	500	2000	754	794	232	420	408	220	646	425
6	TSS, mg/l	-	-	1.1	0.5	0.7	0.8	Nil	0.4	1.2	Nil
7	T Hardness as CaCO3, mg/l	300	600	258	304	100	220	376	138	288	348
8	Chloride asCl, mg/l	250	1000	270	230	12	38	64	20	42	50
9	Alkalinity, mg/l	200	600	236	252	90	164	180	118	160	187
10	Sulphates as, SO4, mg/l	200	400	2.86	1.87	15	18	24	12	16.8	28
11	Nitrates as NO3, mg/l	45	100	2.1	4.2	7.8	1.8	1.13	1.22	11.2	8.4
12	Fluoride as F, mg/l	1	1.5	0.50	0.48	0.53	0.45	0.35	0.43	0.56	0.81
13	Iron as Fe, mg/l	0.3	1	1.20	0.89	0.46	0.87	0.61	0.92	0.046	0.51
14	Zinc as Zn, mg/l	5	15	1.10	0.92	0.74	1.34	1.23	1.10	1.26	1.29
15	Calcium as Ca	75	200	74	102	24	64	75	32	48	70
16	Magnesium as Mg	30	100	18	20.3	9.7	14	46	14	41	42
17	Cadmium as Cd, mg/l	0.01	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Copper as Cu, mg/l	0.05	1.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Nickel as Ni, mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead as Pb, mg/l	0.05	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Mercury as Hg, mg/l	0.001	No relaxation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Chromium (Total as Cr, mg/l	0.05	No relaxation	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Arsenic as As, mg/l	0.05	No relaxation	<0.025	<0.025	<0.025	<0.025	0.03	<0.025	0.04	<0.025
24	Phenolic compound	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
25	Total coliform MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
26	Fecal Coliform, MPN/100ml	-	-	NI	NI	NI	Nil	NI	Nil	Nil	Nil

Source: Data sampling & Analysis by JV and NABL accredited Lab

Observation on Ground Water Quality

The Physico-chemical characteristics of the ground water samples were assessed with respect to prescribed drinking water standard IS: 10500.Few parameters namely TDS, total hardness and chloride values are marginally above the desirable limits at Haldia and Sahibganj, Howrah and Kolkata but all were within the permissible limits as per prescribed Standard (IS: 10500) except Fe which exceeds the prescribed limits at certain locations. Other heavy metals were either present in traces or below prescribed standards. The arsenic content in ground water sample of Bhagalpur and Munger were found present but lower than the permissible limit.

4.4.2. *Ganga River Water Quality **in NW-1** Stretch*

4.4.2.1 Secondary Data Analysis

Ganga river quality data monitored by CPCB at different locations along NW-1 are shown in **Table 4.18** and Graphic representation of selected parameters are given at **Figure 4.17 and Figure 4.18.** CPCB guidelines are available to evaluate the quality of river for its Best Designated Use(BDU). Water can be classified in five classes depending upon its chemical properties as per Indian BDU Criteria Standard prescribed by CPCB. (Refer **Table 4.17** for standards).

As per the monitored results, DO & pH – meets the water quality criteria for bathing at most of the monitoring locations. DO vary from 4.8-12.8 mg/l and found within water quality criteria of river. BOD ranges from 1.1-8.2 mg/l. The maximum value of BOD was recorded at Diamond harbour. Faecal Coliform values ranged from 230-650000 MPN/100ml. The total coliform values ranged from 490 at Mirzapur to 85,0000 at Howrah. It is mostly above 5000 MPN/100ml/coliform limit for category ‘C’ -designated best use requirement.

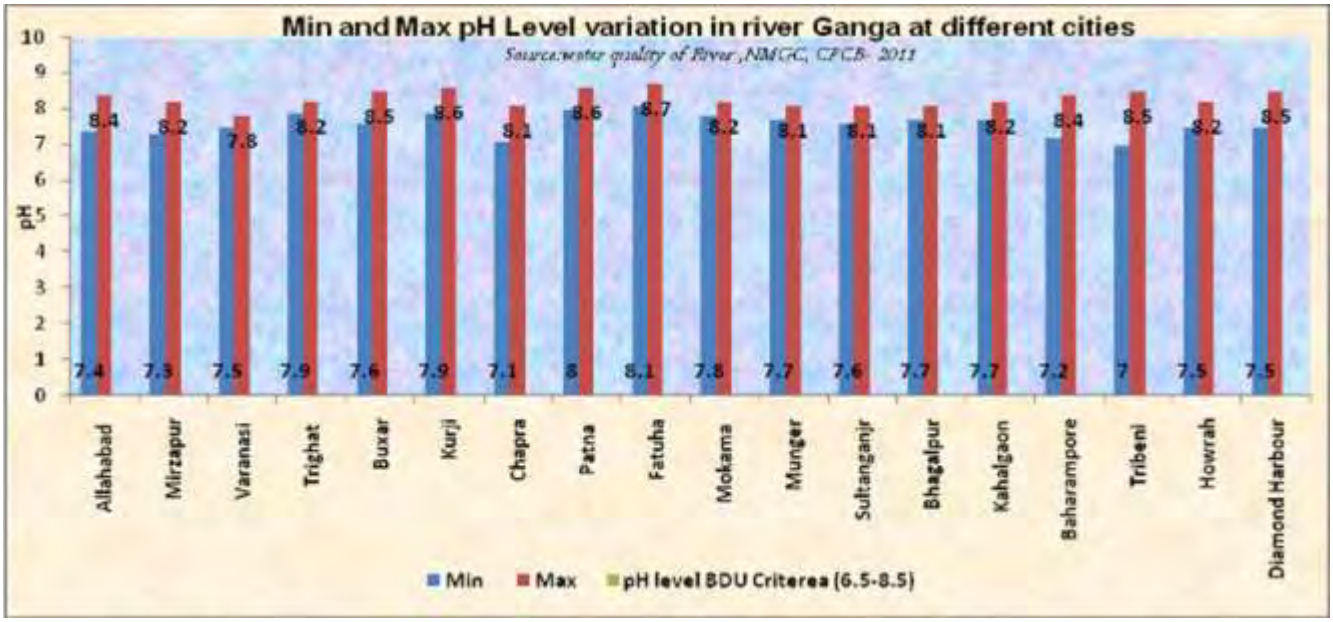
Table 4.17 : CPCB Best Designated Use Standard (source: CPCB)

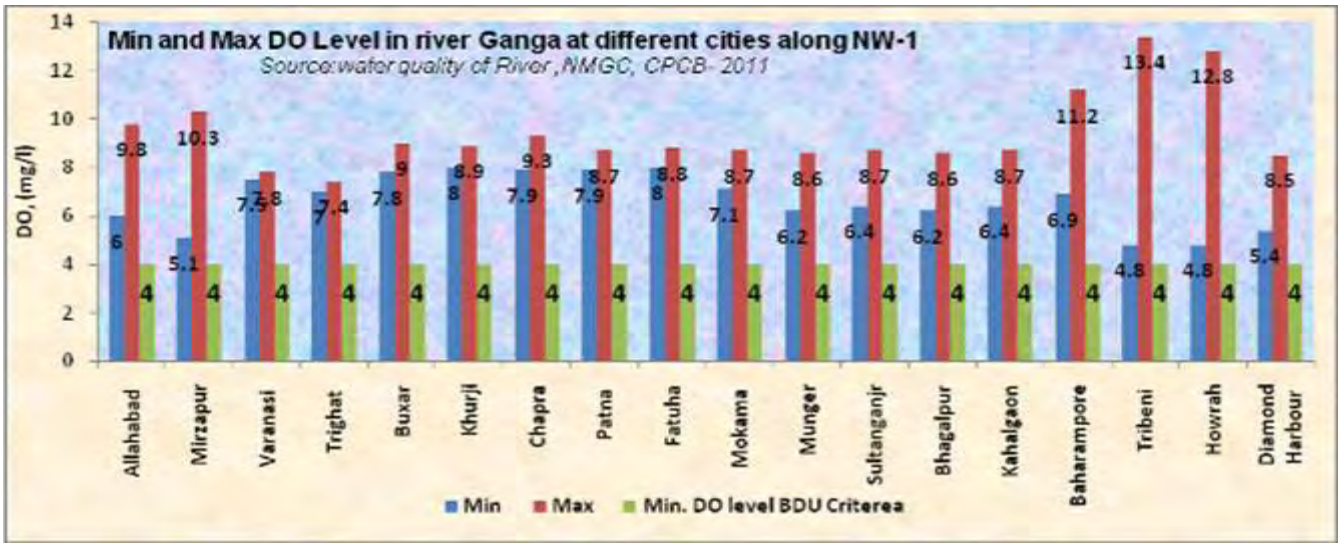
Designed Best Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	**A**	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organized)	**B**	• Total Coliforms Organism MPN/100ml shall be 500 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	• Total Coliforms Organism MPN/100ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	**D**	• pH between 6.5 to 8.5 • Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	**E**	• pH between 6.0 to 8.5 • Electrical Conductivity at 25°C micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 and Boron Max. 2mg/l

Table 4.18 : River Water Quality at Different cities along NW-1

Locations	State	Temperature °c		DO (mg/l)		Ph		Conductivity (µmhos/cm)		BOD (mg/l)		Fecal coliform (mpn/100ml)		Total coliform (mpn/100ml)	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Water Quality Criteria (C Category for Drinking water source after conventional treatment and disinfection)				**> 4 mg/l**		**6.5-8.5**		**-**		**< 3 mg/l**		**< 2500 mpn/100ml**		**< 5000 mpn/100ml**	
At Allahabad (Rasoolabad)	UP	21.0	29.0	6.0	9.8	7.4	8.4	278	488	2.8	6.0	3000	3500	7000	9000
Ganga d/s, Mirzapur	UP	18.0	33.0	5.1	10.3	7.3	8.2	207	555	2.9	4.5	230	7000	490	17000
At Varanasi u/s (Assighat)	UP	18.0	27.0	7.5	7.8	7.5	7.8	224	266	3.7	4.2	8000	8000	13000	13000
Ganga at Trighat (Ghazipur)	UP	19.5	28.5	7.0	7.4	7.9	8.2	232	270	4.1	4.4	13000	13000	17000	21000
Ganga at Buxar, Bihar	Bihar	16.0	31.0	7.8	9.0	7.6	8.5	287	402	2.7	2.8	1100	9000	2800	16000
Ganga at Khurji, Patna u/s	Bihar	17.0	32.0	8.0	8.9	7.9	8.6	262	416	2.6	2.8	1300	5000	2400	16000
At confl. Sone Doriganj, Chapra	Bihar	16.0	25.0	7.9	9.3	7.1	8.1	214	380	2.7	2.8	1100	3000	2200	5000
At Patna d/s (ganga bridge)	Bihar	18.0	32.0	7.9	8.7	8.0	8.6	292	495	2.7	3.0	3000	9000	9000	24000
Ganga at Fatuha	Bihar	18.0	31.0	8.0	8.8	8.1	8.7	282	420	2.7	2.9	1400	5000	3000	16000
Ganga at Mokama (u/s)	Bihar	20.0	30.0	7.1	8.7	7.8	8.2	339	389	2.6	2.8	1100	5000	2200	16000
Ganga at Munger	Bihar	20.0	28.0	6.2	8.6	7.7	8.1	298	366	2.6	2.9	800	5000	2200	9000
Ganga at sultanganj, Bhagalpur	Bihar	20.0	27.0	6.4	8.7	7.6	8.1	354	384	2.7	2.8	1300	3000	2200	5000
Ganga at Bhagalpur	Bihar	20.0	27.0	6.2	8.6	7.7	8.1	355	395	2.6	2.9	1300	9000	2200	90000
Ganga at Kahalgaon	Bihar	19.0	30.0	6.4	8.7	7.7	8.2	286	372	2.7	2.9	1100	9000	2800	24000
Ganga at Baharampore	WB	14.5	32.0	6.9	11.2	7.2	8.4	209	360	1.0	3.9	17000	240000	26000	300000
Tribeni burning ghat	WB	20.0	32.0	4.8	13.4	7.0	8.5	185	354	0.8	2.9	700	11000	900	14000
Ganga at Howrah-Shivpur	WB	19.0	32.0	4.8	12.8	7.5	8.2	194	370	2.4	8.2	33000	650000	34000	850000
Ganga at diamond harbor	WB	18.0	32.0	5.4	8.5	7.5	8.5	261	10240	1.1	5.1	8000	80000	11000	110000

Source: (NMGC / CPCB Ganga Water Quality Assessment -2011)


Min and Max pH Level variation in river Ganga at different cities
Source:water quality of River ,NMGC, CPCB- 2011
pH
Allahabad
Mirzapur
Varanasi
Trighat
Buxar
Kurji
Chapra
Patna
Fatuha
Mokama
Munger
Sultanganjr
Bhagalpur
Kahalgaon
Baharampore
Tribeni
Howrah
Diamond Harbour
Min
Max
pH level BDU Criterea (6.5-8.5)


Min and Max DO Level in river Ganga at different cities along NW-1
Source:water quality of River ,NMGC, CPCB- 2011
DO, (mg/l)
Allahabad
Mirzapur
Varanasi
Trighat
Buxar
Khurji
Chapra
Patna
Fatuha
Mokama
Munger
Sultanganjr
Bhagalpur
Kahalgaon
Baharampore
Tribeni
Howrah
Diamond Harbour
Min
Max
Min. DO level BDU Criterea

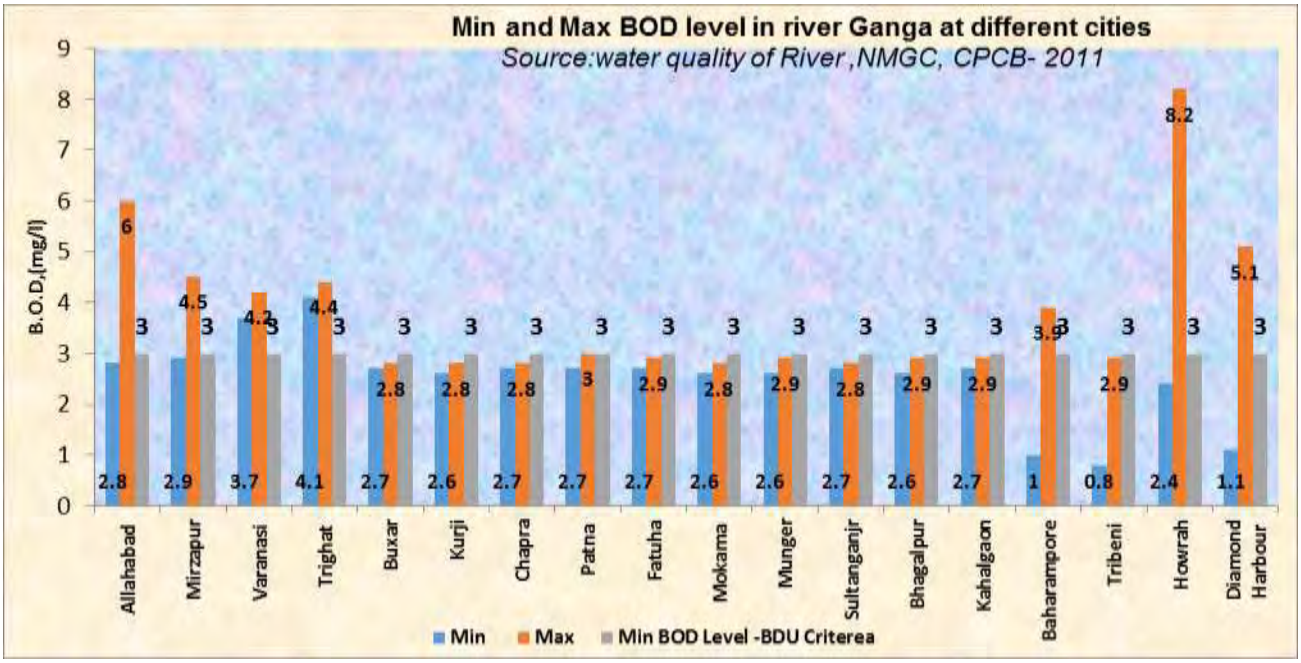
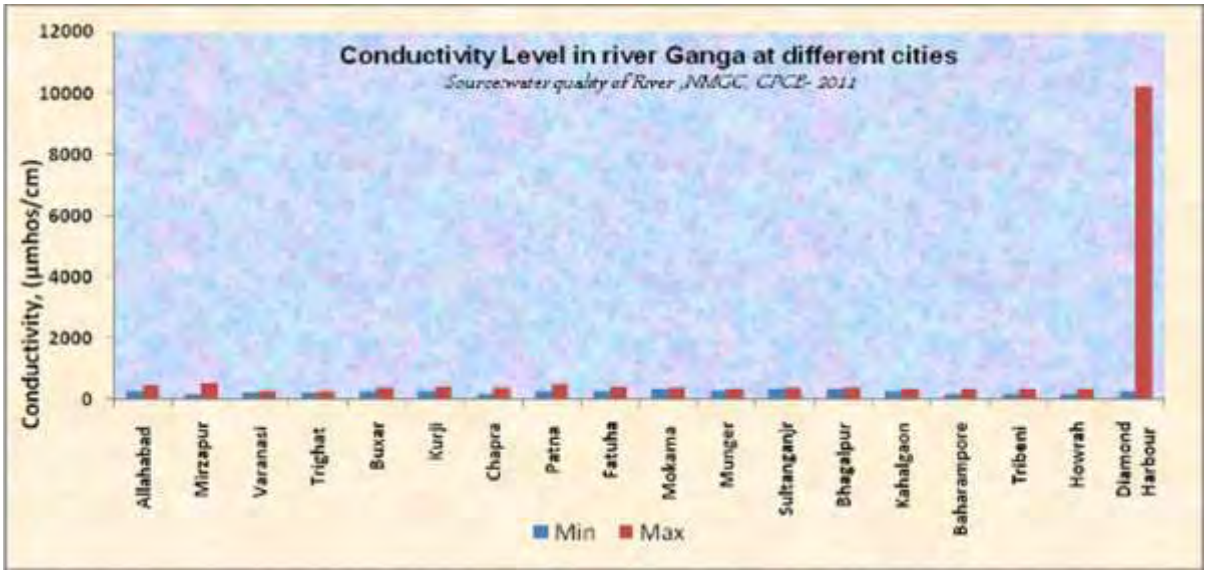
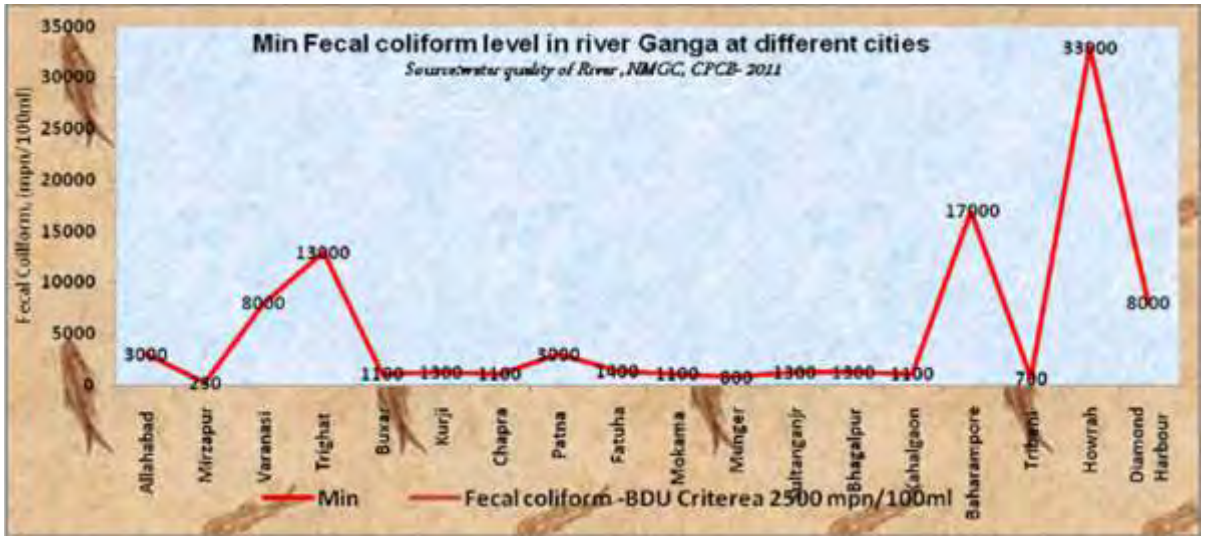


Figure 4.17 : Graphical representation of Ganga River water quality at Different Locations





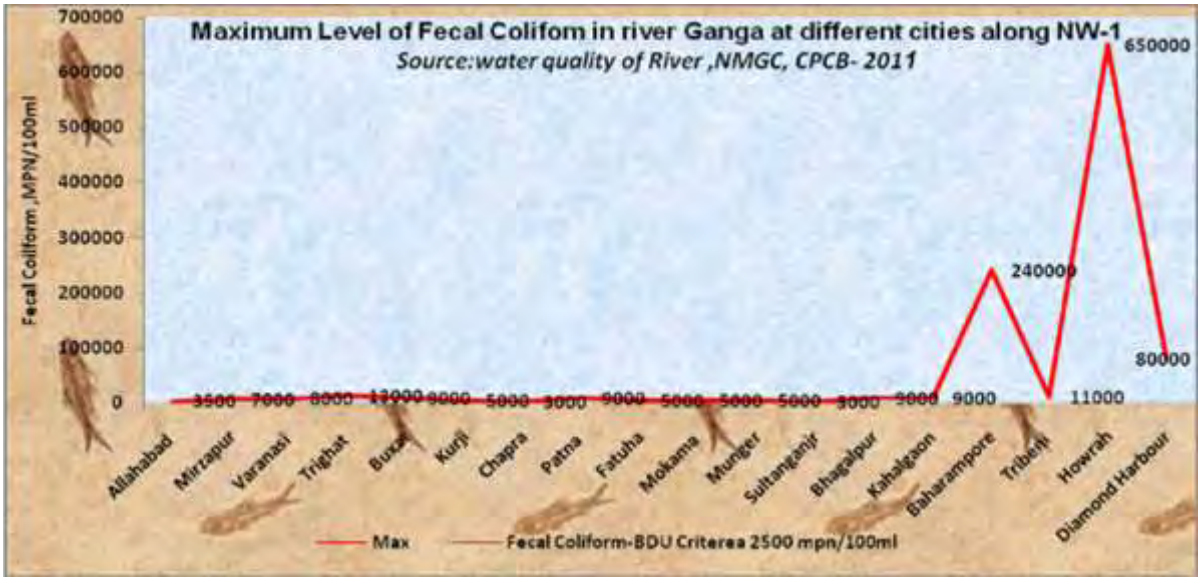


Figure 4.18 : Graphical representation of Ganga Water Quality at Different Cities along NW-1

4.4.2.2 Primary Data Analysis

Surface water sample were collected[26] from the upstream and downstream of the proposed and planned terminals/ lock locations and environmental sensitive receptors present all along the NW-1. One sample each were also collected from existing ro-ro/jetty/floating terminals. The water samples were examined for physico-chemical parameters as well as for bacteriological parameters. Samples were analysed for various parameters using the CPCB's BDU Criteria. The name of water sampling locations is given at **Table 4.19** and shown at **Figure 4.19**. The analysis results of surface water are presented in **Table 4.20 to 4.22.** Photograph of water sampling is provided in **Figure 4.20** and **4.21**.

Table 4.19 : Name of Surface Water Sampling Locations

[26]Samples were collected as per the standard protocol. The samples for bacteriological analyses were collected in sterilized bottles.

Sl. No.	Terminal Location	Surface water sampling Location	Location Code	Source
Proposed and Planned Terminals				
1	Haldia Terminal, West Bengal	Hoogly River Upstream of Terminal Site and Green Belt Canal	SW-1	Hooghly River
		Hoogly River downstream of Terminal Site and Green Belt Canal	SW-2	Hooghly River
2	Tribeni Terminal, West Bengal	Ganga River Upstream of proposed Tribeni Terminal Site	SW-3	Ganga River
		Ganga River downstream of proposed Tribeni Terminal Site near Shibpur ghat	SW-4	Ganga River
9.	Farakka Lock, West Bengal	Ganga River Upstream of existing Farakka lock site	SW-5	Ganga River
		Ganga River downstream of existing Farakka lock site	SW-6	Ganga River
10.	Sahibganj Terminal, Kharkhand	Ganga River Upstream of Terminal site near Samda village	SW-7	Ganga River
		Ganga River Downstream of Terminal site near Samda village	SW-8	Ganga River
11.	Gazipur Terminal, Uttar Pradesh	Ganga River Upstream of proposed Terminal site at Ghazipur	SW-9	Ganga River
		Ganga River Downstream of proposed Terminal site at Ghazipur	SW-10	Ganga River
12.	Varanasi Terminal, Uttar Pradesh	Ganga River upstream of Gurha Nala and proposed Terminal site	SW-11	Ganga River
		Ganga River downstream of Gurha Nala and proposed Terminal site	SW-12	Ganga River
Existing Ro/Ro/Jetty/Floating Terminals along NW-1				
1	West Bengal	Diamond Harbour	SW-13	Ganga River
2	West Bengal	Howrah	SW-14	Ganga River
3	West Bengal	Shantipur	SW-15	Ganga River
4	West Bengal	Katwa	SW-16	Ganga River
5	West Bengal	Hazardwari	SW-17	Ganga River
6	West Bengal	Pakur	SW-18	Ganga River
7	Jharkhand	Magalhal	SW-19	Ganga River
8	Uttar Pradesh	Buxar	SW-20	Ganga River
9	Uttar Pradesh	Munger	SW-21	Ganga River
10	Uttar Pradesh	Patna	SW-22	Ganga River
Sensitive Locations (Turtle, Vikramshila Dolphin and Hilsa Sanctuaries)				
1	Near Sanctuary Areas	Three locations per Sanctuary areas	-	Ganga River

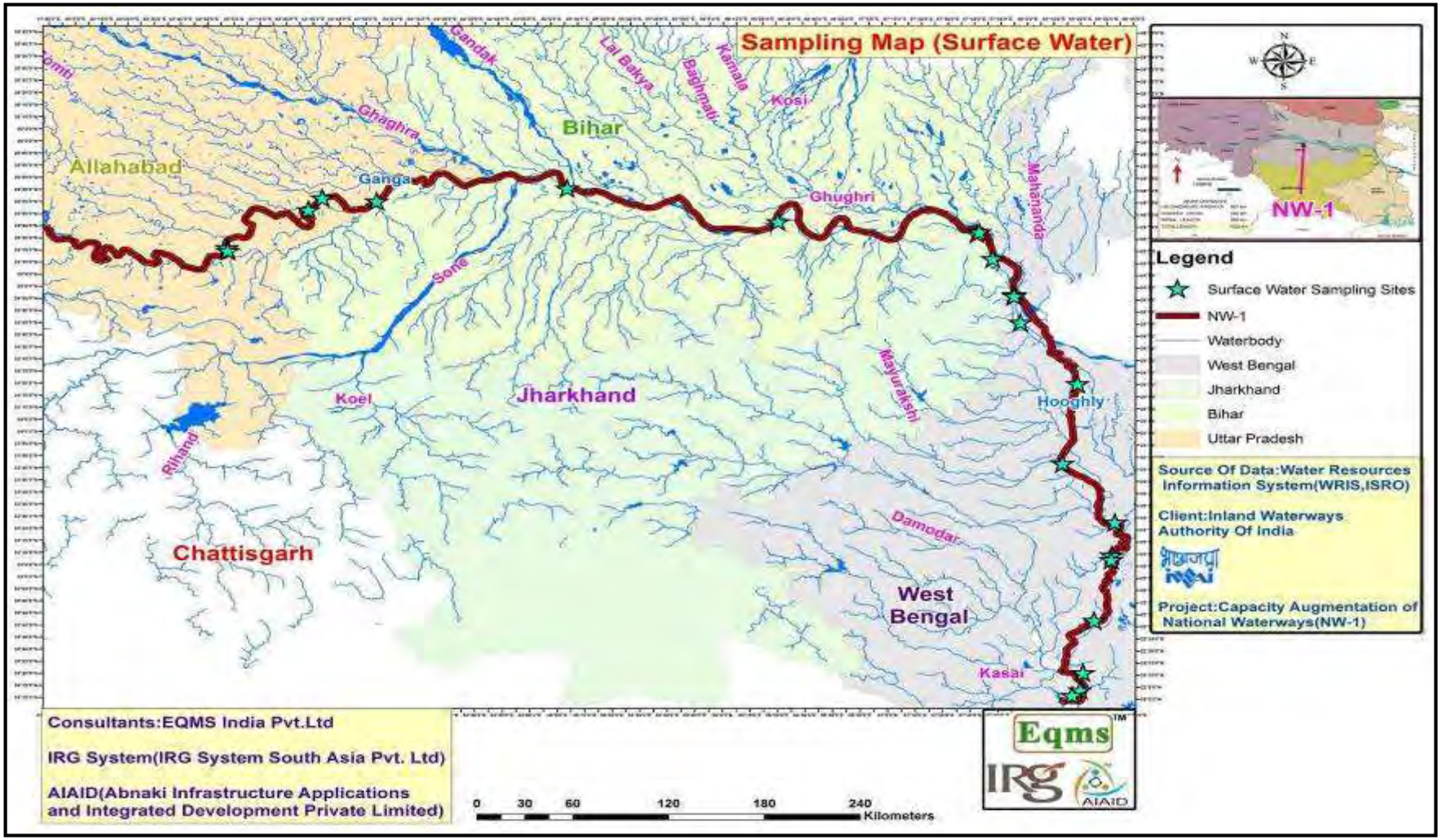


Figure 4.19 : Surface Water Sampling Locations

Table 4.20 : Ganga Water Quality NW-1 (near proposed and planned Terminal Site location)

		Haldia West Bengal		Tribeni West Bengal		Farakka, West Bengal		Sahibganj Jharkhand		Ghazipur Uttar Pradesh		Varanasi Uttar Pradesh	
Sl.No.	**Parameters**	**SW-1**	**SW-2**	**SW-3**	**SW-4**	**SW-5**	**SW-6**	**SW-7**	**SW-8**	**SW-9**	**SW-10**	**SW-11**	**SW-12**
1	pH	7.12	7.52	7.22	7.19	6.68	6.54	7.04	6.98	7.8	7.4	7.46	7.45
2	Temperature ^{0}C	24.1	24.6	23.8	24.2	26.2	25.9	25.4	25.8	25.1	25.3	-	-
3	Conductivity, μmhos/cm	858	880	304	335	288	298	340	354	258	262	509	499
4	Turbidity (NTU)	2.1	3.2	3.1	2.5	1.8	1.9	1.6	1.5	1.2	1.8	-	-
5	Total Dissolved solids	484	497	189	208	192	198	208	214	170	178	339	355
6	Total Suspended solids	8	18	12	10	6	8	8	9	12	10	-	-
7	Dissolved Oxygen (mg/litre)	6.9	6.2	7.0	7.6	7.1	6.9	6.9	7.2	7.6	7.4	6.0	6.2
8	BOD, (for 3 days at 27^{0}C) (mg/litre)	4.1	2.6	3.6	3.9	2.2	2.3	2.4	2.1	4.8	4.3	7.43	6.85
9	Chemical Oxygen Demand, (mg/litre)	13.2	8.6	12.1	13.0	8.4	8.2	8.6	8.2	15.7	16.2	-	-
10	Total Hardness, mg/l	219	268	180	192	123	116	123	128	114	116	-	-
11	Oil & grease, mg/l	0.2	0.6	0.5	0.4	0.2	0.2	0.4	0.3	0.5	0.3	-	-
12	Chloride, mg. l	172	168	28	26	14	16	14	16	14		-	-
13	Nitrates as NO_3, mg/l	1.9	2.4	0.86	0.88	0.16	0.14	0.21	0.20	0.30	0.28	-	-
14	Iron as Fe, mg/l	0.13	0.19	0.42	0.49	0.31	0.33	0.28	0.25	0.41	0.36	-	-
15	Zinc as Zn, mg/l	0.2	0.6	2.2	2.3	2.9	2.8	3.4	3.5	2.9	2.8	-	-
16	Calcium as Ca, mg/l	72	79	37	38	24	22	26	28	22	26	-	-
17	Magnesium as Mg, mg/l	18	19	21	24	15	14.4	14	13	14	12	-	-
18	Cadmium as Cd, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
19	Copper as Cu, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
20	Nickel as Ni, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
21	Lead as Pb, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
22	Mercury as Hg, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-
23	Total Chromium (Total as Cr), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-
24	Arsenic as, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	-	-
25	Silica, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
26	Fecal coliform MPN/100ml	3920	4370	5462	4370	3890	3940	3429	3390	8756	9472	12300	15400
27	Total coliform MPN/100ml	10234	11343	12300	11343	12324	12574	11489	11206	14520	16120	-	-
28	Pesticides (Present /Absence)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	-	-

Source: Data sampling & Analysis by JV and NABL accredited Lab

Table 4.21 : Ganga Water Quality Along NW-1 (near Existing Ro-Ro/Jetty/Floating Terminal sites)

		West Bengal						Jharkhand	Bihar		
Sl.No.	**Parameters**	**SW-13**	**SW-14**	**SW-15**	**SW-16**	**SW-17**	**SW-18**	**SW-19**	**SW-20**	**SW-21**	**SW-22**
1	pH	7.20	8.1	7.45	7.80	7.65	7.54	7.31	8.1	7.7	8.2
2	Temperature ^{0}C	25.0	26.0	25	24.8	23.8	25.0	24.8	23.8	23.8	24.0
3	Conductivity, μmhos/cm	1230	320	315	405	345	319	327	305	318	290
4	Turbidity (NTU)	2.4	4.2	3.5	4.7	3.1	3.1	2.7	2.5	2.1	4.8
5	Total Dissolved solids	840	201	195	260	204	198	204	196	204	188
6	Total Suspended solids	14	6	5	11	9	11	9	8	10	13
7	Dissolved Oxygen (mg/litre)	5.8	6.5	7.6	6.5	7.2	7.8	7.1	7.8	6.7	8.1
8	BOD, (for 3 days at 27^{0}C) (mg/litre)	2.6	5.4	3.5	2.6	2.0	2.4	2.8	2.1	2.3	2.8
9	Chemical Oxygen Demand, (mg/l)	9.4	19	10.6	9.3	7.8	8.9	10	7	8.4	10.4
10	Total Hardness, mg/l	322	168	164	214	168	160	168	156	158	152
11	Oil & grease, mg/l	0.2	1.1	0.3	0.7	0.4	0.4	0.1	0.2	0.4	0.6
12	Chloride, mg. l	212	26	24	34	28	24	26	22	26	22
13	Nitrates as NO_3, mg/l	1.6	2.45	2.68	1.87	1.90	2.91	1.68	1.28	1.14	1.10
14	Iron as Fe, mg/l	0.14	1.45	1.28	0.56	0.98	2.21	2.31	1.20	1.08	1.34
15	Zinc as Zn, mg/l	0.22	0.87	0.25	0.45	0.40	0.29	0.45	0.50	0.34	0.67
16	Calcium as Ca, mg/l	92	34	32	38	34	32	34	28	30	31
17	Magnesium as Mg, mg/l	22	20	20	29	20	19	20	21	20	18
18	Cadmium as Cd, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Copper as Cu, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Nickel as Ni, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Lead as Pb, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Mercury as Hg, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Total Chromium (Total as Cr), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
24	Arsenic as As, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
25	Silica, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Fecal coliform MPN/100ml	6120	18456	6450	8760	7890	4580	3890	2340	2460	3890
27	Total coliform MPN/100ml	11720	45680	12400	12988	11340	9890	8790	5430	5980	8790
28	Pesticides (Present /Absence)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Source: Data sampling & Analysis by JV and NABL accredited Lab

Table 4.22 : Ganga Water Quality near sensitive locations along NW-1

		Hilsa Sanctuary Area			Dolphin Sanctuary			Kashi Turtle Sanctuary		
S.No.	**Parameters**	Farakka Barrage	Near Diamond Harbour	Near Katua	Sultanganj Ghat	Near Vikramshila setu, Bhagalpur	Ganga ghat near Kahalgaon	Near Dashashwamegh ghat	Near Tulsi Ghat	Near AssiGhat
1	pH	7.10	6.95	7.67	6.85	7.43	6.47	7.65	7.23	7.72
2	Temperature ^{0}C	25.4	24.8	24.5	25.2	24.6	24.8	23.6	24.2	24.3
3	Conductivity, μmhos/cm	304	838	400	335	436	368	545	486	532
4	Turbidity (NTU)	2.1	3.0	3.8	1.2	3.8	1.8	6.7	7.2	8.0
5	Total Dissolved solids	200	465	254	208	275	222	368	328	352
6	Total Suspended solids	8	10	9	11	4	6	12	8	14
7	Dissolved Oxygen (mg/litre)	6.7	7.5	7.0	7.8	6.9	7.9	7.3	7.8	7.0
8	BOD, (for 3 days at 27^{0}C) (mg/litre)	2.8	3.1	2.8	2.2	2.0	3.1	6.8	5.2	7.2
9	Chemical Oxygen Demand, (mg/l)	9.0	11.3	10.8	6.4	5.8	11.8	19.8	17.2	23.0
10	Total Hardness, mg/l	130	210	208	176	192	170	234	208	222
11	Oil & grease, mg/l	0.4	0.2	0.4	0.1	0.5	0.2	2.1	1.6	2.4
12	Chloride, mg. l	16	158	32	28	48	30	48	32	40
13	Nitrates as NO_3, mg/l	0.23	2.3	1.98	0.89	3.82	0.88	0.89	0.67	1.10
14	Iron as Fe, mg/l	0.45	0.67	0.58	2.31	2.50	1.25	1.20	0.98	1.16
15	Zinc as Zn, mg/l	2.45	1.23	0.68	1.06	0.78	1.28	1.10	1.12	1.21
16	Calcium as Ca, mg/l	28	68	34	35	38	36	58	46	48
17	Magnesium as Mg, mg/l	15	10	30	22	24	19	22	23	25
18	Cadmium as Cd, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Copper as Cu, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Nickel as Ni, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Lead as Pb, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Mercury as Hg, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Total Chromium (Total as Cr), mg/l	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
24	Arsenic as As, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
25	Silica, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Fecal coliform MPN/100ml	3100	4560	4560	2340	2200	2980	8670	5680	7988
27	Total coliform MPN/100ml	11876	13467	24356	10120	12340	12650	14790	13210	14218
28	Pesticides (Present /Absence)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Source: Data sampling & Analysis by JV and NABL accredited Lab

Primary Data Analysis and Observation on Surface Water Quality

The river water quality observations reflect that water quality meets with BDU Class D Criteria of CPCB barring few parameters PH, DO which meets A class criterion. Metallic and pesticide level is within prescribed limit of Drinking water standard. The primary data results are similar to secondary data analysed. The analysis concludes that the river water is good for propagation of Wild life and fisheries.

4.4.2.3 River Water Quality at dredging locations

IWAI undertakes dredging to maintain the LAD for effective navigation. To analyse the effect of dredging activity on water quality water samples in upstream and downstream of the river at different distance from the operating dredger were taken during study period. During site visit dredging was in operation only in Farakka navigational lock channel. The details of sampling locations and analysis results are presented in **Table 4.23.** Photographs of dredging operation is provided at **Figures 4.20**:

Figure 4.20 : View of Dredging Operations at Farakka

Table 4.23 : Ganga Water Quality NW-1 (U/S and D/S of the Dredging Machine)

		Location: 90° of Farakka Navigational channel near existing Lock at Farakka Upstream of the Dredger			Location: 90° of Farakka Navigational channel near existing Lock at Farakka (Downstream of the Dredger)			
Sl.No.	**Parameters**	**200 m u/s of Dredger**	**300 m u/s of Dredger**	**500 m u/s of Dredger**	**200 m d/s of Dredger**	**500 m d/s of Dredger**	**700 m d/s of Dredger**	**1000 m d/s of Dredger**
1	pH	6.75	6.72	6.66	6.58	6.6	6.75	6.82
2	Temperature ^{0}C	25.4	25.6	26.0	25.2	25.3	25.5	26
3	Conductivity, μmhos/cm	292	288	294	298	295	305	293
4	Turbidity (NTU)	4.5	4.3	4.0	10.9	7.7	4.4	4.4
5	Total Dissolved solids	194	189	196	200	197	206	195
6	Total Suspended solids	10	9	8.8	19	15	9.5	9.0
7	Dissolved Oxygen (mg/litre)	7.4	7.1	7.2	7.5	6.9	7.0	6.5
8	BOD, (for 3 days at 27^{0}C) (mg/litre)	2.3	2.4	2.2	2.5	3.0	2.3	3.1
9	Chemical Oxygen Demand, (mg/litre)	8.6	8.8	8.3	9.0	9.2	8.5	9.2
10	Total Hardness, mg/l	126	130	128	122	125	129	124
11	Oil & grease, mg/l	0.2	0.2	0.2	0.3	0.3	0.2	0.1
12	Chloride, mg. l	14	12	14	16	14	14	16
13	Nitrates as NO_3, mg/l	0.17	0.17	0.15	0.20	0.18	0.16	0.16
14	Iron as Fe, mg/l	0.49	0.50	0.48	0.98	0.69	0.50	0.49
15	Zinc as Zn, mg/l	2.64	2.45	2.57	2.82	2.72	2.52	2.59
16	Calcium as Ca, mg/l	26	27	24	23	25	25	23
17	Magnesium as Mg, mg/l	14.8	15.2	16.5	15.7	15.2	16.0	16.0
18	Cadmium as Cd, mg/l	0.04	<0.01	<0.01	0.08	0.02	<0.01	<0.01
19	Copper as Cu, mg/l	0.06	<0.01	<0.01	0.05	0.02	0.01	<0.01
20	Nickel as Ni, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Lead as Pb, mg/l	0.08	<0.01	<0.01	0.10	0.09	0.03	<0.01
22	Mercury as Hg, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Total Chromium (Total as Cr), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
24	Arsenic as As, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
25	Silica, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Fecal coliform MPN/100ml	3780	3680	3700	3840	3790	3800	4210
27	Total coliform MPN/100ml	12180	11890	11970	12340	12120	12250	12880
28	Pesticides (Present /Absence)	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Source: Data sampling & Analysis by JV and NABL accredited Lab

Observation on Surface Water Quality during Dredging operation:

The river water quality observations reflect that the parameters like turbidity and total suspended solid increases in downstream of the dredging location up to 700 m, which gradually normalised at a distance of 1000 m from the dredging location. In upstream side of the river there were no major changes observed in these parameter. However, the metals like iron, copper, cadmium and lead were also detected in traces in water sample close to the dredging location in downstream. No variation was observed in other water quality parameter.

4.4.3. River Sediment Analysis.

For mapping the river bed sediment quality, about 110 river bed sediment samples were collected (average 3 samples per location upto the depth of 3m) spread across the NW-1 and analysed for various parameters/contaminants. (Refer **Figure 4.21**). The summery of the test results of river bed sediment sample at different stretches of the NW-1 is given in **Table 4.24** and graphically presented at **Figure 4.22 to Figure 4.25.**

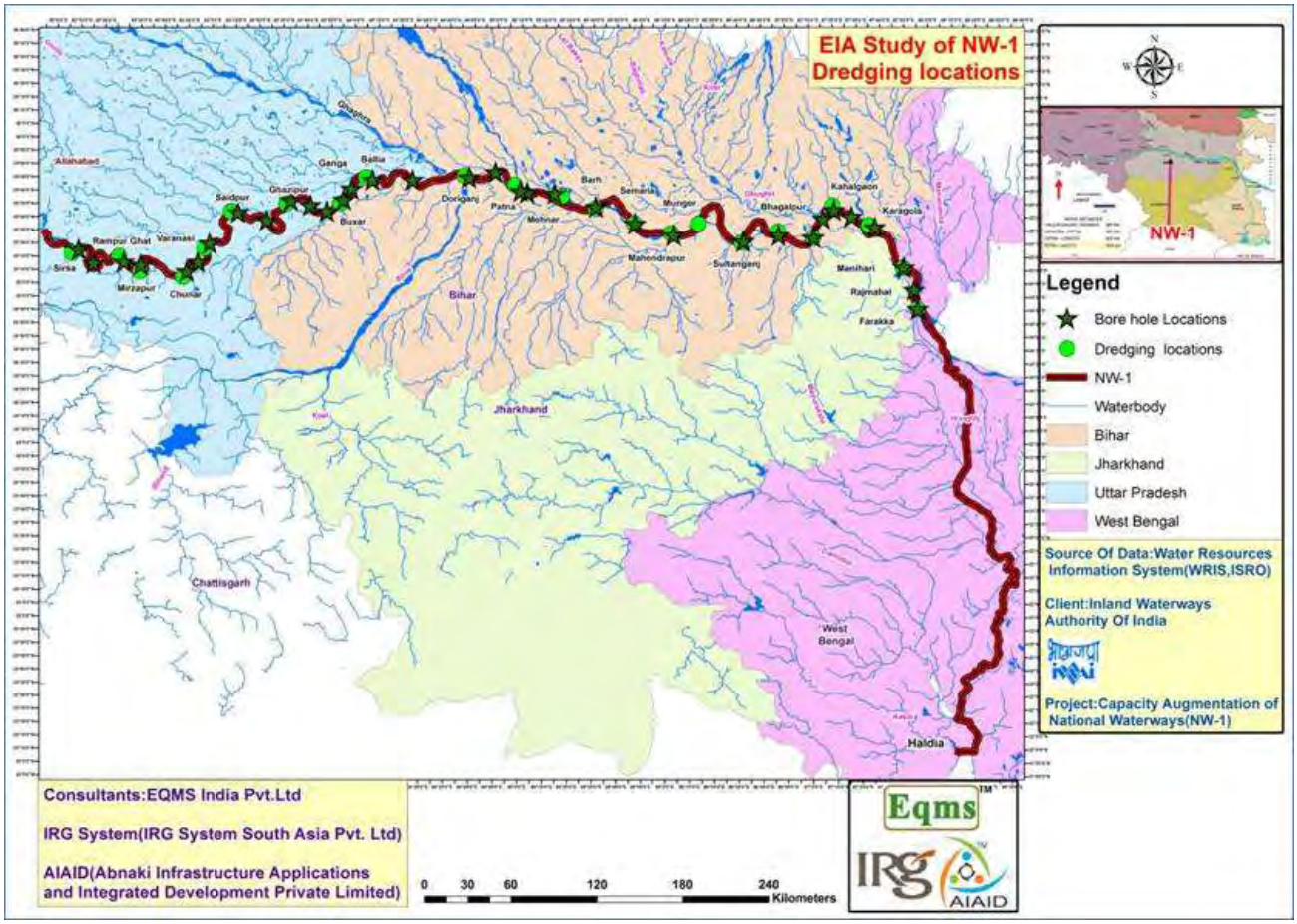
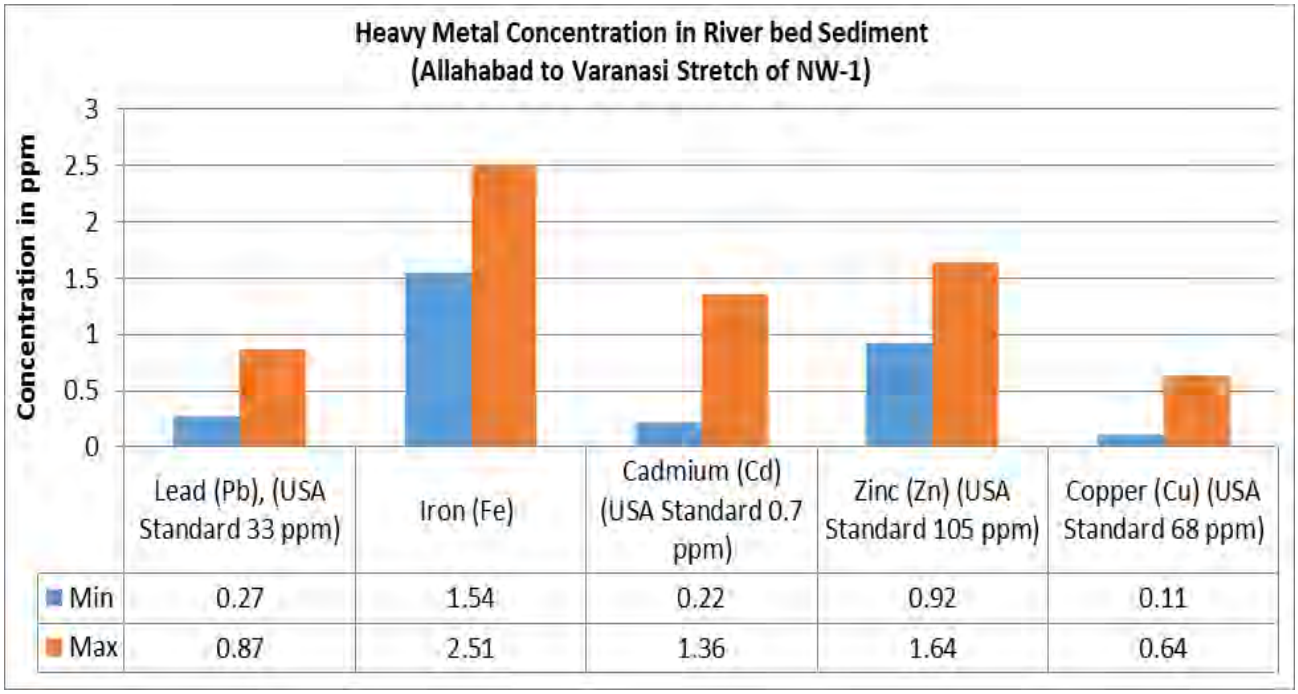


Figure 4.21 : Dredging and Bore hole locations along NW-1



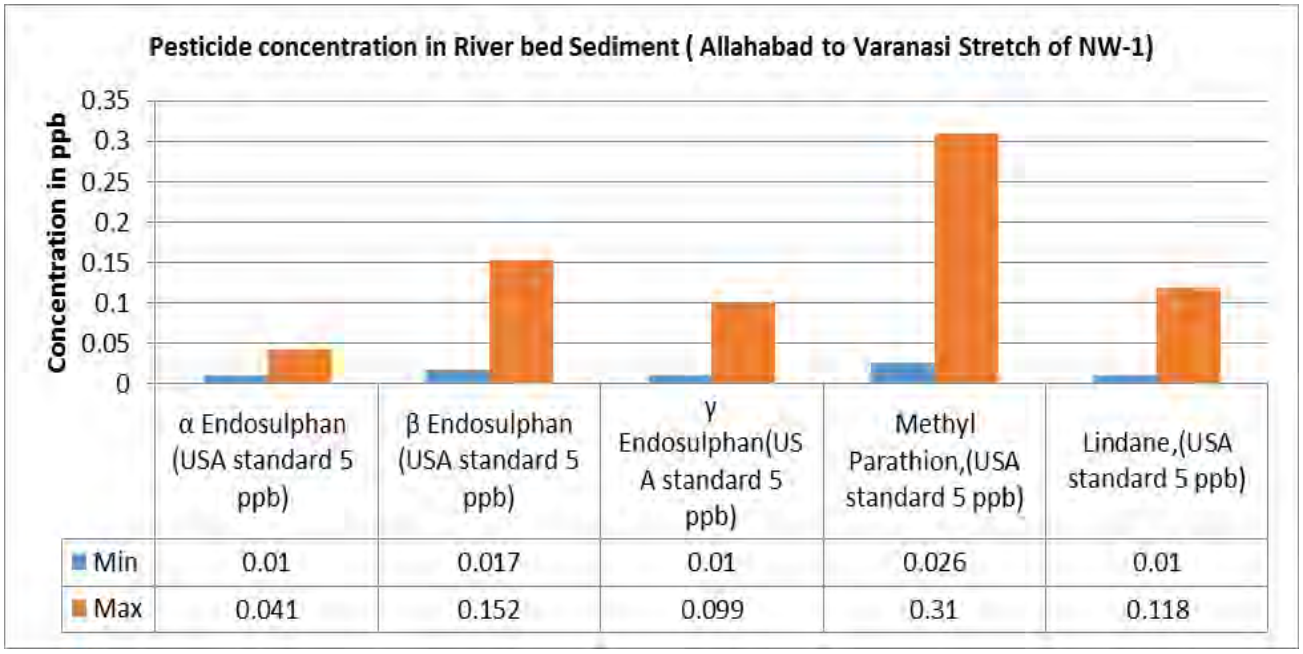
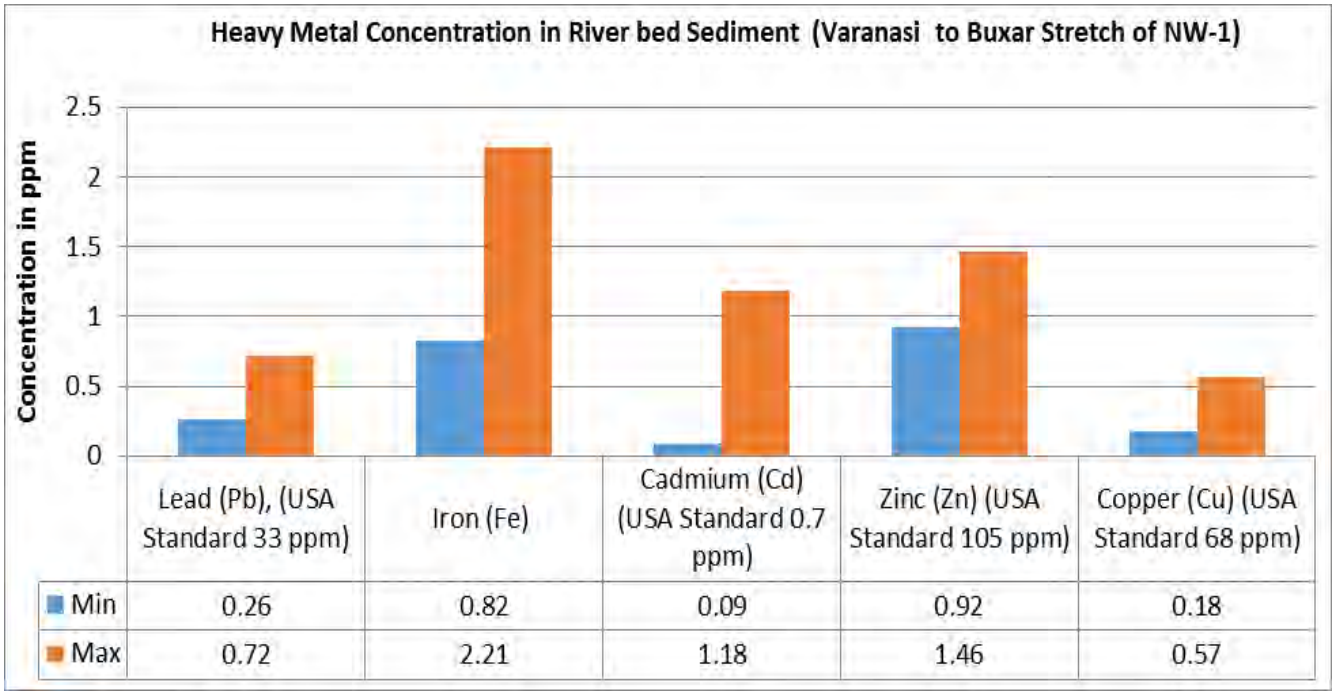


Figure 4.22 : River Bed Sediment Analysis between Allahabad to Varanasi Stretch



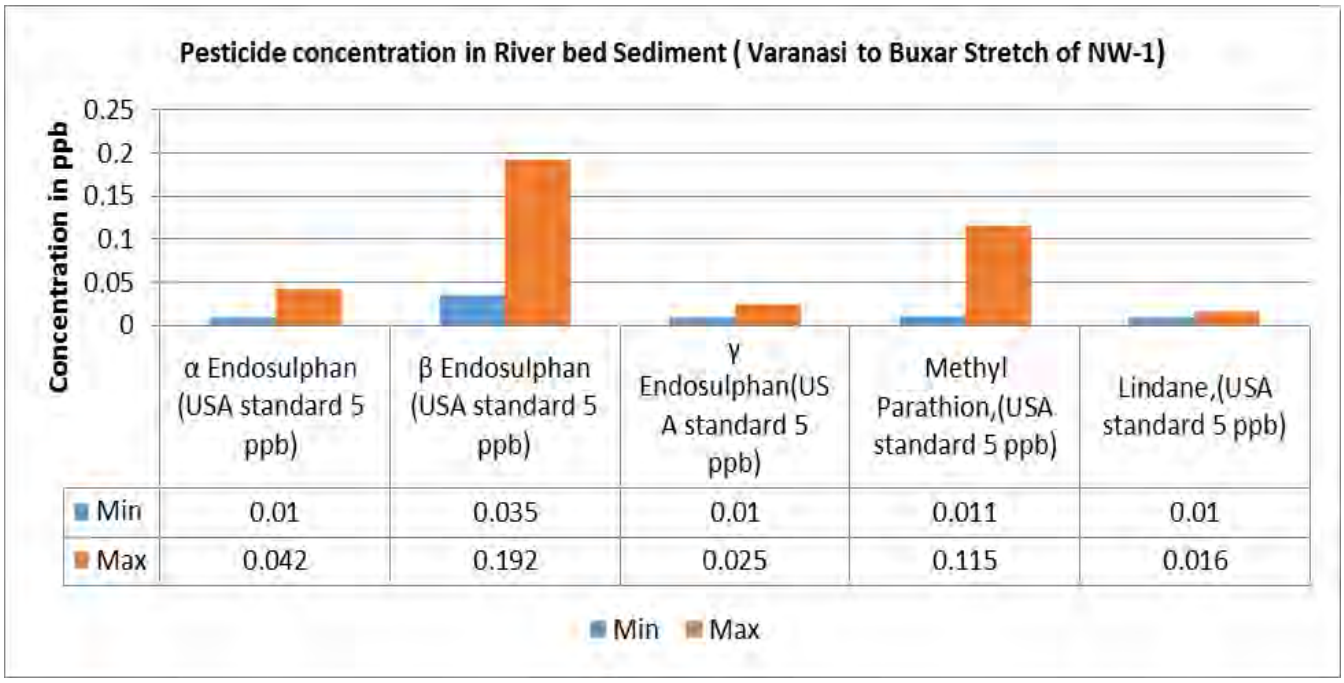
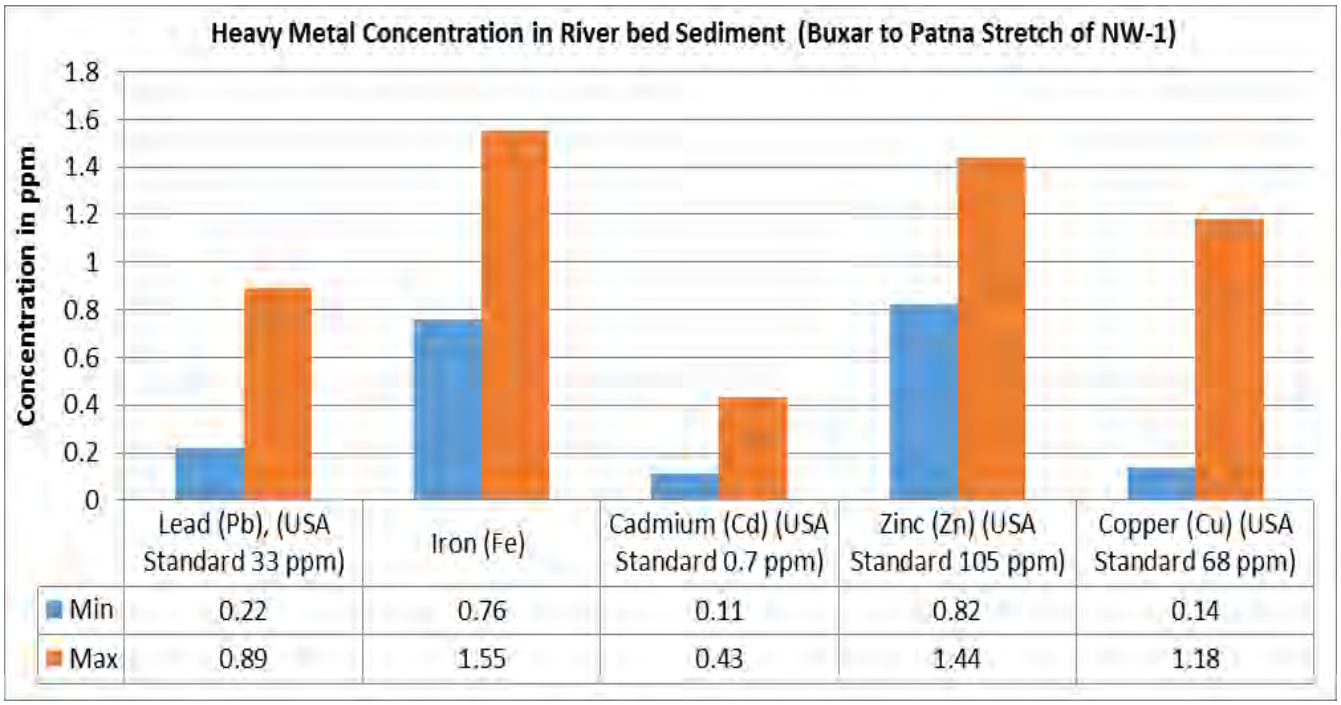


Figure 4.23 : River Bed Sediment Analysis between Varanasi to Buxar Stretch



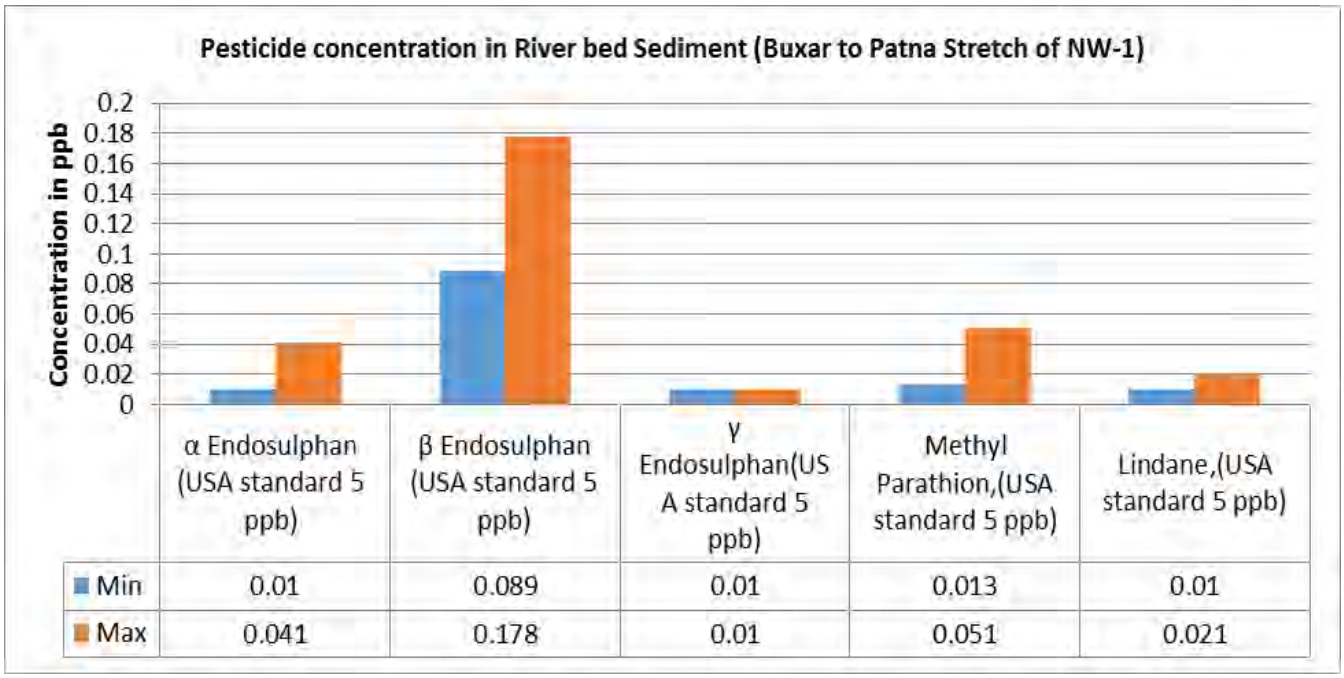
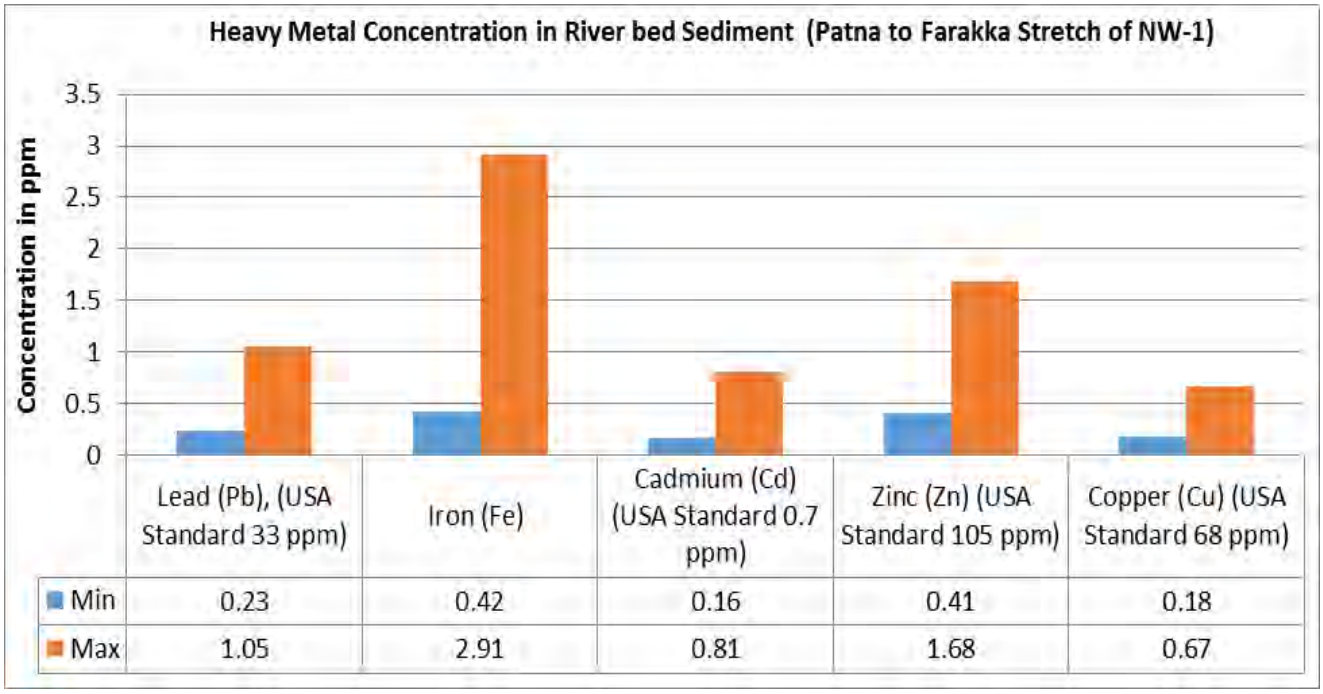


Figure 4.24 : River Bed Sediment Analysis between Buxar to Patna Stretch



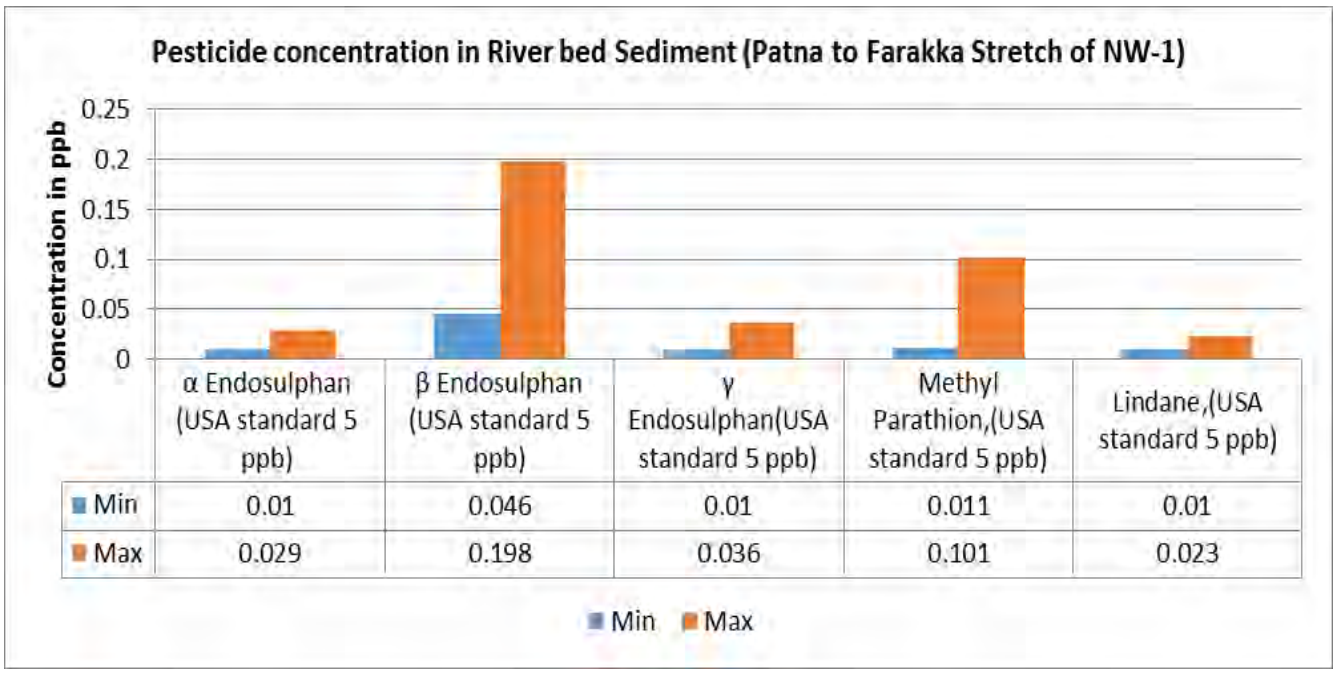


Figure 4.25 : River Bed Sediment Analysis between Patna to Farakka Stretch

Table 4.24 : Summary of River Bed Sediment Quality

S. No.	Parameters	Unit	Standard USA	Sirsa Area (U.P.)		Rampur Area (U.P.)		Mirzapur Area (U.P.)		Chunar Area (U.P.)		Varanasi Area (U.P.)		Saidpur Area (U.P.)	
				Min	Max	Min	Max	Min	Min	Max	Max	Min	Max	Min	Max
Physical Characteristics															
1	Texture, USDA System	USDA System	-	Sandy Loam / Clay Loam		Sandy Loam / Clay Loam		Sandy Loam / Sandy		Sandy Loam / Clay Loam		Sandy Loam / Clay Loam		Sandy Loam / Clay Loam	
2	Bulk Density (BD), gm/cc	gm/cc	-	1.28	1.62	1.28	1.59	1.47	1.66	0.88	1.69	1.28	1.55	1.27	1.68
Chemical Characteristics															
3	pH	20% Slurry	-	7.35	7.62	7.41	7.62	7.39	7.54	7.42	7.79	7.42	7.51	7.18	7.54
4	Conductivity (EC)	µmhos/cm	-	199	235	211	238	199	231	232	288	238	250	236	256
5	Cation Exchange Capacity (CEC)	meq/100gm	-	9.7	26.8	6.4	27.4	5.8	11.2	10.5	27.6	9.8	26.7	4.5	27.3
6	Organic Matter	%	-	0.79	0.98	0.78	1.1	0.86	1.08	0.62	1.14	0.88	1.1	0.86	1.09
7	Chromium as Cr	ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
8	Arsenic as As	ppm	12.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
9	Mercury as Hg	ppm	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10	Lead as Pb	ppm	33	0.42	0.62	0.35	0.62	0.58	0.67	0.27	0.87	0.36	0.45	0.26	0.59
11	Iron as Fe	ppm	-	2.1	2.26	2.01	2.35	2.11	2.32	1.89	2.51	1.54	1.65	1.82	2.21
12	Cadmium as Cd	ppm	0.7	1.07	1.21	1.08	1.29	1.02	1.28	0.22	1.36	0.82	0.91	0.89	1.18
13	Nikel as Ni	ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
14	Zinc as Zn	ppm	105	1.21	1.56	1.31	1.51	1.29	1.44	0.92	1.64	1.18	1.32	1.18	1.46
15	Copper as Cu	ppm	68	0.29	0.5	0.31	0.47	0.21	0.59	0.11	0.64	0.11	0.21	0.18	0.39
Pesticides /Insecticides															
16	α Endosulphan	ppb	5	<0.01	0.026	<0.01	0.031	<0.01	0.029	<0.01	0.041	<0.01	<0.01	<0.01	0.011
17	β Endosulphan	ppb	5	0.086	0.135	0.071	0.139	0.099	0.145	0.065	0.152	0.017	0.126	0.035	0.103
18	γ Endosulphan	ppb	5	0.031	0.085	0.028	0.092	0.071	0.088	<0.01	0.099	<0.01	0.011	<0.01	0.025
19	Methyl Parathion,	ppb	5	0.117	0.148	0.12	0.156	0.109	0.142	0.026	0.31	0.098	0.109	0.091	0.115
20	Lindane	ppb	5	<0.01	0.118	<0.01	0.026	<0.01	0.021	<0.01	0.042	<0.01	<0.01	<0.01	0.016

Source: Data sampling & Analysis by JV and NABL accredited Lab

Summary of River Bed Sediment Quality (cont..)

S. No.	Parameters	Unit	Standard USA	Ghazipur (U.P.)		Buxar (Bihar)		Ballia (Bihar)		Doriganj (Bihar)		Patna (Bihar)		Mehnar (Bihar)	
				Min	Max	Min	Max	Min	Min	Max	Max	Min	Max	Min	Max
Physical Characteristics															
1	Texture, USDA System	USDA System	-	Sandy Loam / Clay Loam / Sandy		Sandy Loam / Clay Loam / Sandy		Sandy Loam / Clay Loam / Sandy		Sandy Loam / Clay Loam / Sandy		Sandy Loam / Sandy		Sandy Loam / Sandy	
2	Bulk Density (BD), gm/cc	gm/cc	-	1.29	1.66	1.25	1.68	1.35	1.6	1.29	1.64	1.36	1.73	1.35	1.52
Chemical Characteristics															
3	pH	20% Slurry	-	7.18	7.68	7.16	7.52	7.21	7.68	7.16	7.75	7.05	7.62	7.28	7.48
4	Conductivity (EC)	µmhos/cm	-	219	278	190	273	199	272	188	248	191	268	216	257
5	Cation Exchange Capacity (CEC)	meq/100gm	-	10.2	27.2	11.7	27.6	10.8	27.2	12.4	26.7	11.4	15.5	13.6	15.7
6	Organic Matter	%	-	0.86	1.12	0.89	1.26	0.9	1.31	0.86	1.29	0.69	0.85	0.74	0.89
7	Chromium as Cr	ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
8	Arsenic as As	ppm	12.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
9	Mercury as Hg	ppm	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10	Lead as Pb	ppm	33	0.38	0.68	0.32	0.72	0.36	0.89	0.35	0.86	0.22	0.47	0.31	0.68
11	Iron as Fe	ppm	-	0.82	1.29	0.86	1.65	0.76	1.55	0.98	1.42	0.86	1.36	0.91	1.42
12	Cadmium as Cd	ppm	0.7	0.09	0.22	0.11	0.29	0.12	0.36	0.16	0.33	0.11	0.43	0.18	0.31
13	Nikel as Ni	ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
14	Zinc as Zn	ppm	105	0.92	1.21	0.96	1.46	0.82	1.31	0.88	1.38	0.91	1.29	0.99	1.44
15	Copper as Cu	ppm	68	0.18	0.37	0.19	0.57	0.22	1.18	0.39	0.69	0.14	0.37	0.26	0.57
Pesticides /Insecticides															
16	α Endosulphan	ppb	5	<0.01	0.042	<0.01	0.031	<0.01	0.038	<0.01	0.041	<0.01	0.036	<0.01	0.028
17	β Endosulphan	ppb	5	0.095	0.178	0.107	0.192	0.089	0.168	0.098	0.178	0.102	0.168	0.107	0.177
18	γ Endosulphan	ppb	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Methyl Parathion,	ppb	5	0.011	0.033	0.011	0.039	0.013	0.028	0.017	0.051	0.015	0.042	0.016	0.042
20	Lindane	ppb	5	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	0.021	<0.01	0.021	<0.01	0.012

Source: Data sampling & Analysis by JV and NABL accredited Lab

Summary of River Bed Sediment Quality (cont..)

S. No.	Parameters	Unit	Standard USA	Barh (Bihar)		Semaria (Bihar)		Mahendrapur (Bihar)		Munger (Bihar)		Sultanganj (Bihar)		Karagola (Bihar)	
				Min	Max	Min	Max	Min	Min	Max	Max	Min	Max	Min	Max
Physical Characteristics															
1	Texture, USDA System	USDA System	-	Sandy Loam / Clay Loam		Sandy Loam		Sandy Loam / Silty Loam		Sandy Loam / Silty Loam		Sandy Loam / Silty Loam		Sandy Loam / Silty Loam	
2	Bulk Density (BD), gm/cc	gm/cc	-	1.35	1.4	1.55	1.68	1.26	1.49	1.39	1.65	1.32	1.67	1.36	1.73
Chemical Characteristics															
3	pH	20% Slurry	-	7.23	7.45	7.26	7.79	7.21	8.01	7.28	7.81	7.38	7.96	7.41	7.99
4	Conductivity (EC)	µmhos /cm	-	208	272	196	258	182	276	188	267	196	262	181	257
5	Cation Exchange Capacity (CEC)	meq/ 100gm	-	14.7	17.3	13.2	17.3	14.8	27.2	12.5	17.4	11.8	18.2	10.8	19.5
6	Organic Matter	%	-	0.82	0.94	0.79	0.9	0.84	0.94	0.61	0.86	0.79	0.91	0.67	0.97
7	Chromium as Cr	ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
8	Arsenic as As	ppm	12.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
9	Mercury as Hg	ppm	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10	Lead as Pb	ppm	33	0.31	0.59	0.44	0.82	0.25	0.74	0.41	0.73	0.23	0.6	0.42	0.96
11	Iron as Fe	ppm	-	0.86	1.18	0.76	1.23	0.42	1.18	0.48	0.79	0.56	1.88	1.59	2.89
12	Cadmium as Cd	ppm	0.7	0.28	0.39	0.22	0.45	0.16	0.31	0.29	0.39	0.27	0.57	0.19	0.52
13	Nikel as Ni	ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
14	Zinc as Zn	ppm	105	0.95	1.26	0.78	1.21	0.57	1.29	0.67	0.84	0.41	0.79	0.72	1.68
15	Copper as Cu	ppm	68	0.32	0.61	0.32	0.58	0.28	0.41	0.36	0.49	0.33	0.67	0.18	0.5
Pesticides /Insecticides															
16	α Endosulphan	ppb	5	<0.01	0.024	<0.01	0.025	<0.01	0.029	<0.01	0.025	<0.01	0.028	<0.01	0.022
17	β Endosulphan	ppb	5	0.123	0.176	0.09	0.148	0.082	0.159	0.092	0.146	0.046	0.198	0.072	0.135
18	γ Endosulphan	ppb	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Methyl Parathion,	ppb	5	0.019	0.031	0.023	0.053	0.021	0.056	0.023	0.036	0.015	0.042	0.016	0.045
20	Lindane	ppb	5	<0.01	0.012	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.023	<0.01	<0.01

Source: Data sampling & Analysis by JV and NABL accredited Lab

Summary of River Bed Sediment Quality (cont..)

S. No.	Parameters	Unit	Standard USA	Manihari (Bihar)		Rajmahal (Jharkhand)		Farakka (West Bengal)	
				Min	Max	Min	Max	Min	Max
Physical Characteristics									
1	Texture	USDA System	-	Sandy Loam / Clay Loam / Silty Loam		Sandy Loam / Clay Loam / Silty Loam		Sandy Loam / Clay Loam	
2	Bulk Density (BD)	gm/cc	-	1.21	1.41	1.16	1.38	1.08	1.57
Chemical Characteristics									
3	pH	20% Slurry	-	7.65	7.92	7.58	7.74	7.67	7.74
4	Conductivity (EC)	µmhos/cm	-	198	252	265	274	225	229
5	Cation Exchange Capacity (CEC)	meq/100-gm	-	18.7	25.2	10.9	26.7	10.9	31.4
6	Organic Matter	%	-	0.85	1.32	0.78	0.98	0.78	0.94
7	Chromium as Cr	Ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
8	Arsenic as As	Ppm	12.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
9	Mercury as Hg	Ppm	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10	Lead as Pb	Ppm	33	0.88	1.05	0.87	0.99	0.86	0.95
11	Iron as Fe	Ppm	-	2.11	2.91	1.99	2.9	2.21	2.26
12	Cadmium as Cd	Ppm	0.7	0.36	0.66	0.72	0.79	0.73	0.81
13	Nikel as Ni	Ppm	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
14	Zinc as Zn	Ppm	105	0.56	0.98	1.12	1.38	1.45	1.54
15	Copper as Cu	Ppm	68	0.26	0.62	0.21	0.31	0.31	0.39
Pesticides /Insecticides									
16	α Endosulphan	Ppb	5	<0.01	0.016	<0.01	0.012	<0.01	<0.01
17	β Endosulphan	Ppb	5	0.089	0.123	0.112	0.121	0.112	0.121
18	γ Endosulphan	Ppb	5	<0.01	0.036	<0.01	<0.01	<0.01	<0.01
19	Methyl Parathion,	Ppb	5	0.011	0.075	0.017	0.101	0.098	0.101
20	Lindane	Ppb	5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Source: Data sampling & Analysis by JV and NABL accredited Lab

Observations on River Bed-Dredge Material Quality

The concentration level of heavy metal was found low in concentration and within acceptable limit as per standard (Criteria for Off-Shore Dumping of Dredged Material, USA) except cadmium which is slightly above the USA standard at some location in UP stretch that may be due to industrial effluent discharge in this section. Pesticide concentration in all sample were found far below the USA criteria. The pesticides presence is on expected line as these are predominantly used for various agriculture applications. The source of these pesticide parathion and endosulphan might be from indiscriminate applications of insecticides and pesticides for agriculture.

Figure 4.26 : Surface and Ground Water Sampling (in- situ testing) at Different Locations along NW-1

Figure 4.27 Surface and Ground Water Sampling at Different Locations along NW-1

4.5. Air Environment

The ambient air quality has been monitored at all proposed terminal/ lock, RO-RO jetty, floating terminal locations along NW-1. Additional baseline monitoring was carried out around proposed terminals/lock site areas. The locations of the monitoring stations were selected based on frequency of wind directions, presence of sensitive receptor (habitation, eco sensitive receptor) located within the buffer zone of 2KM. Three monitoring station was setup (One station close to the terminal/lock site, one location in downwind direction and other location was near to the existing air pollution source (if any) such as industrial area, crushers or mining areas. Ambient air quality monitoring was carried out between 16th September to 28th February 2016 with the frequency of weekly two samples of 24 hourly average each (8 hrs. averaging for CO) at each monitoring location around designated terminal/lock location (5 terminals and one lock[27]) and 10 nos. of existing Ro-Ro jetty/ floating terminal of NW1 to get representative data along NW-1 spread over longer period and stretch. Air sampling location map is projected in **Figure 4.28.**

4.5.1. *Ambient Air Quality along Nw-1 (at Proposed or Planned Facilities)*

The AAQ data of NW-1 are summarised in **Table 4.25** to **Table 4.28**. Graphical representations of the AAQ data are given at **Figure 4.29 and Figure 4.30.**

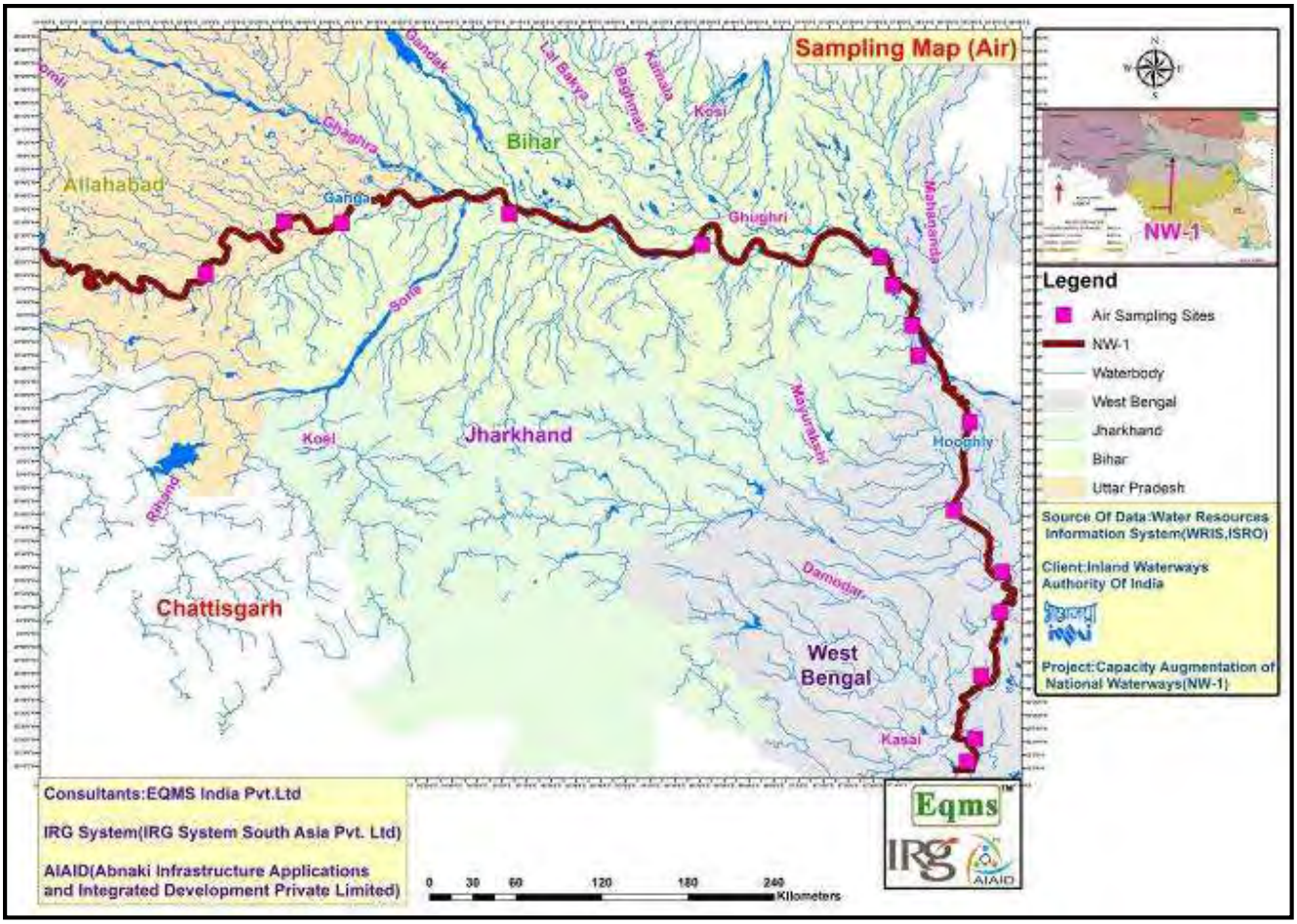


Figure 4.28 : AAQ Monitoring Location Map

[27]These terminals and lock are located at close to start point at Haldia and end point near Varansi. Intermitant locations Farakha, Sahibganj, Tribeni, Chazipur are also located far apart from each other locatios.

Table 4.25 : Ambient Air Quality results for PM2.5 and PM10 (24-hour average) along NW-1 (at Proposed Terminal Locations)

Terminal Location	$PM_{2.5}$, µg/m³		PM_{10} (µg/m³)	
	Min	Max	Min	Max
Haldia Terminal, West Bengal	19	37	58	97
Farakka Lock, West Bengal	18	36	44	74
Tribeni Terminal, West Bengal	22	38	55	84
Sahibganj Terminal, Jharkhand	14	34	40	82
Ghazipur Terminal, Uttar Pradesh	17	28	44	64
Varanasi terminal, Uttar Pradesh	20	58	54	145

Source: Data Sampling & Analysis by JV and NABL accredited Lab

Table 4.26 : Ambient Air Quality Monitoring Results for SOx, NOx (24-h avg.) along NW-1 (at Proposed Terminal Locations)

Terminal Location	SO_2, µg/m³		NO_2, µg/m³		CO(mg/m³) 8 hrs avg.	
	Min	Max	Min	Max	Min	Max
Haldia Terminal, West Bengal	7.9	15.0	22.5	48.0	0.5	1.2
Farakka Lock, West Bengal	4.5	8.9	9.0	13.6	<0.1	<0.1
Tribeni Terminal, West Bengal	6.1	10.2	9.2	17.2	0.18	0.22
Sahibganj Terminal, Jharkhand	4.4	7.8	9.0	13.4	<0.1	<0.1
Ghazipur Terminal, Uttar Pradesh	5.0	8.2	9.0	14.2	<0.1	<0.1
Varanasi terminal, Uttar Pradesh	13.4	35.6	17.4	46.8	0.25	0.69

Source: Data Sampling & Analysis by JV and NABL accredited Lab

Table 4.27 : Ambient Air Quality results for PM2.5 and PM10 (24-hour average)along NW-1 (at RO-RO Jetty/ Floating Terminals)

RO-RO Jetty/ Floating Terminal Location	$PM_{2.5}$, µg/m³		PM_{10} (µg/m³)	
	Min	Max	Min	Max
Diamond Harbour	24	47	53	89
Howrah	31	56	68	125
Shantipur	21	34	43	70
Katwa	18	30	39	64
Hazardwari	19	32	41	67

Pakur	19	32	40	68
Magalhat	16	29	39	62
Buxar	21	36	46	78
Munger	18	32	43	71
Patna	29	56	72	138

Source: Data Sampling & Analysis by JV and NABL accredited Lab

Table 4.28 : Ambient Air Quality Monitoring Results for SOx, NOx and CO (24-h avg.) along NW-1(at RO-RO Jetty/ Floating Terminals)

Terminal Location	SO_2, µg/m^3		NO_2, µg/m^3		CO(mg/m^3) 8 hrs avg.	
	Min	Max	Min	Max	Min	Max
Diamond Harbour	5.2	12.3	9.4	18.6	0.2	0.4
Howrah	6.8	17.6	13.6	32.4	0.3	0.9
Shantipur	4.8	7.4	9.0	11.2	<0.1	<0.1
Katwa	5.2	8.7	9.2	14.3	<0.1	<0.1
Hazardwari	4.7	7.8	9.1	13.2	<0.1	<0.1
Pakur	5.1	8.6	9.0	14.3	<0.1	<0.1
Magalhal	4.4	6.7	9.0	11.2	<0.1	<0.1
Buxar	5.2	9.4	9.3	13.2	<0.1	<0.1
Munger	5.0	8.3	9.1	15.5	<0.1	<0.1
Patna	6.3	14.6	13.2	22.3	0.20	0.45

Source: Data Sampling & Analysis by JV and NABL accredited Lab

4.5.2. *Observation on Ambient Air Quality*

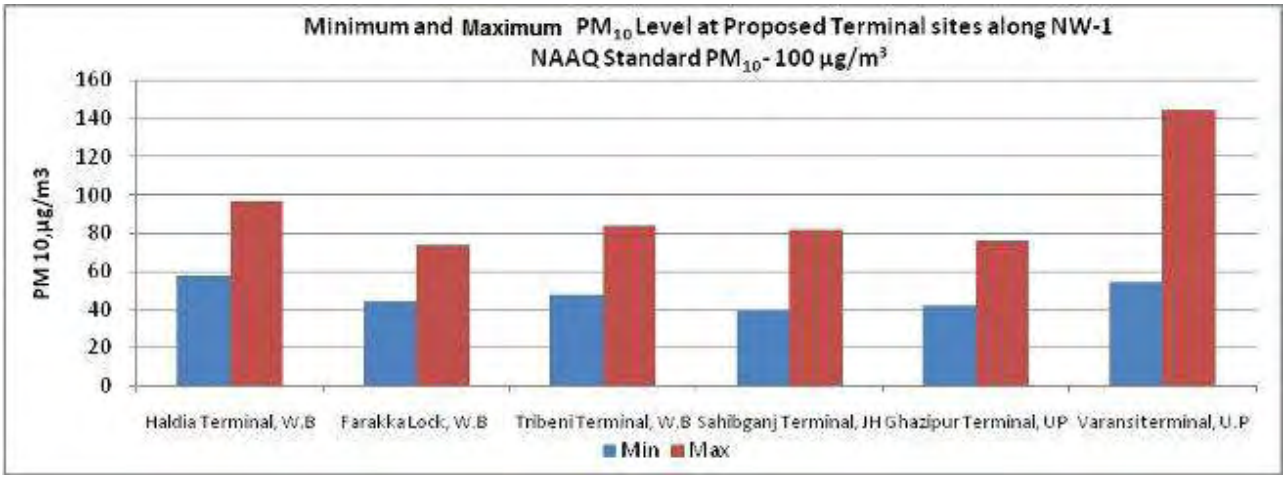
Particulate Matter (PM_{10}): Particulate Matter PM_{10} level at proposed and planned terminal and existing jetty locations along NW-1 varies from 39 to 145µg/m^3. PM_{10} values in all locations are within the specified limit of 100 **µg/m^3** as per NAAQS except at Varanasi, Patna and Howrah. The higher concentration of PM_{10} i.e.145 µg/m^3 is observed at Ramnagar area of Varanasi followed by Patna and Howrah. The higher dust levels are because of industrial activities, heavy vehicular pollution and domestic burning in these large urban agglomerations.

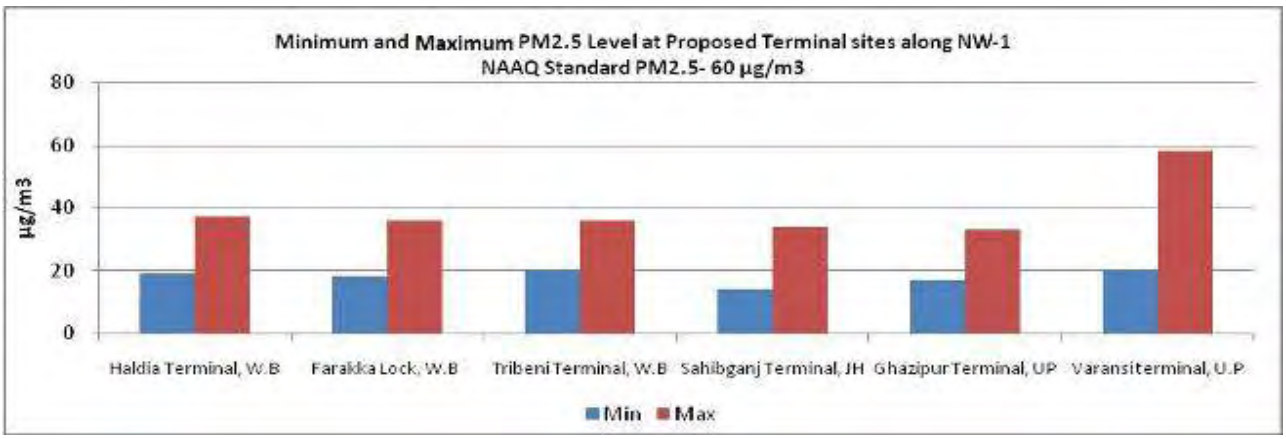
Particulate Matter ($PM_{2.5}$): $PM_{2.5}$ levels were found ranging from 16 to 58µg/m^3. All value of $PM_{2.5}$are within the specified limit of 60 **µg/m^3** as per NAAQS but high values with respect to $PM_{2.5}$ were recorded in Varanasi, Patna and Howrah locations. The higher fine respirable dust levels are because of various industrial and domestic combustions (coal and biomass burning) and heavy construction activities in these areas.

Sulphur Dioxide (SO_2):SO_2 levels were universally found low with respect to particulate matter. Background level of SO_2 ranged from 4.4 to 35.6 µg/m^3. The highest levels of SO_2 were found at Varanasi, Howrah and Patna location that may be due to heavy vehicular movement and industrial activities in these locations.

Oxides of Nitrogen (NO_x): High NOx was observed in those locations that lie in city area like Varanasi, Patna, Howrah and Haldia. The NO_x levels were found ranges between 9.0 to 48µg/m^3. The observed NO_x level was found within the national Ambient Air Quality Standard. Again, the highest levels of NO_x were found at Haldia followed by Varanasi, Patna, Howrah, Tribeni and Diamond Harbour location. Predominant sources contributing to high level of NOx in the study area are industrial pollution arising out from industries and vehicle/motorboats operating in the area.

Carbon Mono-oxides (CO):CO was detected in few locations i.e. Haldia, Howrah, Patna and Varanasi. CO was not detected either in all enrooted cities or around other facilities of NH-1. The 8hrs CO level was found ranging between 0.18 to 1.2 mg/m^3, which is found within the national Ambient Air Quality Standard. The highest levels of CO were found at Haldia location.





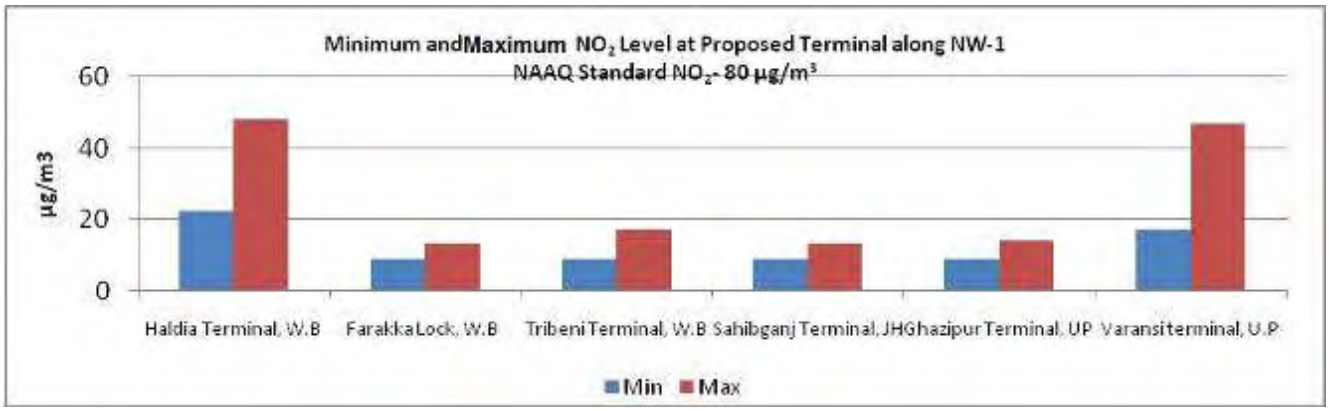
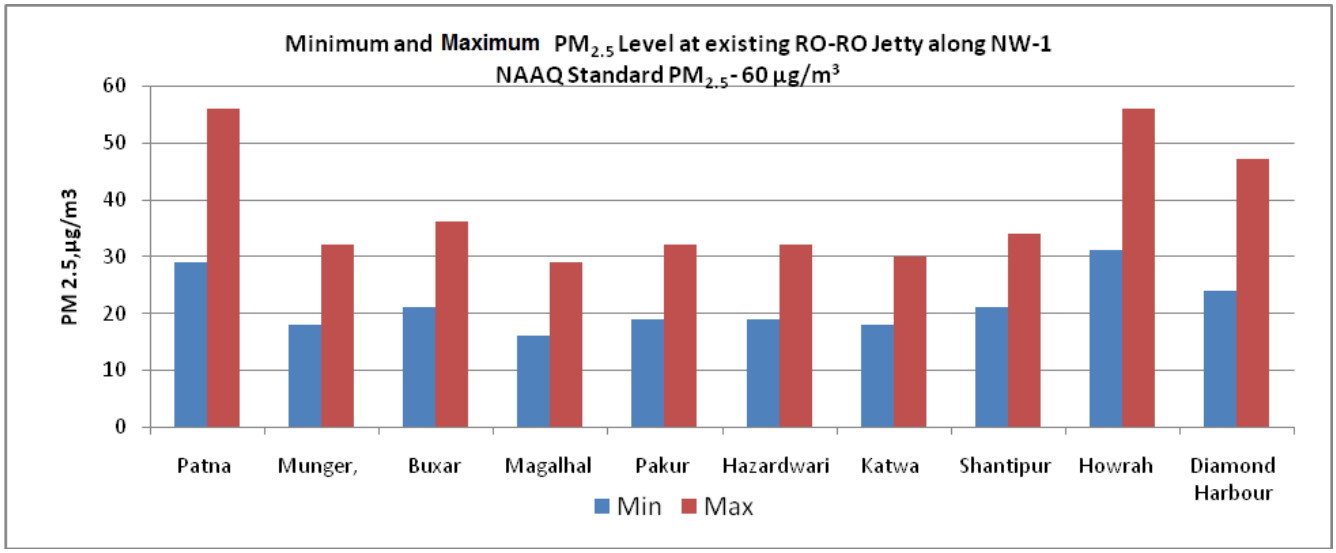
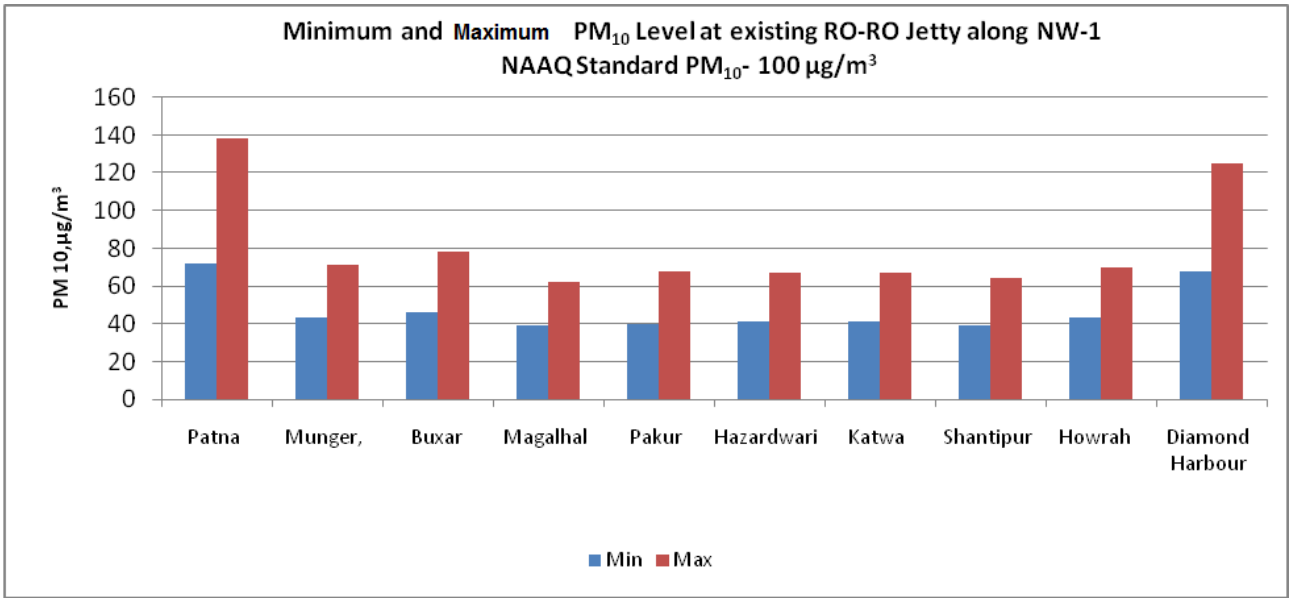
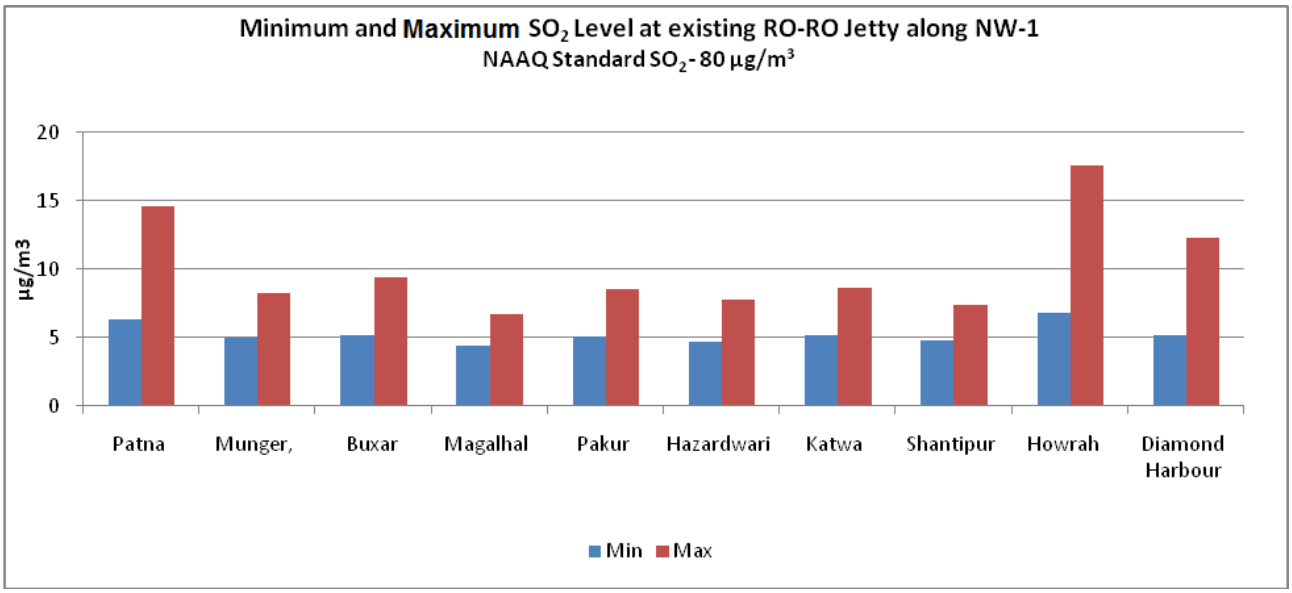


Figure 4.29 : Graphical Representation of AAQ monitoring results around Proposed Terminal and Lock Locations







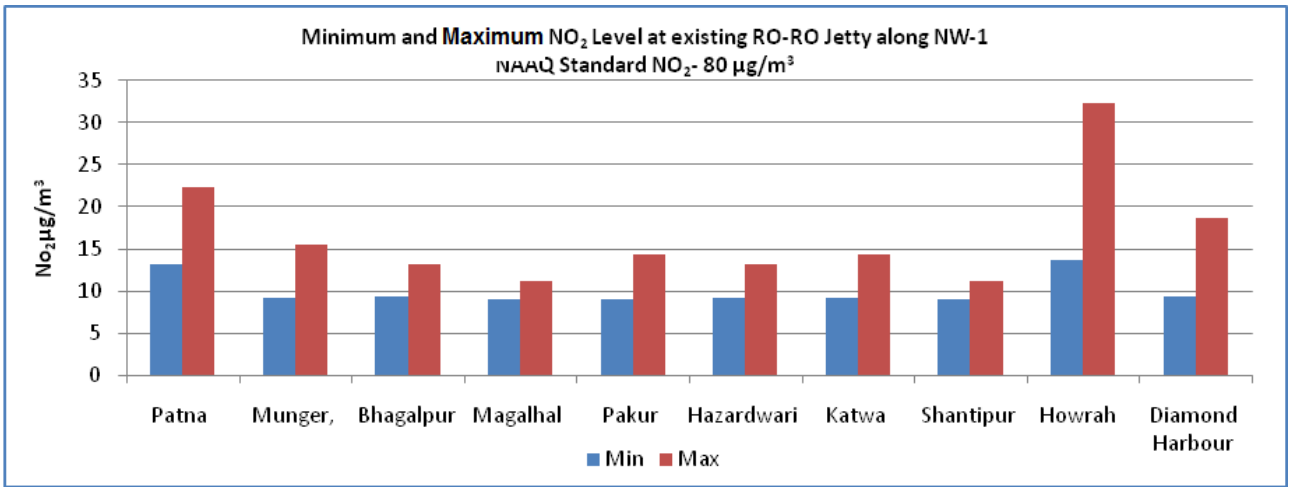


Figure 4.30 : Graphical Representation of AAQ Monitoring Results at RO-RO and Floating Jetty Locations

AAQ Moniroing at Haldia site

AAQ Moniroing at Farakka site

AAQ Moniroing at Varansi site

AAQ Moniroing at Sahibganj site

AAQ Moniroing at Tribeni site

AAQ Moniroing at Ghazipur site

AAQ Moniroing at Buxar site

AAQ Moniroing at Ghazipur

Figure 4.31 : Photographs of AAQ Monitoring Along NW-1

4.6. Ambient Noise Quality

The noise level was measured as per the monitoring plan approved by IWAI/world bank at proposed terminals/locks, around sensitive receptors and existing Ro-Ro/jetty along the NW-1. At each location, readings were taken at uniform interval of 5 seconds over a period of 10 minutes per hour for each of twenty-four hours' period, with further divisions of day and night noise as per CPCB guidelines (between 6.00 A.M. to 10.00 P.M. and between 10.01 P.M. to 5.59 A.M. representing day and night period noise levels)[28]. Ambient noise monitoring was carried out at 3 locations at each terminal, five locations around each sensitive ecosystem and one location each at ro-ro jetty locations. Noise monitoring locations map is shown at **Figure 4.32.**

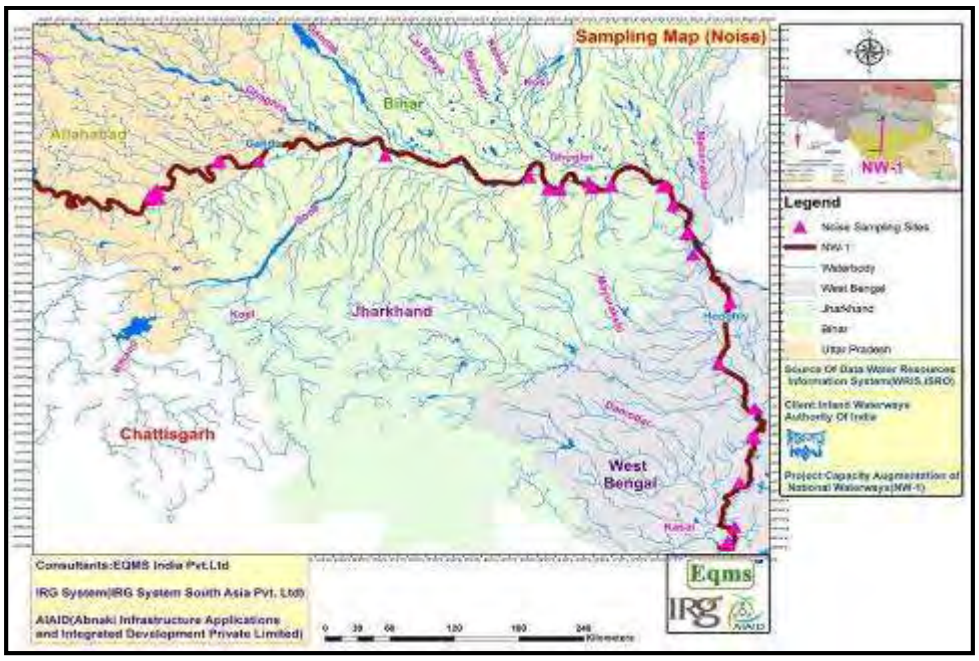


Figure 4.32 : Noise Monitoring Location Map

4.6.1. *Noise Levels in the Study Area*

Noise monitoring results (min, max and Leq at all monitoring stations) for day time and night time are presented in **Table 4.29 and Table 4.30.**

Table 4.29 : Ambient Noise level along NW-1 and proposed intervention locations

Terminal Site	Location Name	Present Category	Day time Leq dB(A)			National Standard Day time Leq; dB(A)	Night time Leq; dB(A)			National Standard Night time Leq; dB(A)
			Min	Max	Leq dB(A)		Min	Max	Leq dB(A)	
Haldia Terminal	Terminal site	Industrial	40.1	55.8	48.2	75	37.3	40.9	38.8	65
	Road connecting to site	Industrial	52.7	60.4	58.2	75	39.7	46.3	43.5	65
	Durgachak	Commercial/ mixed use Area	53.8	67.4	62.6	65	47.4	57.8	54.1	55
T r	Kalyani Town	Mixed use	47.8	64.6	58.5	65	42.1	52.3	51.2	55

[28]A sound level meter has been used to measure noise levels as instant values which are integrated over a defined period to give Leq values as A weighted average.

Ter min	Location Name	Present Category	Day time Leq dB(A)			National Standard Day time	Night time Leq; dB(A)			National Standard Night time
	Near terminal site	Residential	41.6	56.3	52.6	55	40.3	46.8	42.6	45
	NH-6 connecting site	Industrial	53.6	68.9	64.8.	75	44.3	62.5	58.5	65
Farakka Lock	Lock gate site	Residential	39.8	51.2	45.6	55	37.0	42.0	38.5	45
	Road connecting to site	Road	44.6	62.6	58.7	65	40.2	58.6	52.7	45
	Ghoraipara village	Residential	40.4	53.2	46.8	55	38.3	44.5	40.1	45
Sahibganj Terminal	Samda nala near Terminal Site	Residential	38.0	54.3	46.2	55	35.1	41.2	38.4	45
	Road connecting to Terminal site	Commercial	50.9	65.5	61.1	65	42.4	55.6	49.6	55
	Rampur village	Residential	39.5	54.5	47.6	55	35.0	42.2	38.7	45
Ghazipur Terminal	Tarighat Near Terminal site	Residential	40.1	52.3	46.5	55	37.4	43.2	39.0	45
	Saraiya village	Residential	40.8	53.2	47.2	55	38.2	43.0	38.6	45
	Village road connecting site to NH-97	Mixed use	43.6	61.8	54.3	65	39.0	54.3		55
Varanasi Terminal	Terminal Site	Industrial	_	_	43.5	75	_	_	40.2	65
	Ramnagar (NH-7)	Commercial	_	_	64.5	65	_	_	54.8	55
	Ralhupur	Residential	_	_	45.8	55	_	_	41.3	45
	Tahirpur	Residential	_	_	46.5	55	_	_	42.0	45
	Bhitti	Residential	_	_	46.8	55	_	_	42.5	45
	Madarwa	Residential	_	_	48.8	55	_	_	43.0	45
	Sultanpur	Residential	_	_	47.3	55	_	_	42.9	45
	Milkipur	Residential	_	_	46.4	55	_	_	42.5	45
Existing Ro-Ro/ Floating terminals	Diamond Harbour	Commercial	45.6	57.2	50.4	65	41.6	46.5	43.6	55
	Howrah	Commercial	47.8	62.3	58.5	65	43.0	54.2	51.6	55
	Shantipur	Residential	42.5	54.4	50.1	55	39.6	46.5	42.6	45
	Katwa	Residential	41.2	54.3	48.5	55	38.2	45.8	43.0	45
	Hazardwari	Residential	40.3	51.2	46.4	55	37.6	43.2	41.5	45
	Pakur	Residential	40.2	48.6	45.0	55	38.1	44.3	41.7	45
	Magalhal	Residential	39.1	47.3	42.8	55	37.2	44.6	40.1	45
	Buxar	Residential	41.3	52.3	47.4	55	40.1	46.4	42.3	45
	Munger	Residential	42.4	54.7	50.1	55	41.2	47.8	43.5	45
	Patna	Commercial	46.7	62.1	57.8	65	43.5	53.4	51.2	55

(Source: Monitored by JV)

Table 4.30 : Ambient Noise level along NW-1 near Sensitive Ecosystems

Sanctuary	Location Name	Day time Leq dB(A)	Standard Day time Leq; dB(A)	Night time Leq; dB(A)	Standard Night time Leq; dB(A)
Kashi Turtle Sanctuary	d/s of sanctuary near KardmeshwarMahdev Temple	53.7	50	39.8	40
	Left bank near Dashashwameghghat	59.3	50	42.3	40
	Right Bank Opposite Dashashwameghghat	49.3	50	38.6	40
	Left Bank near TulsiGhat	58.5	50	40.6	40
	Right Bank oppositeTulsiGhat	47.6	50	38.2	40
	Upstream of sanctuary near BaluaGhat	55.6	50	38.7	40
Vikramshila Dolphin Sanctuary	d/s of sultanganj Ghat right bank of river along ghat	46.6	50	37.6	40
	u/s of sultanganj Ghat Left bank of river	44.5	50	36.3	40
	Ganga river left bank near Vikramshila setu, Bhagalpur	47.8	50	38.4	40
	Ganga river right bank near Vikramshila setu, Bhagalpur	45.3	50	37.0	40
	Upstream along Ganga ghat right bank near Kahalgaon	45.6	50	37.2	40
	Upstream apposite Ganga ghat near Kahalgaon	44.4	50	36.8	40

(Source: Monitored by JV)

4.6.2. *Observation of Ambient Noise Quality*

Ambient noise levels of the entire NW-1 stretch are within the prescribed National Ambient Noise Quality Standard for respective residential and commercial category at all the monitored locations. The noise level recorded within Vikramshila dolphin sanctuary area was also found within the sensitive category threshold at all monitoring locations. However, the noise level was not meeting the sensitive criteria for Kashi turtle sanctuary area because of anthropogenic activities. There are 81 Ghats along with few temples within the limit of Kashi turtle Sanctuary area. There is a large gathering of people in Ghat area in most of the time. Loud speakers in nearby temples is the another source of noise in the sanctuary area.

Figure 4.33 : Photographs of Noise Monitoring along NW-1

4.7. Biological Environment (NW-1)

This Section provides detail of terrestrial and aquatic environment along NW-1, and study area around NW-1 and planned interventions areas. Ecological profile of the area has been described in terms of biogeographic zone followed by terrestrial & aquatic flora & fauna and the critical environmental resources.

4.7.1. *Ecological Profile - Biogeographic Zone*

Biogeographic zone indicates area of animal and plant distribution having similar or shared characteristics throughout. NW-1 falls largely under Gangetic Plain Biogeographic zone (7) [29] and small section under Coast Biogeographic Zone (8) (**Figure 4.34).** Biogeographically the NW-1 falls in Gangetic plain. Biogeographic zone which is divided in two biotic provinces namely Upper Gangetic plain (7A) and Lower Gangetic plain (7B)[30].Part of NW-1 near Haldia is falls under East Coast (8B) area. Details of the biogeographical zone i.e. Zone 7 and zone 8(B) is briefly discussed below:

Gangetic Plain Zone (7A and 7B): Plains of UP, Bihar, West Bengal which is most fertile alluvial soils, mostly under crop having very little forest cover. The trees belonging to these forests are teak, sal, shisham, mahua, khair etc.

Zone 8 (B): Coastal belts of east coasts, higher rainfall, and exposure to cyclones near sea coast, rich in flora and fauna exactly replicating the peninsular type of vegetation near estuary areas.

[29]Biogeographic classification is India is the division of India according to biogeographic characterstics. It is based on distribution of species (biology), organism and in ecosystem in geographic space. There are ten biogeographic zones in India namely 1. Trans Himalayan Zone, 2. Himalayan Zone, 3. Desert Zone, 4, Semiarid zone, 5. Western ghat zone, 6. Deccan Plateau Zone 7. Gangetic Pl ain Zone, 8. North East Zone, 9. Coastal Zone 10. Island present near the shore line zone.

[30]Biogeographic classification of India was done by Rodgers and Panwar (1988), describing 10 biogeographic zones in India, further divided into 25 biogeographic provinces. The maps were further revised by Rodgers, Panwar and Mathur (2002), using GIS techniques into 10 zones and 26 provinces. The classification was done using various factors such as altitude, moisture, topography, and rainfall.

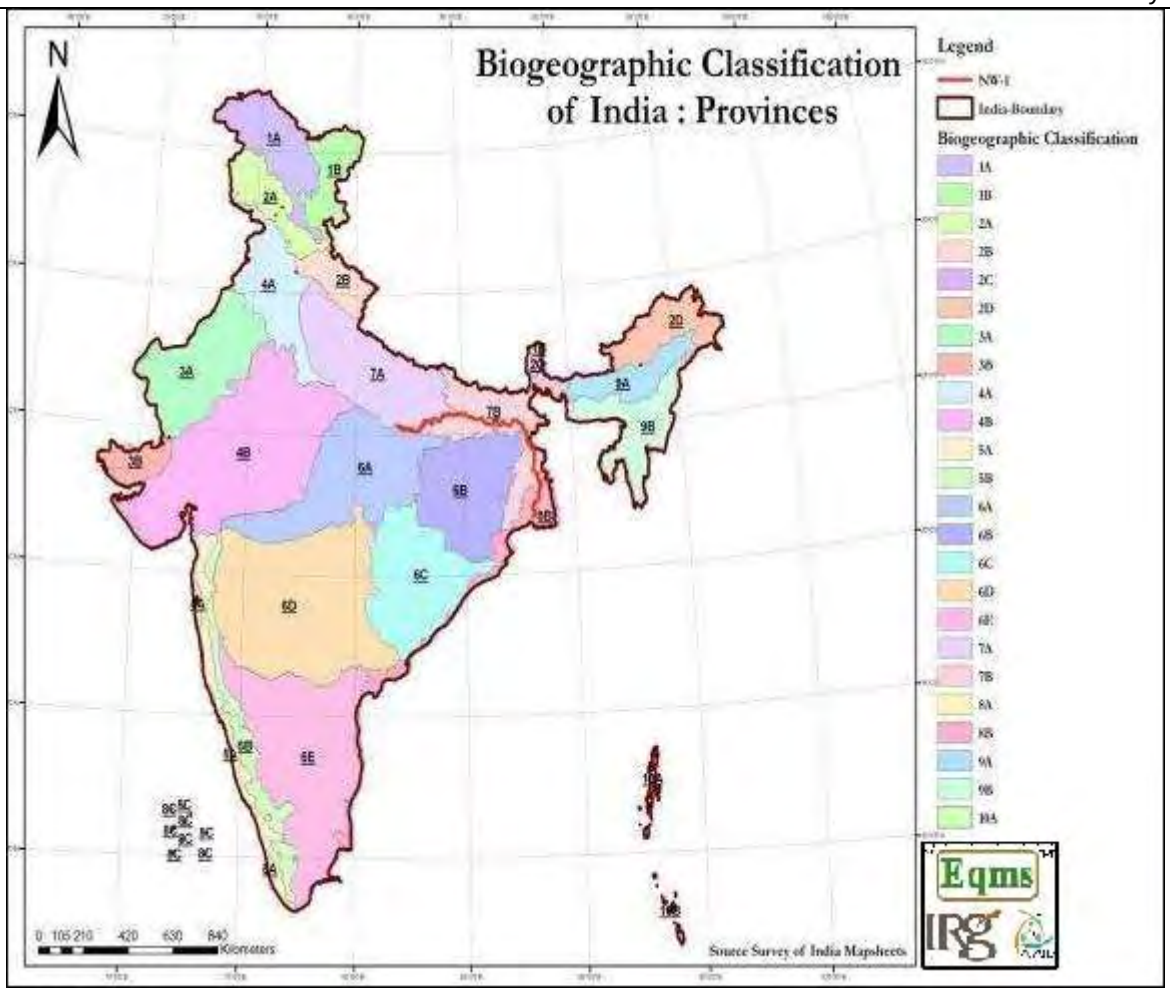


Figure 4.34 : Biogeographic zone and provinces falling in NW-1

Biodiversity of study area & NW-1 uniquely synthesizes two different eco-regions of India situated along climatic gradients, namely, the Gangetic plains and the Deltaic regions in line with its Biographic classification. The unique biodiversity in the study area has been summarized in terms of Forest types and Critical Environmental Resources. The river's biodiversity comprises periphytons, phytoplanktons and macrophyteswhich are consumers in the trophic level of energy pyramid and thus the real commercialproducts at tertiary level of food chain. Together, these micro- and macro-organisms, are important for a sustaining ecosystem of ganga river system.

4.7.2. *Forest type*

Data on forest and tree cover in states[31]traversed by NW-1 indicates that forest and tree cover is highest in Jharkhand (32.74% of total geographical area) followed by West Bengal (21.35%), Bihar (10.04%) and Uttar Pradesh (8.82%) as given in **Table4.31.** Reserved forest map in the state traversed by NW-1 is provided in **Figure 4.35**. No portion of NW-1 and intervention areas falls under any reserved forest or normal forests area. The forest cover directly and indirectly impacts the quality as

[31]*State of Forest Report, 2013*

well as quantity of water and sediment load of the rivers in the whole Indo-gangetic plain.

Table 4.31 : State-wise Forest and Tree Cover in study area and State Traversed by NW-1

State	Geographical Area (Sq. km)	Forest and Tree Cover					% of Geographical Area of the State	Biogeographic Zone and Chainage of NW-1
		Very Dense Forest (Sq. km)	Moderately Dense Forest Cover (Sq. km)	Open Forest (Sq. km)	Tree Cover (Sq. km)	Total (Sq. km)		
West Bengal	88,752	2971	4146	9688	2144	18949	21.35	7B (NW-1 indicative chainage 583)
Jharkhand	79,714	2587	9667	11,219	2629	26,102	32.74	7B (NW-1 indicative chainage 583-1547)
Bihar	94,163	247	3380	3664	2164	9455	10.04	7B NW-1 chainage indicative 583-1547
Uttar Pradesh	240,928	1623	4550	8176	6895	21,244	8.82	7A NW-1 Indicative chainage 583-1547
(Total)	**503,557**	**7,428**	**21,743**	**32,747**	**13,832**	**75,750**		

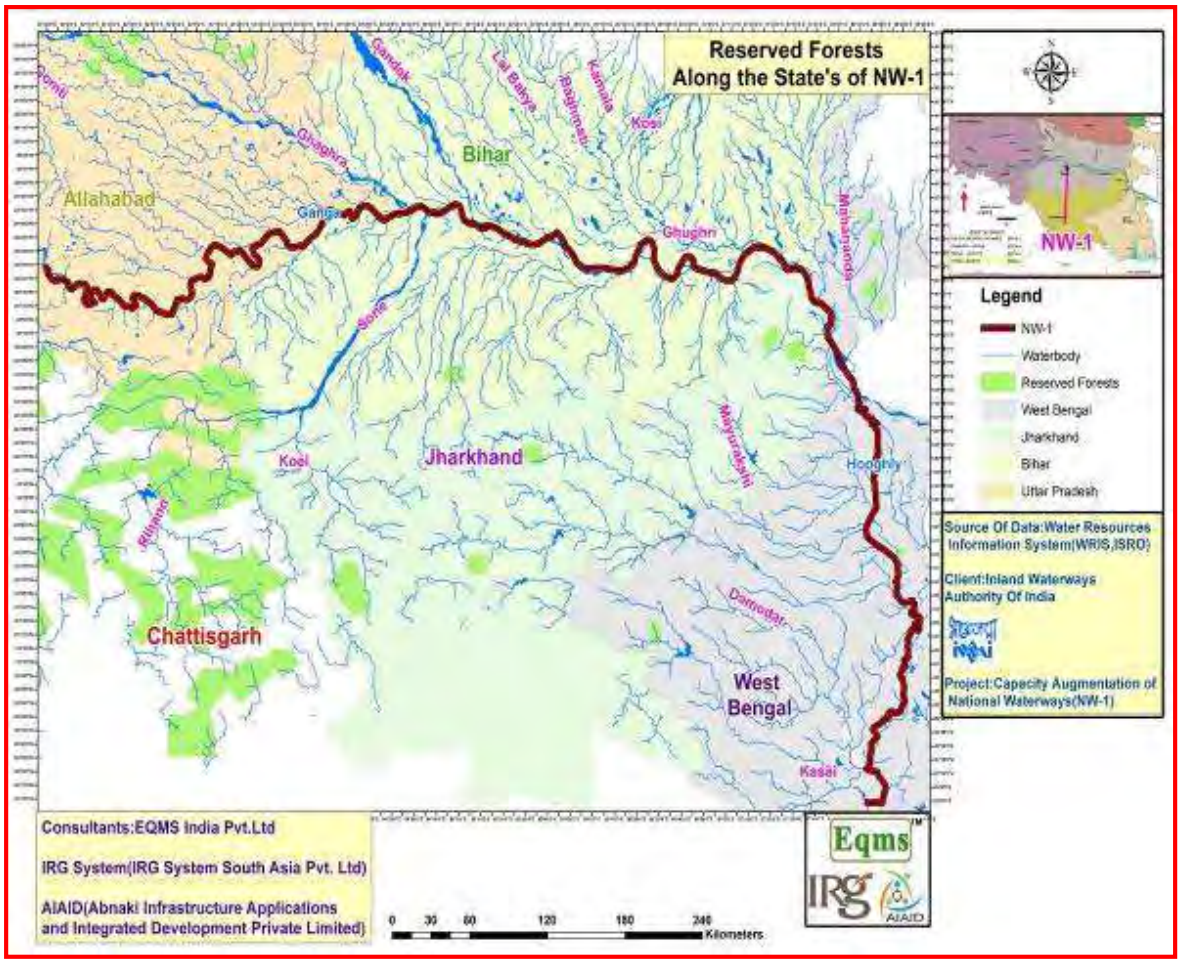


Figure 4.35 : Reserve Forest Map of States Traversed by NW-1

4.7.3. *Critical Environmental Resources in Project Area (NW-1)*

The critical Environmental Resources (CERs) namely Biosphere Reserves, Wildlife Sanctuaries, National Parks, wetlands, Tiger Reserves, Important bird areas, and Breeding and nesting grounds for aquatic species (Schedule-I species) are identified and mapped for entire NW-1 stretch due their importance for providing suitable habitats for wildlife, humans, and their role in sustaining ecological functions. There are 2 wildlife life Sanctuaries, and one Hilsa Fish sanctuary are located within river boundary of NW-1 stretch. Udhwa bird sanctuary and 5 other important bird areas are also located within 10 km radius of NW-1 stretch. CERs details along NW-1 are described in following sections:

4.7.3.1 Wildlife Sanctuaries within NW-1

There are two notified wild life sanctuaries Namely Kashi Turtle Sanctuary and Vikramshila, Dolphin Sanctuary and Hilsa Sanctuary Stretches) located within the NW-1. Hilsa Sanctuary has not been notified under Wild Life (Protection) Act. It is notified only to propagate Hilsa Fish production. Salient features of the wild life sanctuaries (refer **Table 4.32**) along with flora and fauna details is described in following sections.

Table 4.32 : Salient features of Wild life Sanctuaries present within NW-1

Sr. No.	State	Wildlife Sanctuary	Protection status	Applicability of Wild life act for NW-1 operations	Applicability of Forest act for NW-1 operations	Regulated buffer Zone (Km radius)
1	UP	Turtle sanctuary, Varanasi	Officially protected Under Wildlife Protection Act, 1972	*Yes*	No	10
2	Bihar	VikramshilaGangetic Dolphin, Sultanganj to Kahalgaon pahad	Officially protected Under Wildlife Protection Act, 1972	*Yes*	No	10
3	West Bengal	Hilsa Sanctuary	West Bengal inland Fisheries Rules, 1985 to facilitate spawning of Hilsa fish only	*No*	No	10

Note: ESZ have not been notified for above sanctuaries hence default area of 10 km from the boundary of sanctuary is considered as the Eco-sensitive zone (ESZ)

The area of the midsection of the Ganga River, between Ramnagar Fort to Malviya Rail/Road Bridge (Raj Ghat Bridge) measuring around 7-km area is declared as the Turtle Wild Life Sanctuary under the State Administration Forests Act, Section-3, Part-4170/14-3-62 dated 21-12-1989. Along with the turtles, incidentally the other species of aquatic bio-

diversity inhabiting this stretches also protected. The Sanctuary also forms the part of Ganga Action Plan. Location of Kashi Turtle sanctuary in NW-1 is shown at **Figure 4.36**.

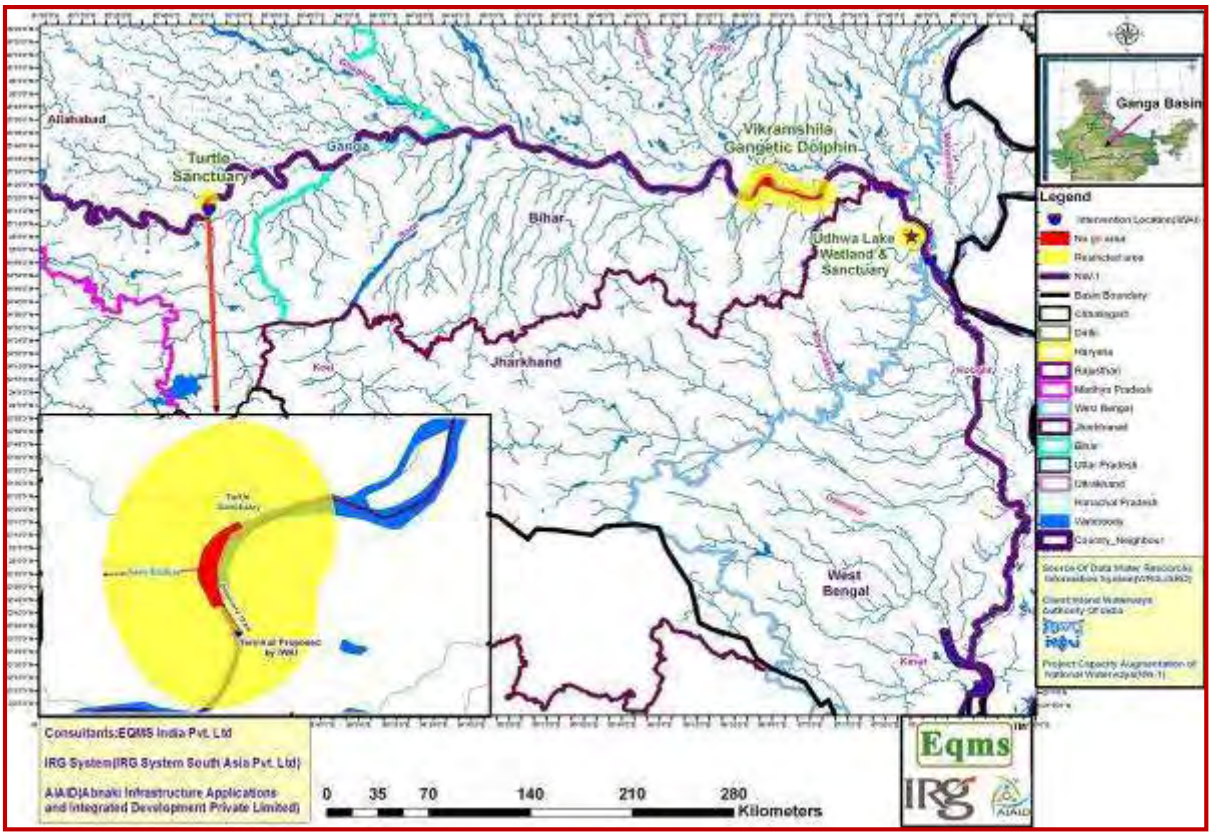


Figure 4.36 : Location of Kashi Turtle Sanctuary in NW-1

Throughout the sanctuary many religious Ghats are located on the banks of Ganga river which are used for Bathing, boating and cremation purposes. Fishing activity and sand mining in sanctuary area is completely prohibited. Biological resource of the sanctuary primarily comprises of Turtle and fishes.

Turtle: As reported in literature freshwater turtles are major biodiversity components of the aquatic ecosystem, often serves keystone species benefiting other animals and plants. They participate in the web of interacting and co-dependent species that constitute a healthy functioning of ecosystem. In Kashi Turtle Sanctuary mainly Aspederites Gangetic (self-shell turtles), Geoclamis, Hamiltonai, ChitraIndica and Lasimous which are carnivorous species and hard shelled herbivorous tortoise- PechraKachhua, SundriKachhua, Tentoria Kachhua, Tongoka are in abundance. The list of Turtle species with their IUCN threatened status is provided in following **Table 4.33.** A tortoise breeding centre is also set up at Sarnath to propagate its population where tortoise (both herbivores and Carnivores) are hatched and reared for one to two year and then are left into Kashi Turtle sanctuary.

Table 4.33 : Turtle species in Sanctuary Area

S.N	Common name	Species	IUCN Classification

1	Self-shell turtle	*Aspederitesgangeticus*	Vulnerable
2	Indian flap shell turtle	Lissemyspunctata	Low risk
3	Narrow headed soft shell turtle	*Chitraindica*	Endangered
4	Spotted pond turtle	*Geoclemyshamiltonii*	Vulnerable
5	Crowned river turtle	*Hardellathurjii*	Vulnerable
6	Indian roofed turtle	*Pangshura tecta*	Lower risk
7	Indian tent turtle	*Pangshura tentoria*	Lower risk
8	Tongoka	*Balagurdhongoka*	Endangered

The right bank of the turtle sanctuary provides a perfect habitat for turtle to breed. However, during the site visit, no such nesting and breeding sites were observed in KTS as well as in Varanasi area.

Fishes:. In sanctuary area major carps like, Rohu (Labeorohita) mrigal (cirrhinusmrigala), katla(catlacatla), kalbasu (labeocalbasu), and cat fishes like padhan (wallagoattu)) tengras (Mystusteengara,) and Magur (Clariasbatrachus), Singhi (Heteropneutesfossilis), Tilapia (Oreocromissps.), Kavai (Anabas testudineus), Mahfish (Barbussps) are present.

A. Vikramshila Dolphin Sanctuary, Bihar

Vikramshila Gangetic Dolphin Sanctuary (VGDS) has been notified on 7th August,1991as Wildlife Sanctuary under Wildlife Protection Act, 1972 for the protection of Dolphin[32].which is categorized as endangered species on the IUCN Red List. VGDS is the only riverine protected area for conservation of Gangetic Dolphin in the eastern Gangetic Plain. The sanctuary includes middle of Ganges between Sultanganj and Kahalgaon Hills (25.254°N to 25.282°N[33]and 86.738°E to 87.229°E)- in Bhagalpur district-. 10 km area around VGDS is the default Eco Sensitive Zone at present. The proposed nearest Terminal at Sahibganj is located about 48 km from VGDS. The location of VGDS in NW-1 and proposed terminal at Sahibganj is shown in **Figure 4.37.**

[32]This species has been included in Schedule- Iof the Indian Wildlife (Protection) Act 1972,Appendix I of the Convention onInternational Trade in Endangered Species(CITES), Appendix II of the Conventionon Migratory Species (CMS) and IUCN red list as endangered species.

[33] The coordinates printed in the notification of the Sanctuary falls outside the Ganga river . Coordinates shown here are as per report published by WWF and corresponding to actual situation on ground. However starting and ending locations name are as per the notification.

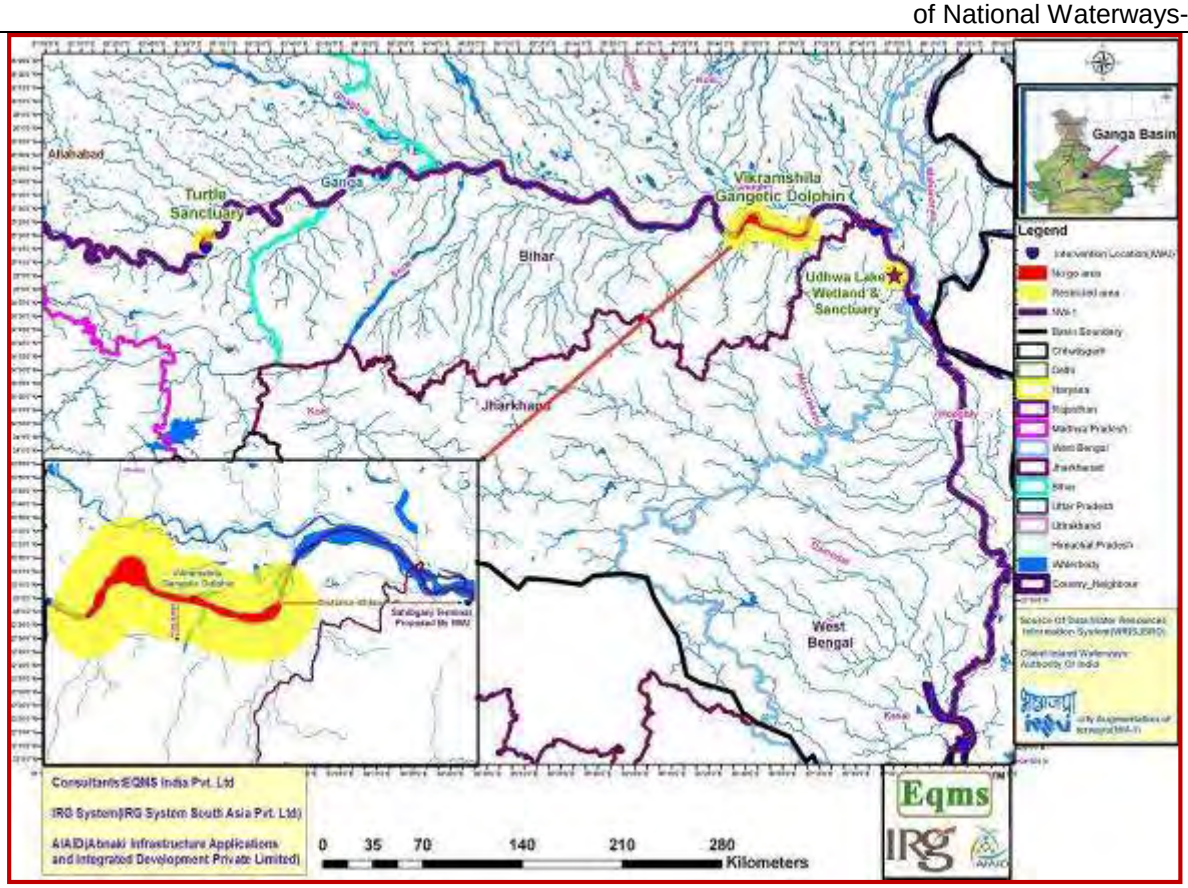


Figure 4.37 : Location of VGDS in NW-1

Various aquatic species of flora and fauna are found in Vikramshila Gangetic Dolphin Sanctuary. Besides Dolphins, other species of freshwater shrimps, fish and crustaceans can be observed. The area of the sanctuary is also an important bird area and the species such as the Greater Adjutant (Leptoptilos dubius) and Lesser Adjutant (L. javanicus) are present. Other storks present are the Ciconia nigra, Black-necked strok (Ephippiorhynchus asiaticus), White-necked (Ciconia episcopus), and the Asian Openbill (Anastomus oscitans). The Sanctuary is rich in waders. Common Crane (Grus grus), Eurasian Spoonbill (Platalea leucorodia) and various ducks are also seen here. The major carps like, Rohu (Labeorohita) mrigal (cirrhinusmrigala), katla(catlacatla), kalbasu (labeocalbasu), and cat fishes like padhan (wallagoattu)) tengras (Mystusteengara,) and Magur (Clariasbatrachus), Singhi (Heteropneutesfossilis), Tilapia (Oreocromissps.), Kavai (Anabas testudineus), Mahfish (Barbussps) etc. are present in the sanctuary area.

B. Hilsa Sanctuary

Hilsa (Tenualosa ilisha) is assessed as Least Concern species as per IUCN's threatened category (version 3.1) but its population is declining due to over fishing and fragmentation of migratory routes along Farakka barrage. This sanctuary is notified[34] mainly with objective of enhancing Hilsa production. In order to facilitate spawning, all types of fish catching are banned in the Hilsa Sanctuaries during June to August and October to December every year in Hilsa Sanctuary areas (Refer **Table 4.34** and **Figure 4.38)**. Fishing of Hilsa is prohibited within 5 square kilometre of the Farakka Barrage (the notified sanctuary area) round the year to protect the Hilsa species and facilitate breeding and spawning in this area.

[34]Notification of Fisheries Department, Government of West Bengal dated Tuesday, April 09, 2013 published in The Kolkata Gazette. The Hilas Sanctuary Is not notified under Wild Life (Protection) Act and as such does not attract any provision of this act.

Table 4.34 : Location of the Hilsa Sanctuary and their stretch

Sr. No.	Location of the Hilsa Sanctuaries and their stretches
1	Diamond Harbour to Nishchintapur Godakhali
2	Katwa to Hooghly Ghat, part of Burdwan and Hooghly District)
3	Between Lalbagh in Farakka, Murshidabad district
4	5 square kilometres area around Farakka Barrage

Salinity is a critical chemical factor in governing the faunal distribution in this zone. The important families are Catla, Labeo rohita, L. calbasu, L. bata, Cirrhinus mrigala, C. reba, Puntius ticto, P. conchonius, P. sarana, P. sophore, Salmostoma bacaila, Danio devario, Brachygobius nunus, Glossogobius giuris, Pseudapocryptus lanceolatus, Stigmatogobius sadanundio, Periopthalmadon schlosseri, Boleophthalmus dussumiere,Gobioptrus chuno, Bathygobins orbicularis,Tenulosa ilisha, Hilsa kelee, Coilia dussumieri, C. ramcorti, C.reynalidy, Setipinna phasa, S. taty, Liza parsia, L. tade, L. macrolepis, Mugil cephalus, Ailia coila, and Eutropiichthys vacha.

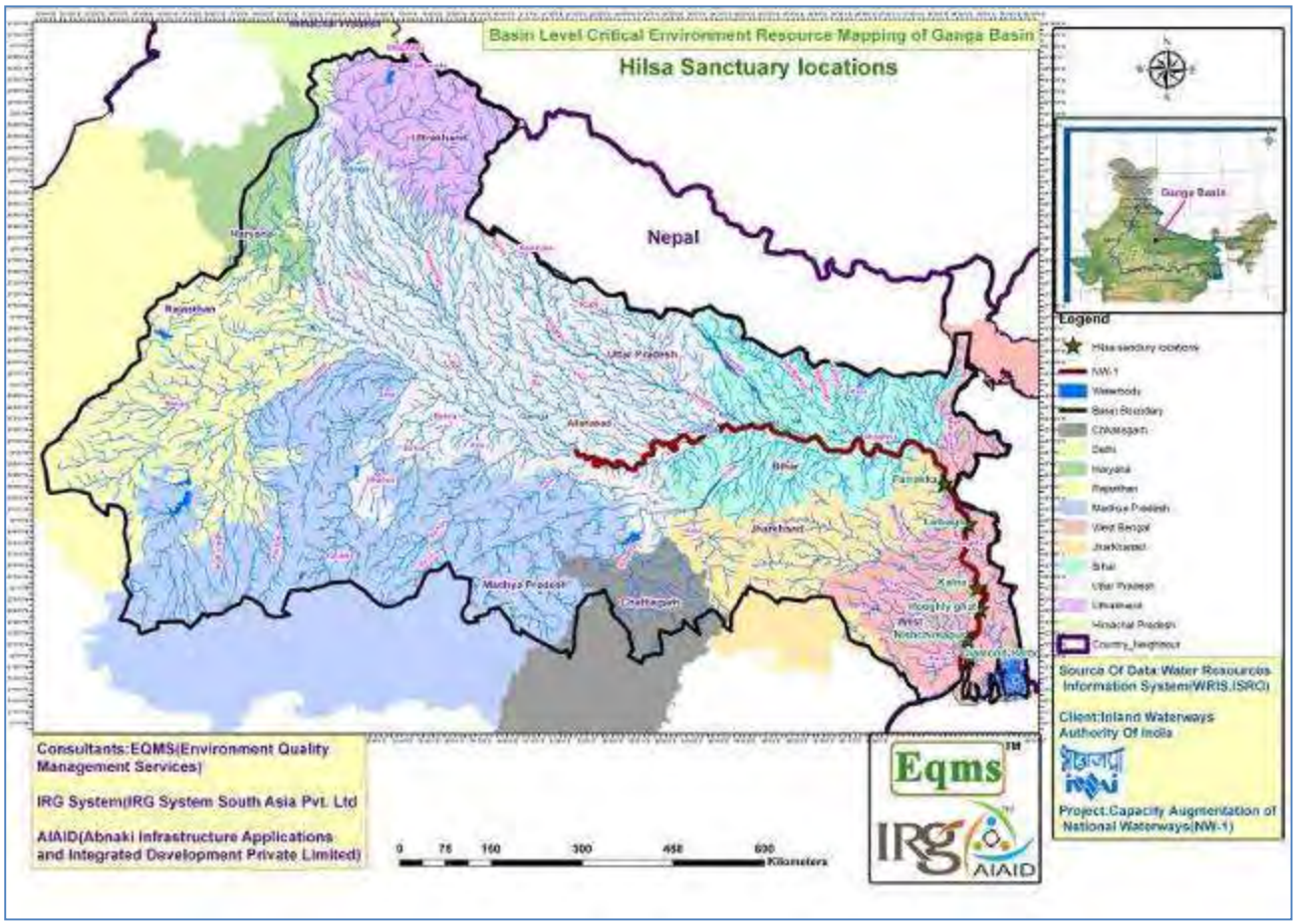


Figure 4.38 : Location of Hilsa Sanctuaries in NW-1

4.7.3.2 Important Bird Area within 10 km area of the NW-1

Seven Important Bird Areas (IBAs)[35] have been identified along NW-1 stretch because they support important congregations of water birds (**Table 4.35**). None of these area is

[35] These IBAs have been identified by Bird Life International under itsBirdLife Important Bird and Biodiversity Area (IBA) Programme

protected except Vikramshila Gangetic Dolphin Sanctuary and Udhwa Lake Bird Sanctuary areas.

Table 4.35 : Important Bird Area within 10 km area of the NW-1

	Name of State	Important Bird Area in Ganga Basin	Coordinates	Protection status	Migration period for Birds	Distance from NW-1 (km)
1	Bihar	Danapur cantonment area	25°39'N 85°02'E	Officially Not protected	Winter	2 km S
2		Kurseala River Course and Diyara Flood Plains	25°27'N 87°15'E	Officially Not protected	Winter	2 km E along NW-1
3		Mokama Taal (Barah) Wetlands	25°28'N 85°42'E	Officially Not protected	Winter	Close to NW-1
4		Vikramshila Gangetic Dolphin Sanctuary Bird area	25°17'N 86°56'E	Officially Not protected	Winter	Within NW-1
5	Jharkhand	Udhwa Lake Bird Sanctuary	25°0'N 87°49'E	Protected as Sanctuary	Winter	9 km W
6	West Bengal	Farakka Barrage and adjoining area	24°48' to 14.05"N, 87°55' to 44.28"E	Officially Not protected	Winter	Surrounding NW-1

Danapur Cantonment Area: is located about 2 km south of the course of NW-1 (River Ganga) in Danapur cantonment area and named as Sainik Pakshi Vihar. It is considered as an IBA because more than 10,000 Asian Open bill Anastomus oscitans breed here. The birds rest and nest in the Army campus. These birds use adjacent water logged and cultivated areas as its feeding ground. Important trees found in the area and used by these birds for nesting are Mangifera indica, Ficus religiosa, F. bengalensis, F. glomerata, Acacia nilotica, Syzygium cumini, Tamarindus indica, Acanthocephalus indicus and Dalbergia sissoo. The globally threatened Lesser Kestrel Falco naumanni is also reported from the area (Arvind Mishra pers. comm. 2003). Other birds seen are cormorants, egrets, bulbuls, owls, and raptors.

Kurseala River Course and Diyara Flood Plains: Kurseala lies at the confluence of the Ganga and Koshi rivers. A stretch of about 16 km and 2,20,000 ha area has been designated as IBA from Naugachhia to Kursela on the national highway NH-8 in state of Bihar. It extends from Diyara floodplain from Naugachhia to Kurseala on its southern side till the margin of River Ganga. Globally threatened species that frequent this IBA are Oriental White-backed vulture (Gyps bengalensis), Lesser Adjutant, Leptoptilos javanicus, Pallas's Fish Eagle (Haliaeetus leucoryphus) and Lesser Kestrel (Falco naumanni). Six Greater Adjutants Leptoptilos dubiuswere seen by the Kursi River near Kurseala in April 1988 (Rahmani et al. 1990).

Mokama Taal (Barah) Wetlands: Mokama Taal wetlands cover more than 1,000 ha of shallow water bodies, situated in Patna, Samastipur and Begusarai districts of Bihar. Mokama tal bird area is located along the NW-1. Mokama Taal exhibits enormous

biodiversity. Kawar (Kabar) Lake, another IBA site is close to Mokama, and when the birds get disturbed at Kawar they fly to Mokama. About 149 species and over 20,000 breeding and migratory water birds reportedly are found in this IBA. The Black Ibis (Pseudibis papillosa), Glossy Ibis (Plegadis falcinellus), Eurasian Spoonbill (Platalea leucorodia), Greylag Goose (Anser anser) and Barheaded Goose (A. indicus) are some of the species reported from the area. Ten globally threatened and Near Threatened species are also found here.

Vikramshila Dolphin Sanctuary area: Vikramshila Gangetic Dolphin Sanctuary located within the NW-1 is also identified at an important IBA. There are many small sandbars inhabited by birds. They serve as breeding grounds for many birds, especially the section from Sultanganj to Bhagalpur, a 36 km stretch, which seems to be a paradise for birds and other aquatic animals. During monsoon, the river inundates a vast floodplain which serves as additional shallow water ground for birds. This is considered as important IBA because of presence of hundreds of Indian Skimmers (Ranchos albicollis). Globally threatened species such as the Greater Adjutant (Leptoptilos dubius) and Lesser Adjutant (L. javanicus). Other storks present are the Ciconia nigra, Black-necked strok (Ephippiorhynchus asiaticus), White-necked (Ciconia episcopus), and the Asian Openbill (Anastomus oscitans). The Sanctuary is rich in waders. Common Crane (Grus grus), Eurasian Spoonbill (Platalea leucorodia) and various ducks are also seen here.

Udhwa Lake Bird Sanctuary: Udhuwa lake Bird Sanctuary is located along NW-1 at about 9 km southeast of Rajmahal in Jharkhand State. Two water bodies, namely Pataura and Barhale constitute the 5.65 km2 of Udhuwa lake bird sanctuary. Pataura Lake is perennial and the average depth is about 2 meter. Total area of the sanctuary is 1605 ha and coordinates of the lake is 87° 48' 55.500" E, 24° 58' 6.400" N. Location Map of Udhwa Lake Sanctuary and photographs are shown at **Figure 4.39** and **Figure 4.40**.

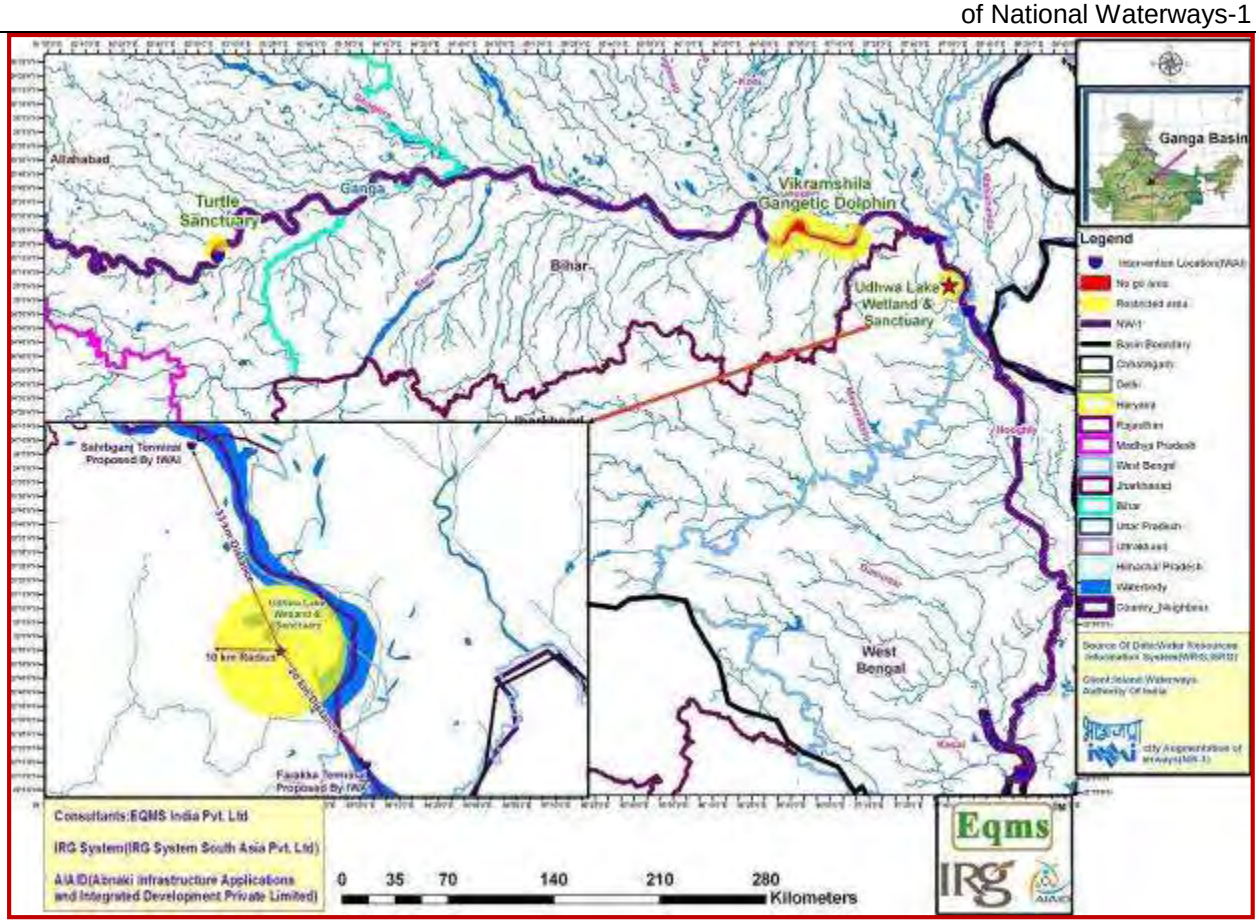


Figure 4.39 : Location of Udhwa Bird Sanctuaries

Figure 4.40 : Photographs of Udhwa Lake Sanctuary

Many migratory birds come to this sanctuary every winter from several parts of the world, including Siberia and Europe. The main birds include the pratincole, egret, wagtail, plover, lapwing, stork, ibis and heron. It is a home to a variety of birds including different mynas, brahminy kites, Cattel Egret, Pond Heron, Purple Heron, Egret, Open Billed stock, White Ibis, Dab chick or little Grebe, fishing eagles, hose swifts and palm swifts flying at dizzying speeds (Refers **Table 4.36**). Complete list of birds visiting the Udhwa lake and surroundings with their conservation status is highlighted in Table 4.34. The lake is infested with aquatic macrophytes comprising emergent, free floating and submerged forms. Water hyacinth was found to be the dominant form. Over all 50% of

the lake surface was covered with aquatic weeds. Udhwa lake is also rich in fish and fish spawn. Some common fishes of the lake are Rohu(Labeo rohita), Catla (Catla catla), Tengra, (Mystus cavasius) Bata (L. bata), reba (C. retra), and Mirka (Cirrihinus mrigala).

Table 4.36 : List of the Birds Visiting Udhwa Lake sanctuary

S. No.	Hindi Name	English Name	Scientific Name	Habitat	IUCN status
1	Pandubbi	Dab Chick of little grebe	*Tachybaptus ruficollis*	R	LC
2	Pankauba	Little cormorant	*Microcarbo niger*	R	LC
3	Pankauba	Large cormorant	*Phalacrocorax carbo*	R	LC
4	Bambi	Snake- bird Darter	Plotus anhinga	R	LC
5	Bagula	Little Egret	*Egretta garzetta*	R	LC
6	Bagula	Median Egret	*Mesophoyx intermedia*	R	
7	Bada Bagula	Large Egret	*Ardea alba*	R	LC
8	Gay Bagula	Cattle Egret	*Bubulcus ibis*	R	LC
9	Andha Bagula	Pond Heron	*Ardeola grayii*	R	LC
10	Anjan	Grey Heron	*Ardea cinerea*	R	LC
11	Ghoghil	Open- billed stork	*Anastomus oscitans*	R,LM	LC
12	Lalag	White-necked stork	*Ciconia episcopus*	R,LM	VU
13	Garud	Lesser adjutant	*Leptoptilos javanicus*	R,LM	VU
14	Girja Billi	Blanck Ibis	*Pseudibis papillosa*	LM	LC
15	Silli	Cotton Teal	*Nettapus coromandelianus*	LM	LC
16	Malki	Gadwall	*Anas strepera*	M	LC
17	Chhoti Lalsar	Wigeon	*Anas americana*	M	LC
18	Chaita	Garganey	*Anas querquedula*	M	LC
19	Tidari	Shoveller	*Anas clypeata*	M	LC
20	Nilsar	Mallard	*Anas platyrhynchos*	M	LC
21	Lalsar	Red- crested pochard	*Netta rufina*	M	LC
22	Giddha	Bengal vulture	*Gyps bengalensis*	R	CR
23	Karan	Purple Moorhen	*Porphyrio coeruleus*	R,LM	LC
24	Sagyar	Coot	*Fulica alai*	R,LM	VU
25	Kaltoyi	Bronze Winged Jacana	*Metopidius indicus*	R	LC
26	Tithari	Lapwing	*Vanellus armatus*	M	LC
27	Chaha	Fantail Snipe	*Gallinago gallinago*	M	LC
28	Tehri	Indian River Tern	*Sterna aurantia*	M	NT
29	Panduk	Ring Dove	*Streptopelia capicola*	R,M	LC
30	Hariyal	Bengal Green Pigeon	*Treron phoenicoptera*	R	LC
31	Kabutar	Blue Rock Pigeon	*Columba livia*	R	LC
32	Kilkila	Pied kingfisher	*Ceryle rudis*	R	LC
33	Kilkila	White breads kingfisher	*Alcedo atthis*	R	LC
34	Chhota Kilkila	Small blue kingfisher	*Alcedo atthis*	R	LC
35	Patinga	Small Green Bee-eater	*Merops orientalis*	R	LC
36	Nilkantha	Indian Roller, Blue Jay	*Coracias benghalensis*	R	LC
37	Bara	Bee-eater	*Merops leschenaulti*	R,LM	LC
38	Hud-hud	Hoopoe	*Upupa epops*	R	LC
39	Koel	Koel	Eudynamys	R	LC
40	Khanjan	Largepled wagtail	*Motacilla maderaspatensis*	M	LC
41	Charchari	Indian pipit	*Anthus rufulus*	R	LC
42	Mahalat	Indian Tree pie	*Dendrocitta vagabunda*	R	LC
43	Bulbul	Red-vented Bulbul	*Pycnonotus cafer*	R	LC
44	Kachbachiya	Common Babbler	*Turdoides caudata*	R	LC
45	Nilkanthi	Bluethroat	*Luscinia svecica*	M	LC
46	Baya	Weaver Bird	Ploceidae	R,LM	LC

R- Resident, M-migratory, LM –Local Migratory
IUCN Status: LC- Least Concerned, CR- Critical, NT-Near threatened, VU-Vulnerable

Farakka Barrage and adjoining area: The Farakka Barrage and adjoining area on Ganges River is a major wintering site for many of migratory water birds and has been designated as an Important Bird Area (IBA) It is located close to the NW-1. Some of the rarer visitors to this IBA are Ythya baeri (Baer's Pochard), Aythya fuligula (Tufted Duck), Dendrocygna bicolor (Fulvous Whistling-Duck), Gyps bengalensis (White-rumped Vulture), Gyps indicus (Indian Vulture), Leptoptilos javanicus (Lesser Adjutant) and Rynchops albicollis (Indian Skimmer).

4.7.4. *Terrestrial biodiversity along NW-1 stretch of River Ganga*

Terrestrial Biodiversity describing riparian flora of the Ganga for NW-1 has been presented for Allahabad to Farakka and Berhampur to Haldia stretches separately to give over view of change in biodiversity between different geographical area.

In Uttar Pradesh, Allahabad to Gazipur area is relatively sparsely occupied with variety of trees which are equally well present up to Farakka belt. However, the density of flora is relatively thin in U.P. & Bihar areas as compared to Jharkhand and West Bengal region. The Allahabad to Balia region comprises about41 varieties of macrophytes in which some species like *Ruellia prostrata*, Amaranthus *spinosus*, Calotropis *procera* and Polygonum *plebeium* are present along the bank of river. Tree cover is formed by the Sal (*Shorea robusta*), Teak (*Tectona grandis*), Sheesham (*Dalbergia sissoo*), Mango (*Mangifera indica*), Neem (*Tamarindus indica*), Banyan (*Ficus* sp.), Peepal (*Ficus religiosa*), Jamun (*Syzygium cumini*), Mahua (*Madhuca longifolia*) and Semal (*Bombax ceiba*).

The riparian flora in Bihar, region is comprising of 7 shrubs species, 41 herbs species, 6 grasses and sedges species, besides these a number of tree species along the banks of river is reported. The tree species in the stretch is mainly composed of Shorea robusta, Diospyros melanoxylon, Boswellia serrata, Dalbergia sisoo, Tamarindus indica Terminalia tomentosa, Terminalia bellirica, Terminalia arjuna, Pterocarpus marsupium, and Madhuca indica.23 families comprising of 48 species in Diara land of Ganga and its tributaries are reported. The important species of this land are Justicia peploides, Rauwolfia serpentina, Eclipta prostrata, Leucas aspera, Desmodium gangeticum, Lippia javanica and Scoparia dulcis.

Farakka to Haldia: The climatic condition of this region is humid, subtropical, and tropical. Humidity is less near Farakka as compared to Haldia. Farakka to Nawadip the riparian flora is similar as in Bihar stretch since it is freshwater flora zone. After Nawadip the salinity increase in river water due to estuarine affect the change in riparian flora is noticed. From Bally to Bandel about 32 species of macrophtes have been reported which includes 7 species of Asteraceae, 4 species of Euphorbiaceae, 2 of Amaranthaceae and 3 of Cyperaceae, 2 of Polygonaceae and 1 of Poaceae. Tree species is mainly comprising of Semal (Bombax ceiba), Mango (Mangifera indica), Peepal (Ficus religiosa), Neem (Tamarindus indica), Jackfruit (Artocarpus heterophyllus) and Pakur (Ficus lacor).Other Macrophytes comprises of Adhatoda zeylanica, Barleria prionitis, B. cristata, Dipteracanthus prostratus, Hygrophila auriculata, Achyranthes aspera, Alternanthera pungens, A. sessilis, Amaranthus spp, Chenopodium album, Centella asiatica, Rauvolfia serpentine, Calotropis procera, Leptadenia reticulate, Asparagus spp., Oroxylum indicum, Cannabis sativa, Cyperus rotundus, Hydrilla verticillata, Marselia minuta. From Bendel to Haldia

The tree species is mainly comprised of Semal (Bombax ceiba), Mango (Magnifera indica), Peepal (Ficus religiosa), Neem (Tamarindus indica), Jackfruit (Artocarpus heterophyllus) and Pakur (Ficus lacor). Other macrophytes (aquatic and semi aquatic) is Alternanthera philoxeoroides, Amaranthus spinosus, Blumea lacera, Eclipta alba, Grangea maderaspatana, Tridax procumbens, Veronia cinerea, Xanthium strumarium, Nasturtium indicum, Chenopodium indicum, Juncellus sp., Cyperus sp., Sida rhombifolia, Chrozophora plicata, Croton bonpandianum, Boerhavia repens, Polygonum sp and Chrozophora plicata species. The list of riparian flora observed during study along NW-1 stretch is given in **Annexure 4.1**.

4.7.4.1.1 ***Aquatic Biodiversity in NW-1***

The Allahabad to Farakka segment of River Ganga (LG-A) comprises a fresh water zone of 701 km. The floral and faunal diversity comprises phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher vertebrates. As per the secondary source[36] the Phytoplankton in Ganga river from Allahabad to Farakka segment is represented by total of 270 taxa (91 sp. of Chlorophyceae, 81 sp. of Bacillariophyceae, 78 sp. of Cyanophyceae, 8 sp. of Euglenophyceae, 3 sp. of Chrysophyceae, 3 sp. of Xanthophyceae, 2 sp. of Dinophyceae, 2 sp. of Rhodophyceae, 1 sp. of Cryptophyceae, 1 sp. of Synurophyceae). Zooplankton comprises of Protozoans (8 sp.), Rotifers (26 sp.) and Crustaceans (5 sp. of Copepods and 13 sp. of Cladocerans). In this stretch all groups are represented though are low in specific composition. The stretch supports the zoobenthos i.e. Insects (43%), Annelids (21%) and Molluscs (36%). Nematodes are also reported in the stretch. Fish in the stretch is represented by total of 121 species belonging to 35 families. Thirty-five commercially important fishes are included in the taxa along with six invasive species. Beside the preponderance of fish species in this zone, an aquatic mammal, Gangetic dolphinis also present in the Bihar stretch.

286 km of stretch of Lower Ganga downstream of Farakka up to Haldiaconsist of Phytoplankton, Zooplankton, Macrobenthos, Nekton, Macrofauna. As per the secondary data analysis Phytoplankton distribution in this stretch is represented by 641 algal species (Cyanophyceae 280 taxa; Chlorophyceae 206 taxa; Bacillariophyceae 115 taxa; Rhodophyceae 17 taxa; Dinophyceae 14 taxa; Xanthophyceae 4 taxa; Euglenophyceae 3 taxa; Phaeophyceae 2 taxa) under 169 genera. The dominant algal species in lower Ganga is Cyanophyceae followed by Chlorophyceae. The zooplankton communities in lower Ganga basin are represented by members of Cnidaria (25 taxa), Rotifera (102 taxa), Copepod (26 taxa), Cladocerans (53 taxa) and larval forms of Decapods and Cyclopods. Macrobenthos and Macro-invertebrates constitute Annelida (90 taxa), Arthropoda (Total 476 taxa;240 species of Crustaceans, 33 species of Arachnids, 201 species of insects and 2 species of Merostomata), Mollusca (Total 68 taxa) and Echinodermata (17 taxa). The Ichthyo-fauna is represented by 175 species, out of which 103 species, under 69 genera and 37 families are strictly estuarine in nature.

Primary Data analysis:

Water quality parameters such as temperature, pH, turbidity, transparency etc. influence the aquatic ecosystem. There are several aquatic floral species present in the riparian zone and in aquatic habitat along the whole NW-1 stretch. Detailed survey for aquatic flora and fauna (Phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher

[36] Status of Heigher Aquatic Vertebrates in the Ganga River GRB EMP: Ganga River Basin Environmment Management Plan by Consotorium of 7 Indian Institute of Technology.

vertebrates) were conducted during June 2015 to September 2015 along the NW-1. Phytoplankton/zoolplanktons, benthos and fish sampling was done at different location along the NW-1 stretch. The floral and faunal diversity comprises phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher vertebrates. In Ganga river from Allahabad to Haldia, NW-1 segment total of 90 taxa (28 sp. of Chlorophyceae, 39 sp. of Bacillariophyceae, 11 sp. of Cyanophyceae, 5 sp. of Euglenophyceae, 5 sp. of Rhodophyceae were observed. Bacillariphyceae (diatoms) dominated having maximum abundance as compared to cholophyceae and cyanophyceae The Zooplankton comprises of Protozoans (11 sp.), Rotifers (10 sp.), and Crustaceans (3 sp. of Copepods and 7 sp. of Cladocerans) were observed during study period. Habitat for Benthos in the river is aphotic zone or benthic zone. Aphotic zone of the aquatic ecosystem is zone where sunlight is completely absent. These are depending on sediments and they take the nutrients for their survival from sediments. The soil samples for benthos were collected from the sediment throughout the NW-1 stretch. The most common Benthos observed in Ganga River were Gabbia sp. Bellamya sp. Lymnaeasp, Belostomaindica and Cybister confuses. The higher aquatic vertebrates observed in this stretch during study period are represented by turtles and dolphins. The Ichthyo-fauna is represented by 106 species, out of which 103 species belonging to family Balilooridae, Siluridae, Cyrinidea, Channidaea, Cobitidaea, Osplronemidae and Nandidae.

The higher aquatic vertebrates present in NW-1 stretch (Allahabad to Haldia area are only Gangetic dolphin (Platanista gangetica gangetica) and turtle species. However, the population dynamics vary for this beautiful mammalian species at different locations. The avifauna observed along NW-1 stretch is discussed in earlier sections. List of flora and fauna observed in NW-1 Stretch (Allahabad to Haldia) is given in **Annexure-4.1**.

4.7.4.1.2 Phytoplanktons & Zoplanktons Observed in Sanctuary Area along NW-1

Aquatic biodiversity depends on quality of water and nutrients present in the water. The variety of zooplankton in any aquatic system reflects the primary productivity status of the system. However, the population of phytoplankton's in riverine system is a sort of moving crop. The phytoplankton basically originate in shallow water levels of low velocity, in streams, pools and zones of shallow meandering of rivers. The submerged aquatic vegetation along riparian areas developed due to accumulation of soil in the course of river serves as good feeding grounds for fishes and their juveniles and zooplanktons. The site observations and literature review shows that the ganga river system has a rich diversity of both types of plantons i.e. phyto-plankton and the Zooplankton, though the diversity varies on account of local anthropogenic impacts from station to station. The diversity of planktons is slightly high in Hilsa Sanctuary than Kashi sanctuary and Vikramshila dolphin sanctuary areas. The list of phytoplankton and zooplanktons, observed in Kashi Turtle sanctuary, Vikramshila Dolphin Sanctuary and Hilsa Sanctuary areas along NW-1 is given in **Table-4.37** and **Table 4.38**.

Table 4.37 : Phytoplankton observed at Sanctuary Area along NW-1

S.N.	***Taxa***	**Kashi Turtle Sanctuary Area**	**Dolphin Sanctuary Area**	**Hilsa Sanctuary area**
Phytoplankton				
Bacillariophyceae				

1.	*Amphora sp.*	+	+	+
2.	*Amphipleura*	+	+	+
3.	*Achnanthes sp.*	-	+	+
4.	*Asterionella sp.*	+	+	+
5.	*Bacillaria sp.*	-	+	+
6.	*Biddulphia sp.*	+	+	+
7.	*Brebissonia sp.*	-	+	+
8.	*Caloneis sp.*	+	+	+
9.	*Ceratoneis sp.*	-	+	+
10.	*Coconeis sp.*	-	-	+
11.	*Chaetoceros sp.*	+	+	+
12.	*Cosinodiscus sp.*	-	+	+
13.	*Cyclotella sp.*	+	-	+
14.	*Cymatopleura sp.*	-	+	+
15.	*Cymbella sp.*	+	+	+
16.	*Diatoma sp.*	+	+	+
17.	*Diatomella sp.*	-	+	+
18.	*Epithelmia sp.*	-	+	+
19.	*Fragilaria sp.*	+	+	+
20.	*Frustulia sp.*	+	-	+
21.	*Gomphoneis sp.*	-	+	+
22.	*Gyrosigma sp.*	+	+	+
23.	*Hantzchia sp.*	-	+	+
24.	*Melosira sp.*	+	+	+
25.	*Meridian sp.*	-	+	+
26.	*Navicula sp.*	+	+	+
27.	*Nedium sp.*	-	+	+
28.	*Pinnularia sp.*	+	-	+
29.	*Pleurosigma sp.*	+	+	+
30.	*Rhicosphenia sp.*	-	+	+
31.	*Stephanodiscus sp.*	-	+	+
32.	*Surirella sp.*	-	+	+
33.	*Tabellariasp*	-	+	+
34.	*Tetracylus sp.*	+	-	+
Chlorophyceae				
35.	*Actinastrum sp.*	+	+	+
36.	*Chlamydomonas sp.*	-	+	+
37.	*Chlorella* sp	+	+	+
38.	*Chlorococium sp.*	-	+	+
39.	*Cladophora sp.*	+	+	+
40.	*Closterium sp.*	+	+	+
41.	*Coelastrum sp.*	+	+	+
42.	*Conococcus sp.*	+	-	+
43.	*Cosmarium sp.*	_	+	+
44.	*Desmidium sp.*	-	+	+
45.	*Eudorina sp.*	+	+	+
46.	*Gonatozygon sp.*	-	+	+

47.	*Gonium* sp	+	+	+
48.	*Hormidium*sp	+	+	+
49.	*Hydrodictyon sp.*	-	+	+
50.	*Microspora sp*	+	+	+
51.	*Oedogonium sp.*	+	+	+
52.	*Pandorina sp.*	+	+	+
53.	*Pediastrum sp.*	+	+	+
54.	*Spirogyra sp.*	+	+	+
55.	*Tetraspora sp.*	-	-	+
56.	*Ulothrix sp.*	+	+	+
57.	*Zygnema sp*	-	+	+
58.	*Debarya*sp	-	+	+
59.	*Mesotaenium*sp	-	+	+
60.	*Stigecloniumsp*	-	+	+
61.	*Tetradesmus*sp	-	-	+
62.	*Rhizocloniumsp*	-	+	+
Cyanophyceae				
63.	*Spirulina sp*	+	+	+
64.	*Rivularia sp.*	+	+	+
65.	*Schizothrix sp.*	+	+	+
66.	*Phormidium sp.*	+	+	+
67.	*Oscillatoria sp.*	-	+	+
68.	*Anabaena* sp .	+	-	+
69.	*Calothrix sp.*	+	+	+
Xanthophyceae				
70.	Bumillaria sp.	+	+	+
71.	Chlorobotrys sp.	+	+	+
72.	Tribonema sp.	-	-	+
73.	T. bombycinum	-	+	+
74.	Voucheria sp.	-	-	+
Euglenophyceae				
75.	Astasis sp.	+	+	+
76.	Euglena sp.	+	+	+
77.	Peronia sp.	+	+	+
78.	Phacus sp.	+	+	+
Rhodophyceae				
79.	*Bostrychia radicans*	-	-	+
80.	*Catenella impudica*	-	+	+
81.	*Ceramium elegans*	-	-	+

Table 4.38 : Zooplanktons observed at Sanctuary Area along NW-1

Zooplankton Group/Species	**Kashi Turtle Sanctuary Area**	**Dolphin Sanctuary Area**	**Hilsa Sanctuary area**
Protozoa			

1.	*Arcella sp*.	+	+	+
2.	*Chilodonella*sp.	+	+	+
3.	*Difflugiia*sp.	+	+	+
4.	*Globigerina* sp.	+	+	+
5.	*Holophrya*sp.	+	+	+
6.	*Noctiluca*sp.	+	+	+
7.	*Paramecium* sp.	-	+	+
8.	*Spathidium*sp.	+	+	+
9.	*Sphenoderia*sp	+	+	-
10.	*Tintinnopsis*sp.	+	-	+
11.	*Vorticella* sp	-	+	+
	Rotifera			
12.	*Anura*sp.	+	+	+
13.	*Asplanchna* sp.	+	+	+
14.	*Brachionus* sp.	+	+	+
15.	*Filinia* sp.	+	+	+
16.	*Horaella* sp.	+	+	+
17.	*Keratella* sp .	+	+	+
18.	*Lecane* sp.	-	+	+
19.	*Notholca* sp.	+	+	-
20.	*Rotaria* sp.	+	+	+
21.	*Testudinella sp*	-	+	+
	Copepoda			
22.	*Cyclops sp.*	+	+	+
23.	*Diaptomus*	+	+	+
24.	*Nauplii*	-	+	+
	Cladocera			
25.	*Bosmina* sp	+	+	+
26.	*Ceriodaphnia* sp.	+	-	+
27.	*Cydorus* sp.	+	+	-
28.	*Daphnia* sp.	-	+	+
29.	*Diphanosoma* sp.	-	+	+
30.	*Moina* sp	-	+	+
31.	*Simocephalus* sp	+	+	+

Phytoplankton group reported from the above sampled locations are Basillariophyceae, Chlorophyceae, Cyanophyceae, Xanthophyceae and Euglenophyceae members. Dominance of Bacillariophyceae members followed by Chrophyceae and Cyanophyceae was observed in studied sampling locations. However, the diversity of the phytoplankton group is high in Hilsa sanctuary area followed by Dolphin Sanctuary and Kashi sanctuary area. Among the zooplankton group, Brachionoussps. (Rotifera) had highest percentage composition and the lowest percentage composition was of Asplanchana sps.

4.7.4.1.3 Breeding and Spawning

Fish Breeding and Spawning: Generally, fish breeding and spawning is most frequent in monsoon season (July to September). Therefore, field studies were conducted overlapping rainy season during mid-June 2015 to September 2015. It was found that spawning grounds of fishes are generally located in shallow parts of river meandering sites where water

current is slow and depth is around 5-10 cm. The fishes of cat fish families like Mystus, Wallago, clarioas make a nest type breeding niche, which is looked after by male and where after a little time courtship female lays its spawn followed by the release of milt leading to fertilization. As per the situation, a small exploratory assessment was done to know the availability of fish spawn/ larvae along the study stretch using spawn collection nets during study period. The cone shaped spawn collection nets were fixed against the water flow along the right and left edges of the NW-1 at each selected sampling site, for a duration of half an hour. The mass of spawn/larvae collected varied from site to site and were a mixture of different species of fishes distributed in the particular sites and the study indicated that fishes were breeding throughout the river stretch and the larvae and the spawns were abundant near river meandering points and shallow zones. The map showing likely breeding and spawning grounds at different stretch along the NW-1 is given in Figure **4.41 to Figure 4.44.**

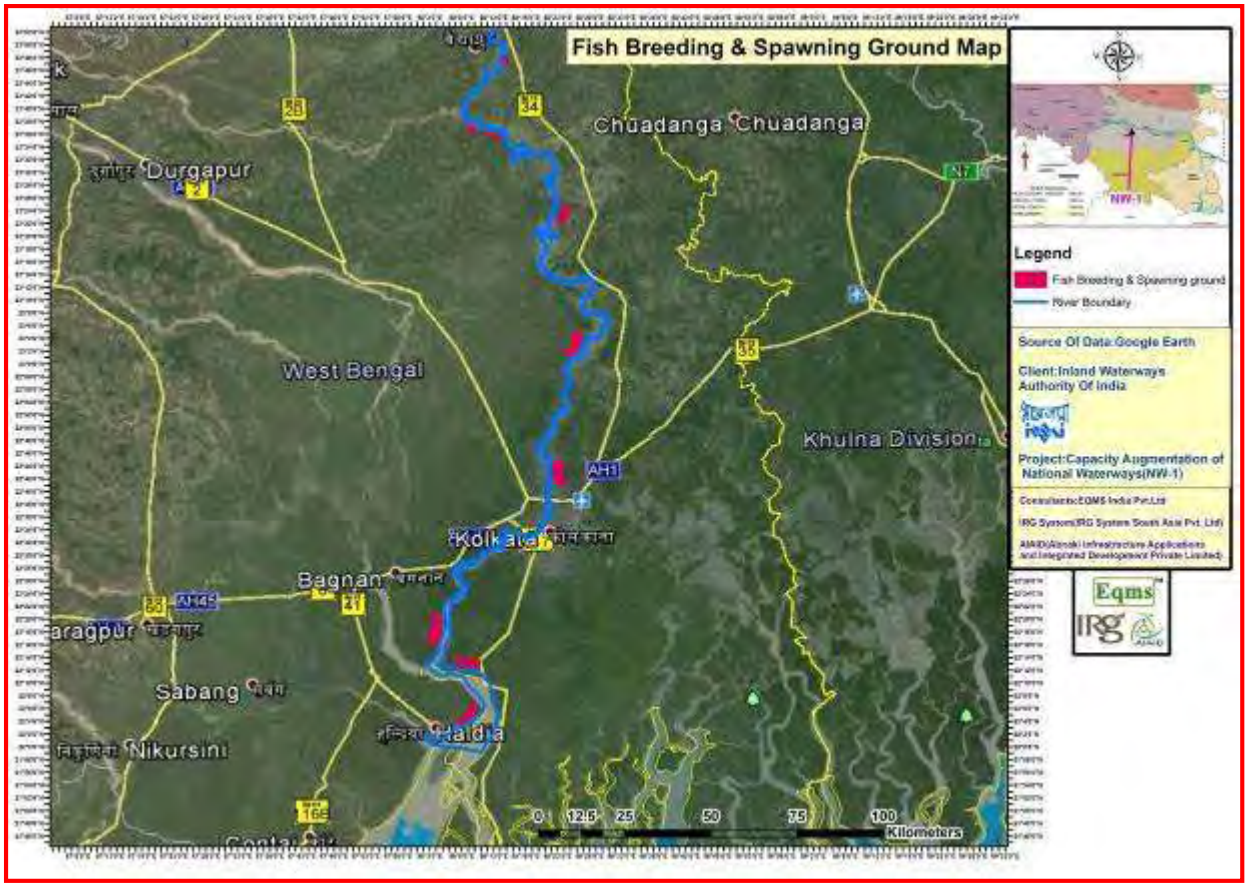


Figure 4.41 : Fish Breeding and Spawning Grounds along NW-1 (Haldia to Baidyapur Stretch)

Figure 4.42 : Fish Breeding and Spawning Grounds along NW-1 (Baidyapur to Sahibganj Stretch)

Figure 4.43 : Fish Breeding and Spawning Grounds along NW-1 (Sahibganj to Patna Stretch)

Figure 4.44 : Fish Breeding and Spawning Grounds along NW-1 (Patna to Allahabad Stretch)

Hilsa Fish Breeding: The Bengal Hilsa (*Tenualosa ilisha*) occurs in marine environment but migrates to fresh water for breeding. It tolerates variations in salinity and travels over 1200 km in inland water for breeding up to Farakka. The Hilsa fish is heterosexual. Breeding starts with start of monsoon in July and peaks in September-December. Hilsa primarily restricted to the estuarine zone only and its migration has been stopped in fresh water zone beyond Farakka.

Dolphin Breeding (reproduction): Calving of Gangetic Dolphin generally occurs in December to January and March to May, though it can occur any time of the year. New-born calves have been observed mainly in April and May[37].

Turtle Breeding: Turtle nesting season vary depending on the species. Its hatching period normally confined between May to October. The nesting and hatching season of fresh water turtle vary from May to October. The Nesting and hatching season of fresh water turtle in NW-1 is given at **Table 4.39**

Table 4.39 : Nesting and hatching season of turtle species

S. No.	Species	Nesting season	Hatching season
1	*Batagur dhongoka*	December-February-April	May
2	*Batagur kachuga*	December-February-April	May
3	*Pangshura smithii*	October-December	May

[37]Dolphin reproduction start with the copulation of group of dolphins.Dolphin mothers usually go to shallow waters to deliver the calves. Usually a single calf is born, which is nursed for around 18 months with milk from the mother.Calves live close to their mothers for around 6 years.

4	*Pangshura tentoria*	September-February	May
5	*Pangshura tecta*	October-December	May
6	*Lissemys punctata*	July-October	July
7	*Chitra indica*	September	October
8	*Nilssonia gangeticus*	August-October	June/July

Reference: Status of Higher Aquatic Vertebrates in the Ganga River GRB EMP: Ganga River Basin Environment Management Plan by consortium of 7 Indian Institute of Technology.

4.7.5. *Terrestrial and Aquatic biodiversity around Finalised intervention sites of NW-1*

IWAI has finalized four interventions namely Haldia Terminal, Sahibganj Terminal, Varanasi Terminal and Farakka Lock. Separate ecological assessment has been carried out around these identified sites and same is summarized in the following sections:

4.7.5.1 Haldia Terminal, Haldia Dock Complex, West Bengal

Terrestrial biodiversity: The proposed site is located in Haldia Dock Complex (HDC) and the vegetation is restricted to road side plantation, open spaces and plantation done by the HDC under green belt development programme. The dominant vegetation type in core zone comprises of trees like Albizzia lebbeck, Casuarina equisetifolia, Phoenix sylvestris, Delonix regia, Acacia spp, Azadirachta indica, and Dalbergia sissoo.

Terrestrial flora in 10 km includes open scrub land, crop land having agrarian ecosystem and road side plantation. Most of the land within the 10 km area of the proposed Haldia terminal site is under water bodies.

Threatened floral and Faunal species: No threatened floral, faunal or schedule I species as per Wildlife Protection Act, 1972, amended till date is recorded in the study area.

Protected Area: No Reserved Forest/National Park/Sanctuary is present within 10 km radius of the Haldia terminal site.

Aquatic biodiversity: Aquatic biodiversity of Hooghly River at Haldia includes plankton diversity, fishes, benthos and mammals. Phytoplankton is dominant group of aquatic flora in the study area. It includes Bacillariophyceae, Chlorophyceae and Cyanophyceae. Bacillariophyaceae also known as diatoms are dominant over the Cyanophyaceae and Chlorophyceae. Abundant species are Amphora, Bacillaria, Cymbella, Denticula, Diatoma, Gomphonema, and Navicula.

The aquatic fauna includes protozoa, cladocera, annelids, mollusca, larvae of insects, copepods, rotifers, fishes, amphibians, reptiles, mammals. Protozoans and rotifer are dominant over other groups of zooplankton.

Most important fish species of Hooghly River at Haldia are Rita, Catla, Mystus, mastacembelus, Labeo spp. Zooplankton includes Protozoa, Rotifera, Copepoda and Cladocera. Rotifera and Porifera are dominant group of Zooplankton in the study area. The most common species of benthos are insects viz. May fly, Odonata, Hemiptera, Coleoptera. Molluscs includes Pelecypoda, Bellamya sp., Gabbia sp., Lymnaea sp. and Thiaria sp.

Fish species are represented by species of Mystus, Puntius, Rita, Wallago, Channa, Labeo and Tenualosa ilisha (Hilsa). Hilsa fisheries in on decline and is assessed as Least Concern

as per IUCN's threatened category (version 3.1)[38]. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Haldia terminal.

4.7.5.2 Farakka Navigation lock, Farakka, Murshidabad district, West Bengal:

Terrestrial biodiversity: The vegetation in the study area of the proposed navigation lock is primarily agriculture related. The prevailing vegetation found in study area represents the trees and river riparian vegetation with dominance of agricultural fields. Major tree species found are Azadirachta indica, Dalbergia sissoo, Albizia lebbeack, Taad (Borassus flabellifer.), Krishnachuda (Caesalpinia pulcherrima), Aam (Mangifera indica L), Ficus religiosa, Ficus benghalensis etc. Mango and Litchi orchards. No forest is present within the study area.

Threatened flora & Fauna: No threatened floral, faunal or schedule I species as per Wildlife Protection Act, 1972, amended till date is recorded in the study area. However, being an important bird area few migratory birds' area found in the study area. The details of Avi fauna of the area is described under IBA section before.

Aquatic biodiversity: Gangetic Dolphin's (Platanista gangetica) presence was reported in this region prior to the construction of Farakka Barrage. No Gangetic Dolphins are found in the proposed lock site area. No other endangered aquatic faunal species are found in the study area.

Fish fauna in the study area includes Labeo sp., Catla, Notopterus sp., Hilsa sp., Rita, Clarias sp., Mystus sp., Osteobrama sp., Chanda nama, Puntius sp., Heteropneustes fossilis, Cyprinus carpio, Cirrhinus mrigala, and Wallago attu.

Phytoplankton found at Farakka Lock are Achnathes, Bacillaria, Caratoneis, Fragillaria, Navicula, Frustulia, Diatoma, Diatomella, Cymbella, Actinastrum, Chlamydomonas, Chlorella, Closterium, Tetracylus, Anabaeana, Ocillatoria, and Microcystis.

Zooplankton of Ganga River at Farakka Lock comprises Protozoa, Rotifera, Copepda, Cladocera. It includes species of Arcella, Difflugia, Noctiluca, Paramecium, Vorticella, Brachionus, Filinia, Keratella, Lecane, Nothlca, Rotaria, Cyclops, Bosmia, Chydorus, Daphnia, and Moina.

Benthos of Ganga River canal at Farakka Lock are Gabbia sp. Bellamya sp. Lymnaea sp, Belostoma indica and Cybister confuses.

In order to facilitate spawning, all types of fish catching are banned in the Hilsa Sanctuaries located within 10 Km of this site, during June to August and October to December every year. Fishing of Hilsa is prohibited within 5 square kilometre of the Farakka Barrage and between Lalbagh in Farakka, Murshidabad district round the year to protect the Hilsaspecies and facilitate brooders spawning in the area[39]. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Farakka Lock.

4.7.5.3 Sahibganj Terminal, Samdaghat, Sahibganj district, Jharkhand

[38] http://www.iucnredlist.org/details/166442/0

[39] *Notification of Fisheries Department, Government of West Bengal dated Tuesday, April 09, 2013 published in The Kolkata Gazette.*

Terrestrial biodiversity: The ecology of 10 km zone around the proposed Sahibganj terminal site included protected forest ecosystem, agrarian ecosystem as well as aquatic ecosystem of Ganga river. The vegetation around the 2 km area of the terminal is agriculture ecosystem. There is no forest present within 2 km area of the proposed terminal site. The dominant vegetation comprises Acacia spp., Mangifera indica, Azadirachta indica, andDalbergia sissoo. However, the southern part of the study area is hilly and fall under forest ecosystem. The forest is classified as protected forest and falls in the jurisdiction of Sahibganj Forest Division. Forests types of the Sahibganj district of Jharkhand are mainly considered as tropical dry deciduous forest (Group 5B/C2)40 according to the revised classification of forests types of India by Champion and Seth 1968. The natural vegetation in this type of forest is pure formations of Boswellia sp., Acacia sp, Butea sp, Tectona sp, Azadirachta sp, Lannea sp and Flacourtia sp.

Threatened flora and Fauna: No rare, vulnerable and threatened species of flora and fauna is recorded in the study area.

Protected Area: There is no National Park, wild life Sanctuary; Biosphere reserve, wetland and elephant/tiger reserve present within 10-km of the proposed project area.

Aquatic biodiversity: Dolphin (Platanista gangetica gangetica) commonly known as Susu as is one of the endangered species found in lower stretch of Ganga River. Very few dolphins are reported at Sahibganj Terminal area in its 500-meter radius. However, during field studies no dolphin was seen in the stretch of Sahibganj terminal.

Aquatic ecology of Ganga river at Samda Ghat includes variety of plankton, fishes and benthos. Phytoplanktons are represented by Bacillariophyceae (diatoms) which is dominant in comparison to Cholrophyceae and Cyanophyceae group. The zooplanktons are represented by Protozoa, Rotifera, Copepoda and Cladocera group. Benthos is represented by Oligochaeta, Insecta, etc.

Fish are represented by Chanda nama, Channa spp., Chela labuca. Cirrhinus mrigala, Cyprinus carpio, Labeo spp., Mastacembelus armatus, Monopterus spp. Mystus spp., Osteobrama cotio, Puntius spp., Rhinomugil corsula, Rita, Wallago attu and Xenentodon cancila. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Sahibganh terminal.

4.7.5.4 Ramnagar Terminal, Varanasi, Uttar Pradesh

Terrestrial biodiversity: The proposed terminal site at Ralhupur, Ramnagar is devoid of any forest. The current land is a fallow land. Total 8-9 trees of Khajur Phoenix sylvestris and Acacia sp. are present on the site and around the site.

[40] Divisional Forest Working Plan of Sahibganj District.Jharkhand

Threatened species: No threatened floral, faunal or schedule I species as per Wildlife Protection Act, 1972, amended till date is recorded in the study area.

Protected areas: Turtle Wildlife Sanctuary (TWS)- Kachua Vanyajeev Vihar- is located about 1.95 km in north direction from the proposed terminal at Ramnagar (**Figure 4.45**).

Aquatic Fauna: Gangetic dolphin is reported in river Ganga but not in 10 Km of this terminal site. Turtle are also found in the study area as Kashi Turtle Wild Life sanctuary is located within 10 Km radius study area (refer **Figure 4.45**) to this terminal. Species details have already been presented in earlier section on Kashi Wild Life Sanctuary.

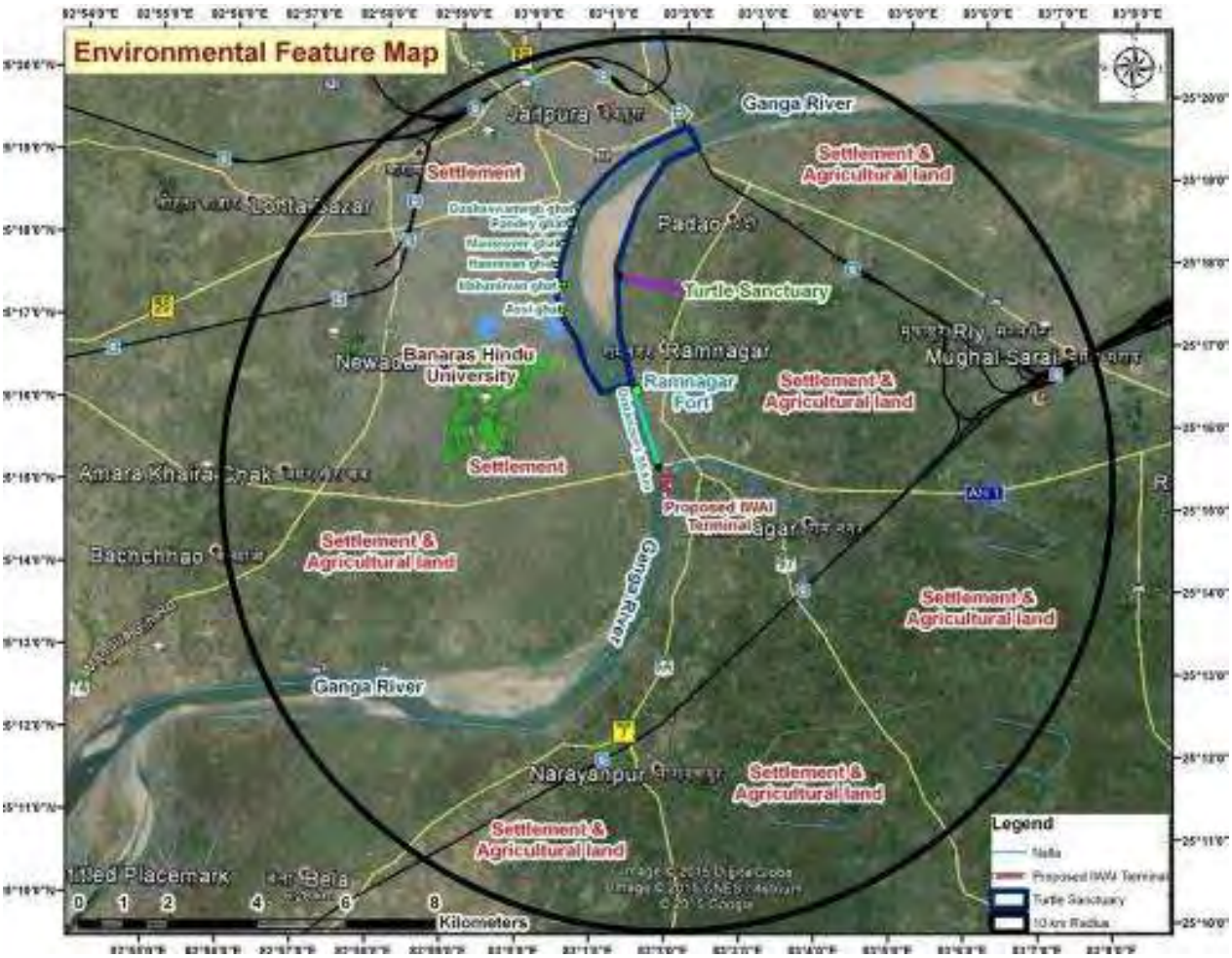


Figure 4.45 : Location of proposed terminal, TWS and study area/NW-1

Phytoplankton group reported from the sampled locations are Bacillariophyceae, Chlorophyceae, Cyanophyceae, Xanthophyceae and Euglenophyceae members. Bacillariophyceae is dominant followed by Chrophyceae and Cyanophyceae observed in studied samples.

Among the zooplankton group, Brachionos sp.(Rotifera) had highest percentage composition and the lowest percentage composition was of Asplanchna sp. The zooplankton Cypris sp and Gastrocypris sp. are also reported.

Zoobenthos in the study area include Gastropods, Annelids and Insects. Gastropods Bellamya sp., Gabbia sp. Lymnaea sp. And Thiaria sp, while annelds are represented by Oligochaetes, and Polychaetes. Insects are represented by Argia sp., Caenis sp. Cloen sp and Enallagma sp.

Fishes include species of major carps like Rohu (Labeo rohita), mrigal (Cirrhinus mrigala), katla (Catla catla), kalbasu (Labeo calbasu), cat fishes like padhan (Wallago attu)) tengras (Mystus teengara) and Magur (Clarias batrachus), Singhi (Heteropneustes fossilis), Tilapia (Oreochromis sp.), Kavai (Anabas testudineus), Mahfish (Barbus sp.), are recorded in the Ramnagar area of Ganga river. Carnivore fishes namely Wallago attu, Bagarius sp. Mystus sp. and few other minor cat fishes like Clarias, Mystus vittatus etc are also reported.

Ilish fish (Hilsa sp). are no more visible around, which used to migrate up to Allahabad prior to construction of barrage on Ganga river at Farakka, coupled with a high rate of pollution along its course. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Sahibganj terminal.

4.8. Socio-economic Environment

NW-1 passes through four Indian states namely Uttar Pradesh, Bihar, Jharkhand, and West Bengal. Each of the state has distinct socio-economic profile. The socio-economic profile of districts/cities/towns of these states falling along NW-1 are analysed to understand overall socio-economic environment around NW-1 project areas.

4.8.1. *Demography*

Demography is one of the important indicators of environmental health of an area. It includes population, number of households, literacy, population density, etc. Demographic profile of the area was analysed based on 2011 census data.

4.8.1.1 Population Distribution in Major Cities along NW-1

There are many cities, towns and villages located along the NW-1. As per the Census Record of India 2011, the population of major cities/ town located along the Ganga river in NW-1 section was recorded as 12875343 comprising 6782150 male and 6093193 females. Total number of 'Households' was also recorded as 2562165 and 0-6-year age population was also recorded as 1308682. City/town wise Population distribution in study area (NW-1 section) is shown in **Table 4.40** and **Figure 4.46**.

Table 4.40 : Population of Major City & Towns along with NW-1

Sl. No.	Name of Town/City	No of Household	Total Population	Male	Female	Population 0-6-year age

1	Allahabad	205529	1168385	630577	537808	120620
2	Sirasa	1867	12686	6637	6049	1826
3	Gyanpur	2906	19058	10029	9029	2662
4	Mirzapur-cum-Vindhyachal	38185	234871	125601	109270	30340
5	Chunar	5951	37185	19647	17538	4926
6	Varanasi	190835	1198491	635140	563351	135677
7	Saidpur	3505	24338	12716	11622	3578
8	Zamania	4863	33243	17322	15921	5226
9	Gahmar	4365	25994	13367	12627	3650
10	Ballia	15772	104424	55459	48965	11623
11	Ghazipur	19556	121020	63513	57507	15139
12	Buxar	16710	102861	54277	48584	14165
13	Chhapra	31501	202352	106501	95851	29100
14	Fathua	8225	50961	26953	24008	8499
15	Hajipur	24033	147688	78047	69641	20899
16	Patna	294631	1684297	893445	790852	203047
17	Barauni	12964	71660	37858	33802	12723
18	Sonepur	6383	37776	19995	17781	5273
19	Bakhtiarpur	7295	47897	25168	22729	8653
20	Kahagaria	9123	49406	26594	22812	7273
21	Begusarai	48620	261384	138519	122865	41560
22	Barh	9310	61470	32823	28647	9627
23	Bihat	12958	67952	35965	31987	10694
24	Munger	38921	213303	113291	100012	30484
25	Sultanganj	9410	52892	28240	24652	8741
26	Bhagalpur	69984	400146	212813	187333	54818
27	Sahibganj	17076	88214	46449	41765	12262
28	Farakka Barrage Township	4786	20126	10430	9696	1882
29	Pakaur	9333	45840	23653	22187	6352
30	Berhampore	43075	195223	100247	94976	13881
31	Katwa	19382	81615	41350	40265	6799
32	Santipur	36506	151777	77011	74766	13573
33	Hugli-Chinsurah	45005	179931	90217	89714	12604
34	Haora	244135	1077075	561220	515855	91315
35	Kolkata	1024928	4496694	2356766	2139928	339323
36	Diamond Harbour	10048	41802	21050	20752	3688
37	Tamluk	14489	65306	33260	32046	6180
38	Haldia	44065	200827	104841	95986	21945
Total		**2562165**	**12875343**	**6782150**	**6093193**	**1308682**

Source: Primary Census of India 2011

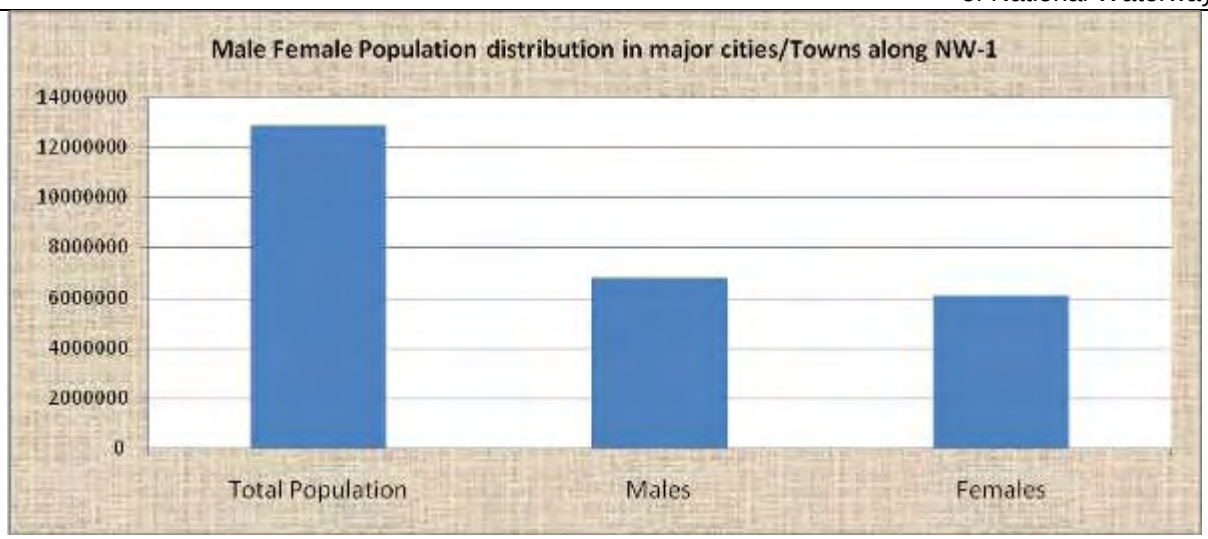


Figure 4.46 : Graphical Presentation of Male-Female Wise Population

4.8.1.2 Scheduled Caste and Schedule Tribe Population in Major cities/Town along NW-1

The schedule Caste (SC) and Schedule Tribe (ST) community are considered as socially weak who are supported by Government through various welfare schemes. Scheduled Caste population consisting of 544284 males and 483706 females respectively in major city/towns along the study area and accounts for 7.9% of the total population. The 'Scheduled Tribe' population consist of 27576 males and 25244 females respectively and accounts for 0.41% of the total population (12875343). It implies that 91.6% of total population belong to the general category and other backward classes. SC & ST population profile is given at **Table 4.41** and **Figure 4.47.**

Table 4.41 : Caste wise (SC & ST) Population breakup in cities/towns along NW-1

Sl. No.	Name	SC Population	SC Male	SC Female	ST Population	ST Male	ST Female
1	Allahabad	148794	80023	68771	2694	1494	1200
2	Sirasa	1799	965	834	21	14	7
3	Gyanpur	911	486	425	0	0	0
4	Mirzapur-cum-Vindhyachal	26700	14495	12205	391	204	187
5	Chunar	5657	3053	2604	119	68	51
6	Varanasi	82190	44058	38132	6595	3558	3037
7	Saidpur	6194	3256	2938	28	13	15
8	Zamania	3359	1758	1601	220	118	102
9	Gahmar	3295	1774	1521	327	168	159
10	Ballia	8703	4637	4066	3942	2088	1854
11	Ghazipur	9548	4965	4583	881	464	417
12	Buxar	8619	4612	4007	1800	961	839
13	Chhapra	16629	8739	7890	566	291	275
14	Fathua	7991	4198	3793	29	12	17
15	Hajipur	24908	13132	11776	97	57	40
16	Patna	151924	80521	71403	5139	2527	2612
17	Barauni	5540	2898	2642	195	103	92

18	Sonepur	5158	2721	2437	138	81	57
19	Bakhtiarpur	7122	3676	3446	50	21	29
20	Kahagaria	3782	2029	1753	89	44	45
21	Begusarai	31227	16668	14559	279	138	141
22	Barh	8578	4575	4003	37	22	15
23	Bihat	8540	4556	3984	274	150	124
24	Munger	14562	7632	6930	406	215	191
25	Sultanganj	4839	2552	2287	19	11	8
26	Bhagalpur	32681	17453	15228	1061	493	568
27	Sahibganj	11105	5848	5257	5306	2688	2618
28	Farakka Barrage Township	6604	3423	3181	274	138	136
29	Pakaur	3224	1625	1599	2557	1258	1299
30	Berhampore	19349	9952	9397	1104	625	479
31	Katwa	12189	6146	6043	209	101	108
32	Santipur	33493	17174	16319	2371	1194	1177
33	Hugli-Chinsurah	26157	13353	12804	1306	658	648
34	Haora	35025	18289	16736	3339	1735	1604
35	Kolkata	241932	128053	113879	10684	5729	4955
36	Diamond Harbour	5221	2677	2544	72	34	38
37	Tamluk	4441	2312	2129	201	101	100
38	Haldia	36946	19342	17604	1560	838	722
		1027990	**544284**	**483706**	**52820**	**27576**	**25244**

Source: Primary Census of India 2011

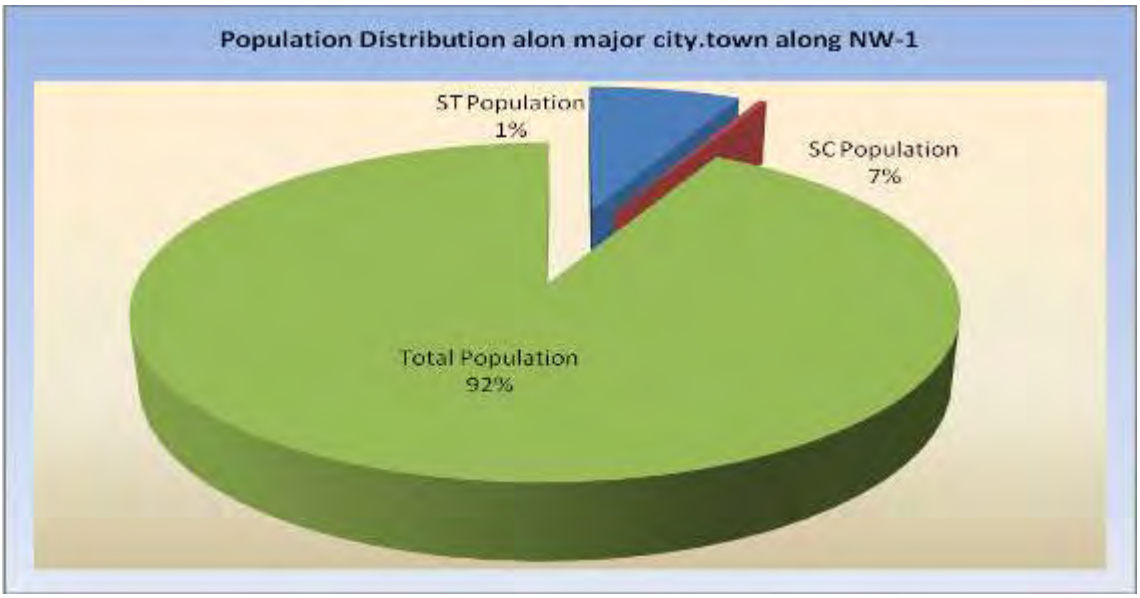


Figure 4.47 : Graphical representation of SC, ST and General Population

4.8.2. *Literacy Level in Major cities/towns along NW-1*

Literacy level is quantifiable indicator to assess the development status of an area or region. The statistic of literate and illiterate male and female population is presented in **Table 4.42 and Figure 4.48**. About 75.4% of the population is literate and 23.6% is illiterate in cities/town located along the NW-1 is illiterate. Male population is more literate than female.

Table 4.42 : Literate and Illiterate Population breakup in cities/towns along NW-1

Sl. No.	Name	Population literate	Male Literate	Male Literate	Population Illiterate	Male Illiterate	Female Illiterate
1	Allahabad	887136	499842	387294	281249	130735	150514
2	Sirasa	8715	5004	3711	3971	1633	2338
3	Gyanpur	13004	7362	5642	6054	2667	3387
4	Mirzapur-cum-Vindhyachal	156408	89938	66470	78463	35663	42800
5	Chunar	24674	14442	10232	12511	5205	7306
6	Varanasi	842497	469653	372844	355994	165487	190507
7	Saidpur	15898	9138	6760	8440	3578	4862
8	Zamania	21462	12473	8989	11781	4849	6932
9	Gahmar	17108	9897	7211	8886	3470	5416
10	Ballia	77331	43298	34033	27093	12161	14932
11	Ghazipur	88656	49359	39297	32364	14154	18210
12	Buxar	74344	41701	32643	28517	12576	15941
13	Chhapra	135951	76783	59168	66401	29718	36683
14	Fathua	29803	17248	12555	21158	9705	11453
15	Hajipur	97372	55206	42166	50316	22841	27475
16	Patna	1234991	685885	549106	449306	207560	241746
17	Barauni	40529	23456	17073	31131	14402	16729
18	Sonepur	25893	14909	10984	11883	5086	6797
19	Bakhtiarpur	27477	16117	11360	20420	9051	11369
20	Kahagaria	35124	19853	15271	14282	6741	7541
21	Begusarai	167178	95014	72164	94206	43505	50701
22	Barh	39168	22578	16590	22302	10245	12057
23	Bihat	44350	25534	18816	23602	10431	13171
24	Munger	146507	82590	63917	66796	30701	36095
25	Sultanganj	31327	18466	12861	21565	9774	11791
26	Bhagalpur	273695	153821	119874	126451	58992	67459
27	Sahibganj	60164	34053	26111	28050	12396	15654
28	Farakka Barrage Township	14394	7907	6487	5732	2523	3209
29	Pakaur	30641	16640	14001	15199	7013	8186
30	Berhampore	163312	85970	77342	31911	14277	17634
31	Katwa	65187	34159	31028	16428	7191	9237
32	Santipur	111806	59588	52218	39971	17423	22548
33	Hugli-Chinsurah	152333	78617	73716	27598	11600	15998
34	Haora	874491	468026	406465	202584	93194	109390
35	Kolkata	3588137	1926915	1661222	908557	429851	478706
36	Diamond Harbour	32753	17193	15560	9049	3857	5192
37	Tamluk	53318	28282	25036	11988	4978	7010
38	Haldia	158380	87334	71046	42447	17507	24940
Total		**9703134**	**5316917**	**4386217**	**3172209**	**1465233**	**1706976**

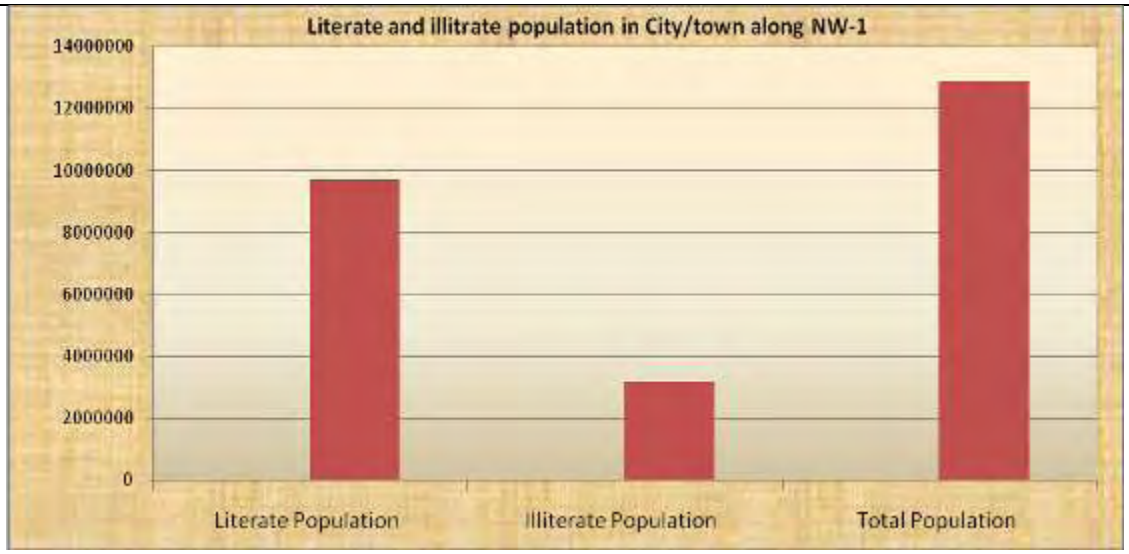


Figure 4.48 : Graphical representation of literate and Illiterate Population

4.8.3. *Workers Scenario and Livelihood Pattern of the community along NW-1*

In cities and town along NW-1 area the main and marginal workers[41] are 14% and 29% respectively while the remaining 57% of total population constitutes non-workers. The main occupation is agriculture, labour class and trading activities. The workers' scenario is given in the cities and town along "NW-1" is presented in the **Table 4.43** and **Figure 4.49**. The occupation based bifurcation of population in study area is provided in **Figure 4.50**.

Table 4.43 : Working and Non-Working Population breakup in cities/towns along NW-1

Sl. No.	Name	Total Workers	Main worker	Marginal Workers	Non workers
1	Allahabad	390202	281443	108759	778183
2	Sirasa	4365	2959	1406	8321
3	Gyanpur	5105	4255	850	13953
4	Mirzapur-cum-Vindhyachal	77247	56326	20921	157624
5	Chunar	11901	7986	3915	25284
6	Varanasi	402122	339305	62817	796369
7	Saidpur	7015	5368	1647	17323
8	Zamania	8459	6527	1932	24784
9	Gahmar	7058	4399	2659	18936
10	Ballia	35256	23069	12187	69168
11	Ghazipur	33464	26881	6583	87556
12	Buxar	26652	23493	3159	76209
13	Chhapra	53479	40896	12583	148873
14	Fathua	13540	11832	1708	37421
15	Hajipur	39836	33596	6240	107852
16	Patna	509839	426086	83753	1174458
17	Barauni	18923	16144	2779	52737
18	Sonepur	9197	7329	1868	28579
19	Bakhtiarpur	12978	8896	4082	34919

[41]A person who has worked for more than 183 days in a year is called the main worker. Marginal workers are those who have worked any time in the year preceding the census but have not worked for major part, which is not more than 183 days, of the year

20	Kahagaria	12925	10808	2117	36481
21	Begusarai	75740	54680	21060	185644
22	Barh (Nagar Parishad)	17152	14417	2735	44318
23	Bihat (Nagar Parishad)	18862	13707	5155	49090
24	Munger	57185	43389	13796	156118
25	Sultanganj(Town)	15403	10520	4883	37489
26	Bhagalpur	119346	95077	24269	280800
27	Sahibganj (Nagar Parishad)	25443	20498	4945	62771
28	Farakka Barrage Township	7174	6153	1021	12952
29	Pakaur	14906	13171	1735	30934
30	Berhampore	73145	68515	4630	122078
31	Katwa	28718	25283	3435	52897
32	Santipur	72023	63783	8240	79754
33	Hugli-Chinsurah	68994	61730	7264	110937
34	Haora	397048	358922	38126	680027
35	Kolkata	1795740	1576419	219321	2700954
36	Diamond Harbour	14808	13178	1630	26994
37	Tamluk	22929	19230	3699	42377
38	Haldia	61216	50792	10424	139611
Total		**4565395**	**3847062**	**718333**	**8510775**

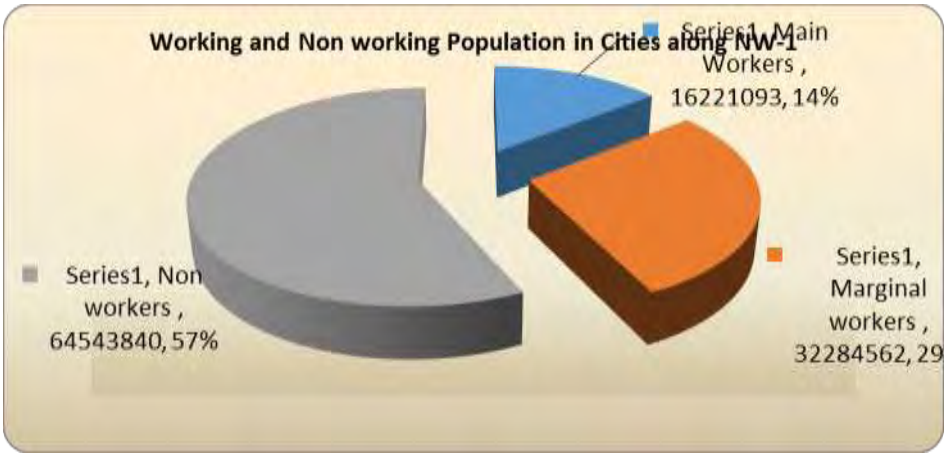


Figure 4.49 : Graphical representation of Working and Non-working Population

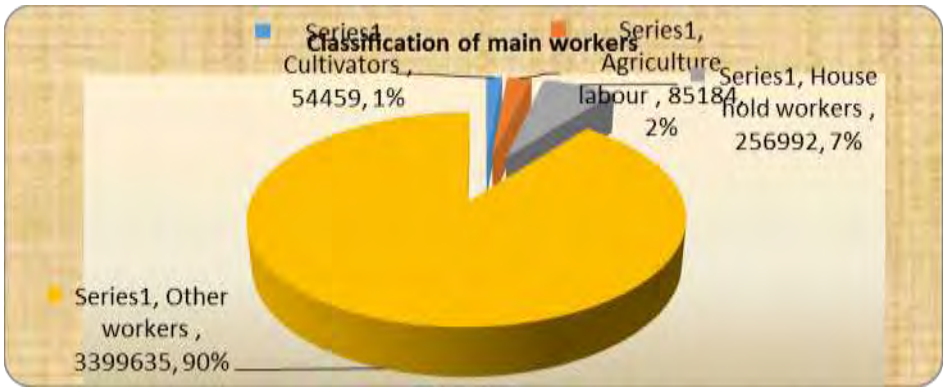


Figure 4.50 : Classification of Main Working Population in cities/town along NW-1

4.8.4. *Livelihood Pattern of the community Depending on the river*

Ganga along the NW-1 state is intrinsically linked to the economy of the area. It provides the necessary silt in much of the land around it, increasing its fertility. Paddy is the greatest crop of the region. Agriculture is the main source of the livelihood generation for the people residing along the NW-1 area. Many towns in the area are primarily industrial. Ganga provides the necessary infrastructure for the factories to perform. Commercial fisheries in the Ganga River System are an important source of livelihood for the people residing along the Ganga river. The Ganga in Allahabad and Varanasi is also considered to be the most auspicious. Thousands of devotee Hindus comes to the Ghats to pray for their ancestors. Pilgrimage and the associated tourism it brings along is a major source of revenue for this religious town and its people.

4.8.4.1 Fishing and Livelihood Generation along NW-1

Ganga is the most important river and source of livelihood for countless fishers inhabiting on its bank. The fishery in the potamon zone of the river is mainly represented by the species belonging to Cyprinidae and Siluridae families. There is substantial decline in major carps fish catch in Allahabad to Farakka stretch over past few years. In recent period, the fishery showed some improvement due to emergence of exotic species, specifically C. carpio and O. niloticus. At Buxer hilsa was the main fishery and with the commissioning of Farakka barrage the fishery declined sharply between 1972-80. Fishery improved during 1981-86 due to improvement in landings of other species. Patna centre also showed drastic decline in major carp landings and as compared to sixties it was almost half during 1986-93. Decline at Bhagalpur was not as severe as at other centres. Gupta and Tyagi (1991) have discussed the fishery of Ganga with an analytical approach and showed that the fishery is harvested at a level higher than the optimum fishing level and efforts should be made to reduce the fishing pressure to obtain a sustainable fishery from the system.

Fishermen Population and Fishing pattern: It is very important to know the total number of fishers involved in capture fisheries in the NW-1 stretch. It is reported that almost every village along the both sides of the river are having some fishermen who earn their livelihood by fishing in the Ganga river. There is no census data available regarding fishers specifically involved in capture fisheries in the whole NW-1 stretch. Generally, one member of the family is engaged in fishing in lower stretch of NW-1(Farakka to Haldia), sometimes two, the average comes to be 1.5. However, in upper stretch (Allahabad to Farakka) the average person engaged in fishing is 1.2 that is mainly due to low fish catch in this stretch. The fishermen do fishing for 5-12 hours daily, depending upon the season. Fishing activities is very less during monsoon season. Fishing is the main occupation to 90% of the fishers, which contribute to more than 80% of their household income. Other major occupation includes fish vending, ferry service, tourism, driving and daily labour. Most of the fisherman does not have agricultural land and small amount of income comes from labour wage, service, and petty business. In the season of less catch the youth generally engage themselves in labour works or rickshaw van pulling to earn their livelihood.

Fishing Income: The monthly average income of the fisherman ranged from Rs.4000 to 7000 per month in Allahabad to Patna stretch. However, in Varanasi stretch the most of the fisherman is engaged in boating and ferry services now and earning more than fishing. In lower zone (Farakka to Haldia) the average income of fisherman is slightly high and ranging between 7000 to Rs. 10,000 per month because of higher catch and high value fish (mainly hilsa) in the catch.

Fishing Crafts: For fishing purpose mainly small or medium sized boats was used. As compared to sixties, the availability of boats per fishermen showed an increase, this may be due to change in fishing pattern. As in past mainly dragnets were used for fishing involving only two boats and more than 10 fishers in a fishing unit. With the passage of time dragnets have lost their place and fishers have switched over to gill nets involving maximum 2-3 persons and a boat. Single piece tin made fishing craft dingi are mostly found in Farakka and surrounding stretch and whereas the wooden boats/ big crafts are mostly found in the lower zone near Haldia.

Nets &Gears: Dragnets, dip net, gill nets, traps, bag nets are commonly used by the fisherman along the NW-1 stretch. Gill nets availability was highest in Patna, Munger and Bhagalpur stretch of NW-1 and lower in Allahabad and Mirzapur stretch of NW-1. Availability of dragnets was low in almost Allahabad to Farakka stretches. Large dragnets were not present at all. Use of hook and lines were mainly in the Allahabad and Mirzapur stretches of NW-1 whereas traps were more in district Ballia and Bihar stretches. Small scoop nets were available in the entire stretch but large size was available only in lower stretches down to Farakka. Dip nets were observed in Allahabad and Mirzapur districts.

Various forms of gill nets and bag nets are found to be operated by the fishers. Among them gill nets are most prevalent throughout the NW-1 stretch. Around 80% of the fishers were using the gear. The gill nets have different local names like Current jal, Nagin jal, Kajli jal, Phasa jal, Bhola jal, Vacha jal, Ghero jal, Dhoali jal, Gule jal, Pungus jal, etc. A number of variations in material and mesh size in gill nets are observeddepending upon the targeted fishes. However, drift gill nets are the major nets used to catch hilsa, the main migratory fish of Bhagirathi- Hooghly river system. All different types of gill nets have their distinct seasonality in operation depending upon the availability of the target species.

Fishing sites and Jal/net operation in river: Most of the gears, bigger nets are operated inside the river for quite long time. Few bigger nets like Khelpa jal / Bachari jal and hooks can operate from river bank. Gears, bigger nets are more frequently used by the fisherman near Farakka and downstream of Farakka to Haldia. However, the use of Gears and bigger nets is not so common in upper reach from Rajmahal to Allahabad.

4.8.5. *Infrastructure Facilities along NW-1*

The cities and towns along NW-1 has most of required infrastructure facilities. Infrastructural facilities namely Industries/industrial areas, transmission line, national highways, other roads, railways, settlement, cultural sites and archaeological site located within 500 either side of NW-1 is mapped using satellite imageries and limited physical verifications. These are presented at **Figure 4.51 to 4.66**.

4.8.5.1 Transport Network (Road/Rail/Water and Airways)

All the towns and cities along the NW-1 are well connected with national highways, state highways, district roads, railways. Cities like Varanasi, Patna, Kolkata are also connected with airways. Some of cities located along the NW-1 are connected with localised ferry services as well.

4.8.5.2 Thermal Power plants along NW-1

Eleven thermal power plants are located in close proximity of river Ganga between Haldia and Allahabad and 10 more are reportedly are proposed to be set up in close proximity of the river. These thermal power plants have boosted the prospect of the waterway like never before for transportation of imported coal to these power stations. Transportation of coal to NTPC power plant at Farakka is already operational through NW-1.

4.8.5.3 Current Pollution Load from Point Sources and its flow at Different Segment of NW-1

There are 30 class I cities and 8 class II towns along the mainstream of river Ganga at NW-1 segment. These cities are discharging 2173.8 MLD wastewater out of which only 959.6 MLD has the treatment Capacity. The City sewage discharge is major source of pollution to river ganga which is another cause of declining fish catch in the river. Status of wastewater generation and treatment capacity in these cities is summarized in **Table: 4.44** and detailed at **Table 4.45.**

Table 4.44 : Wastewater Generation and Treatment Capacity

Category	Wastewater Generation, MLD	Treatment Capacity, MLD
Class-I (30)	2110.4	957.6
Class-II (8)	63.4	2
Total	**2173.8**	**959.6**

Source: CPCB report Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities Class-II Towns of India

Table 4.45 : Sewage Generation of class Cities-I in River Ganga

State	City/Town	Sewage Generation (MLD)	Treatment Capacity (MLD)
Uttar Pradesh	Allahabad	208	89
	Mirzapur	27.5	14
	Varanasi	187.1	141
	Sub-Total	**422.6**	**244**
Bihar	Patna	249.2	109
	Munger	34	13.5
	Bhagalpur	61.6	11
	Katihar	31.7	31.7
	Sub-Total	**376.5**	**165.2**
West Bengal	Kolkata	618.4	172
	Haldia	24.5	24.5
	santipur	18.7	18.7

	Nabadwip	15.5	10
	Basirhat	15.3	--
	Bangaon	13.8	--
	South dumdum	53	52.9
	Rajpur sonarpur	33.6	45.4
	Kamarhati	48.8	40
	North Dumdum	29.7	--
	Naihati	20.5	--
	Ulberia	27.3	--
	Kanchrapara	17	--
	Halisahar	16.8	--
	North Barrackpur	19.2	16.7
	Rishra	13.5	15.3
	Ashoknagar Kalyangarh	17.3	15
	Haora	136.2	63.9
	Bhatpara	59.7	28.5
	Maheshtala	52.5	3.9
	Serampore	26.7	18.9
	Chandannagar	16.1	22.7
	Habra	17.2	--
	Sub-Total	**1311.3**	**548.4**
	Total	**2110.4**	**957.6**

Source: CPCB report Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities Class-II Towns of India

Waste water generation from cities and towns along NW-1 in Uttar Pradesh segment generated 422.6 MLD i.e. 26. % of total wastewater generation. Waste water generation from cities and towns along NW-1 in Bihar segments 376.5 MLD i.e. 14 % of total wastewater generation. The major city is Patna which generates 249.2 MLD of total waste water generated from this stretch. The cities/towns located along NW-1segment of West Bengal generate about 1311 MLD i.e. about 50 %. Out of the total waste water generation in NW-1 segment. Kolkata alone contributes47% and Howrah generates 10% of the total waste water generation of west Bengal stretch.

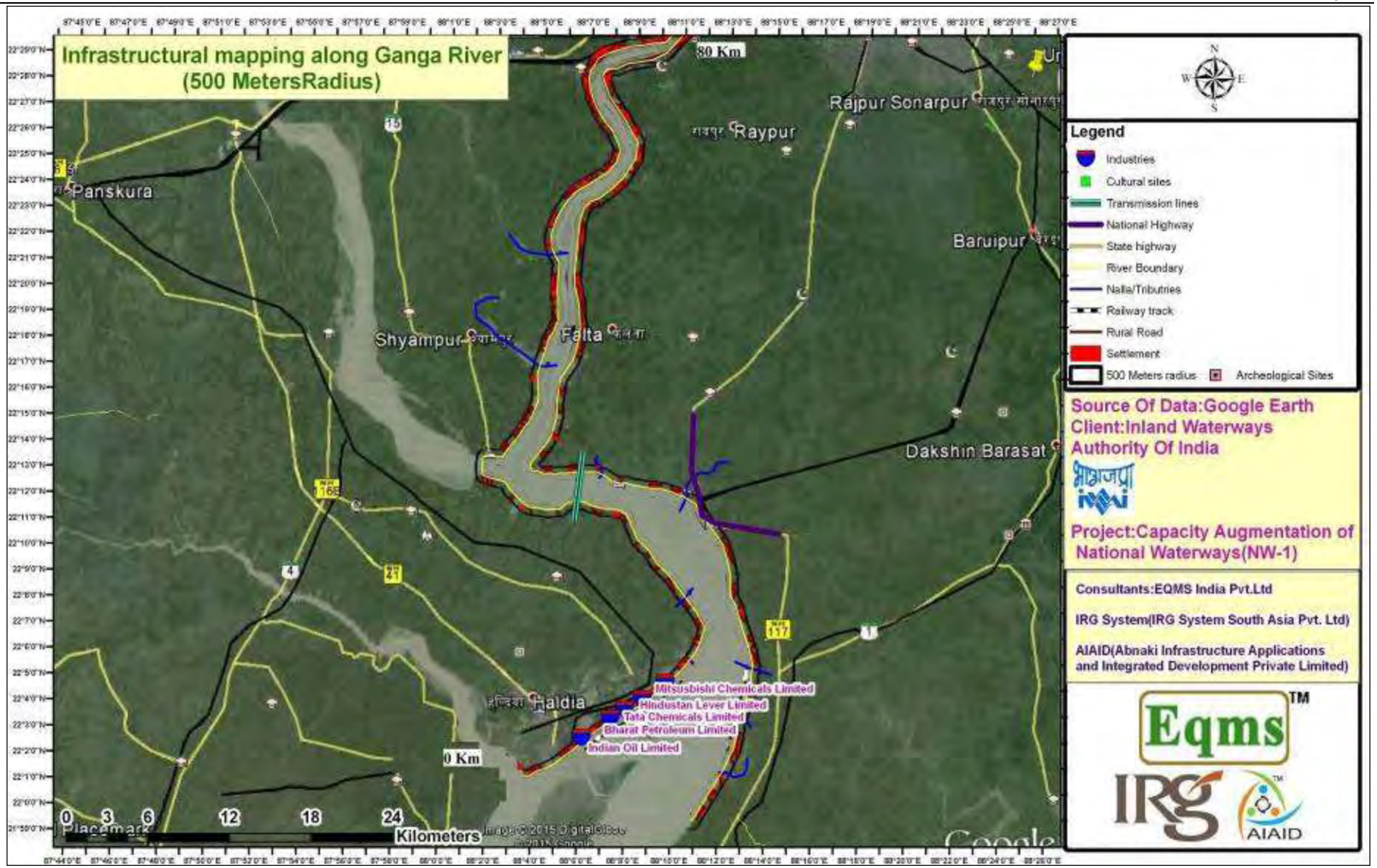


Figure 4.51 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 0-80 km)

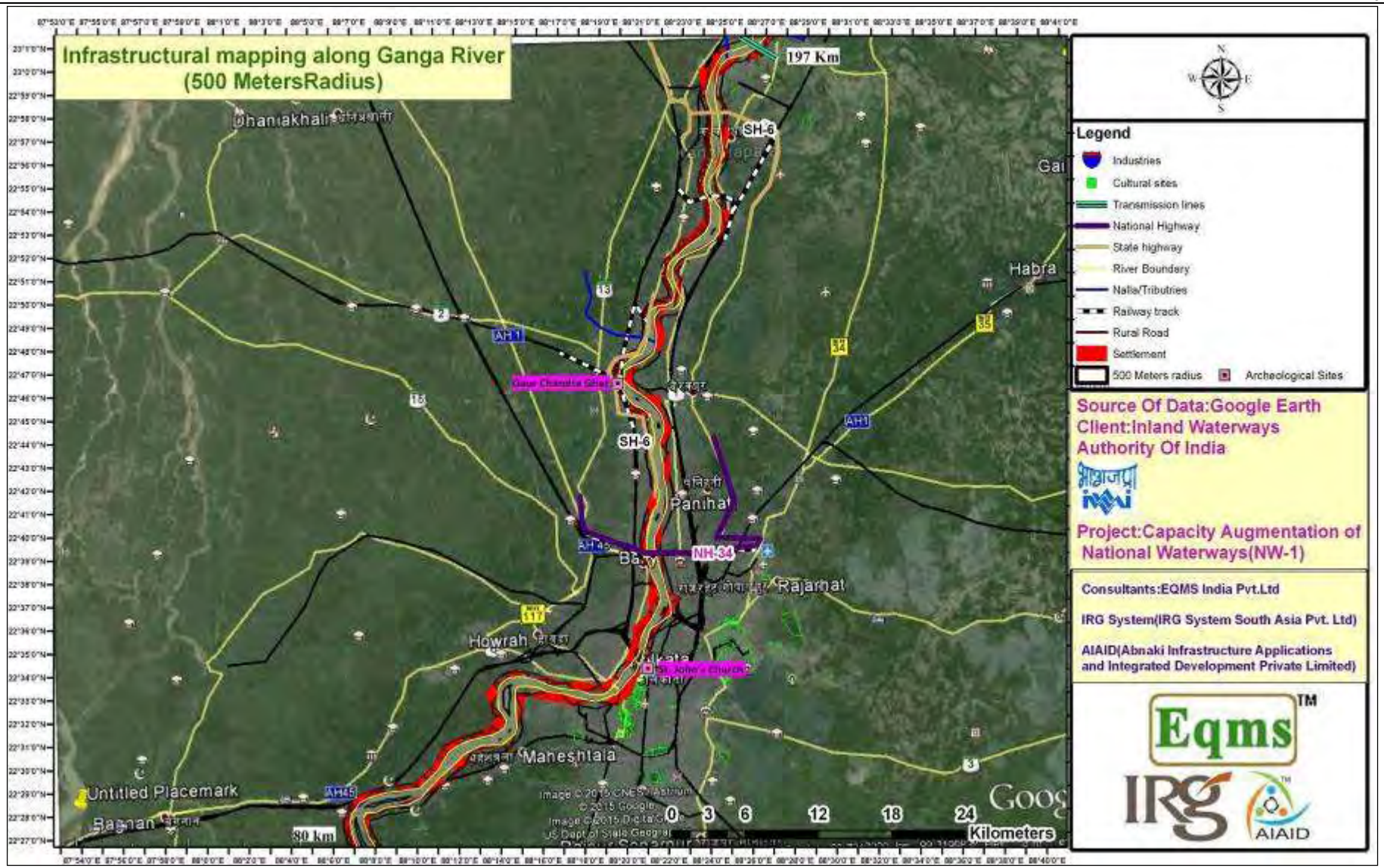


Figure 4.52 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 80-197 km)

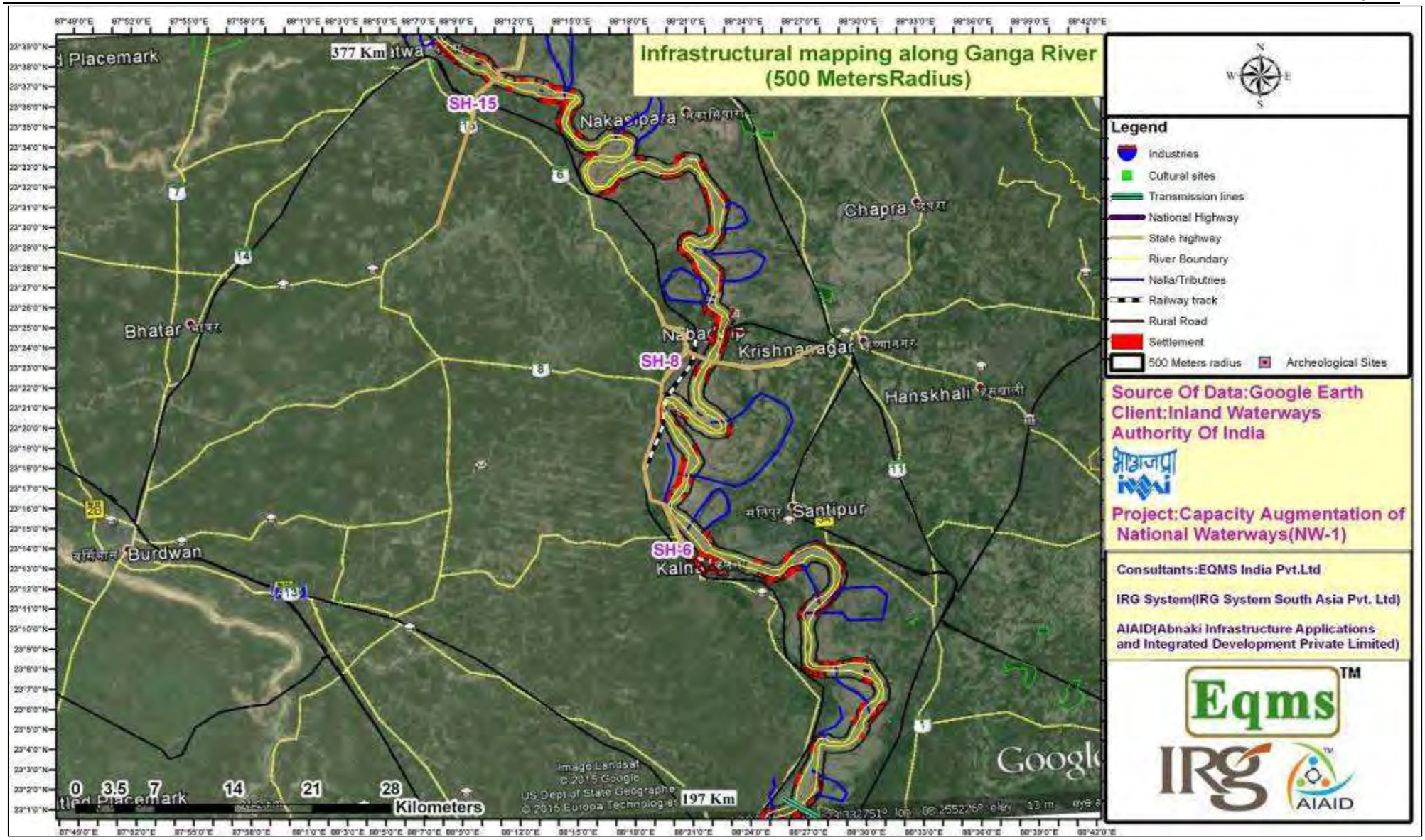


Figure 4.53 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 197-377 km)

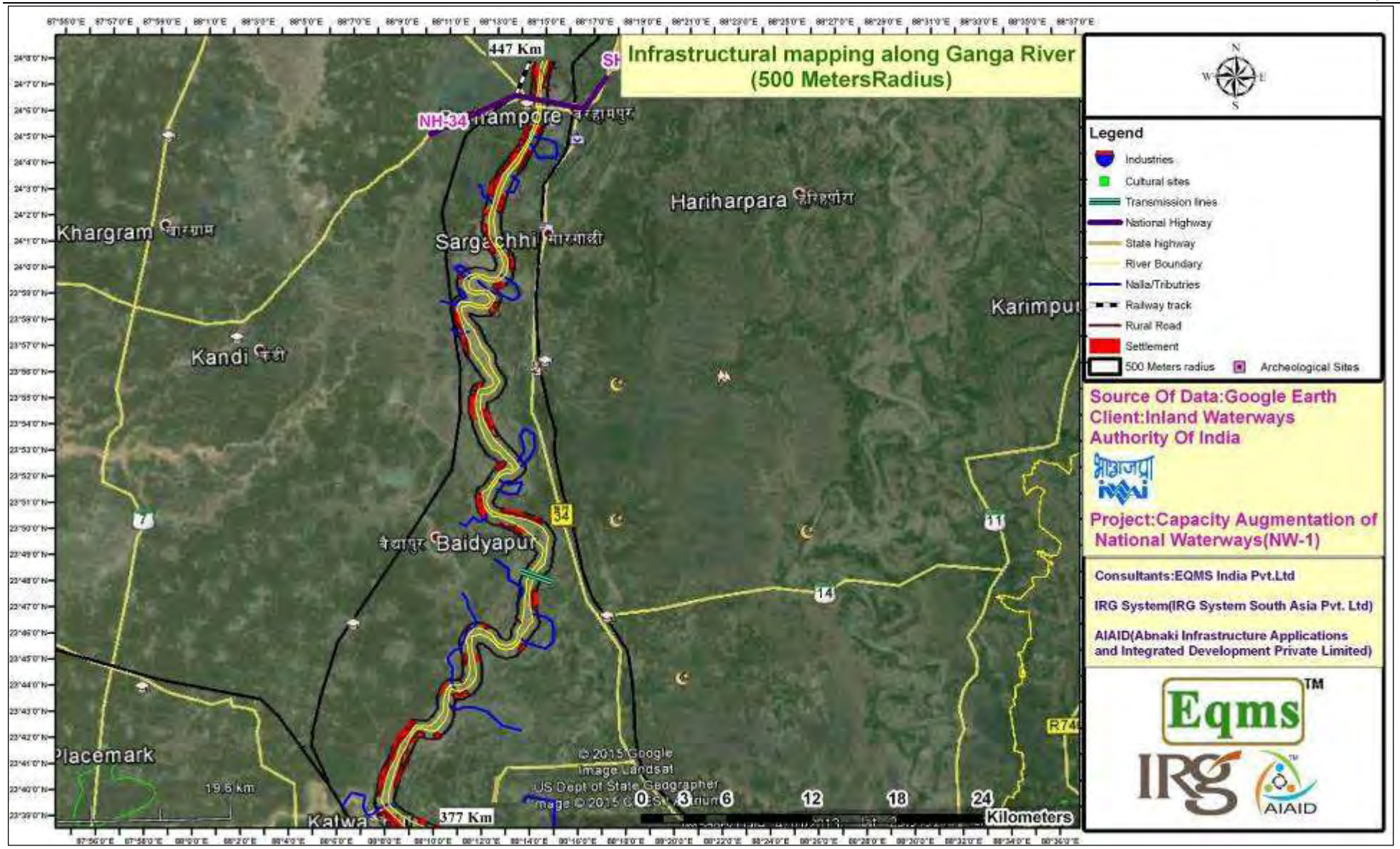


Figure 4.54 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 377- 447 km**)**

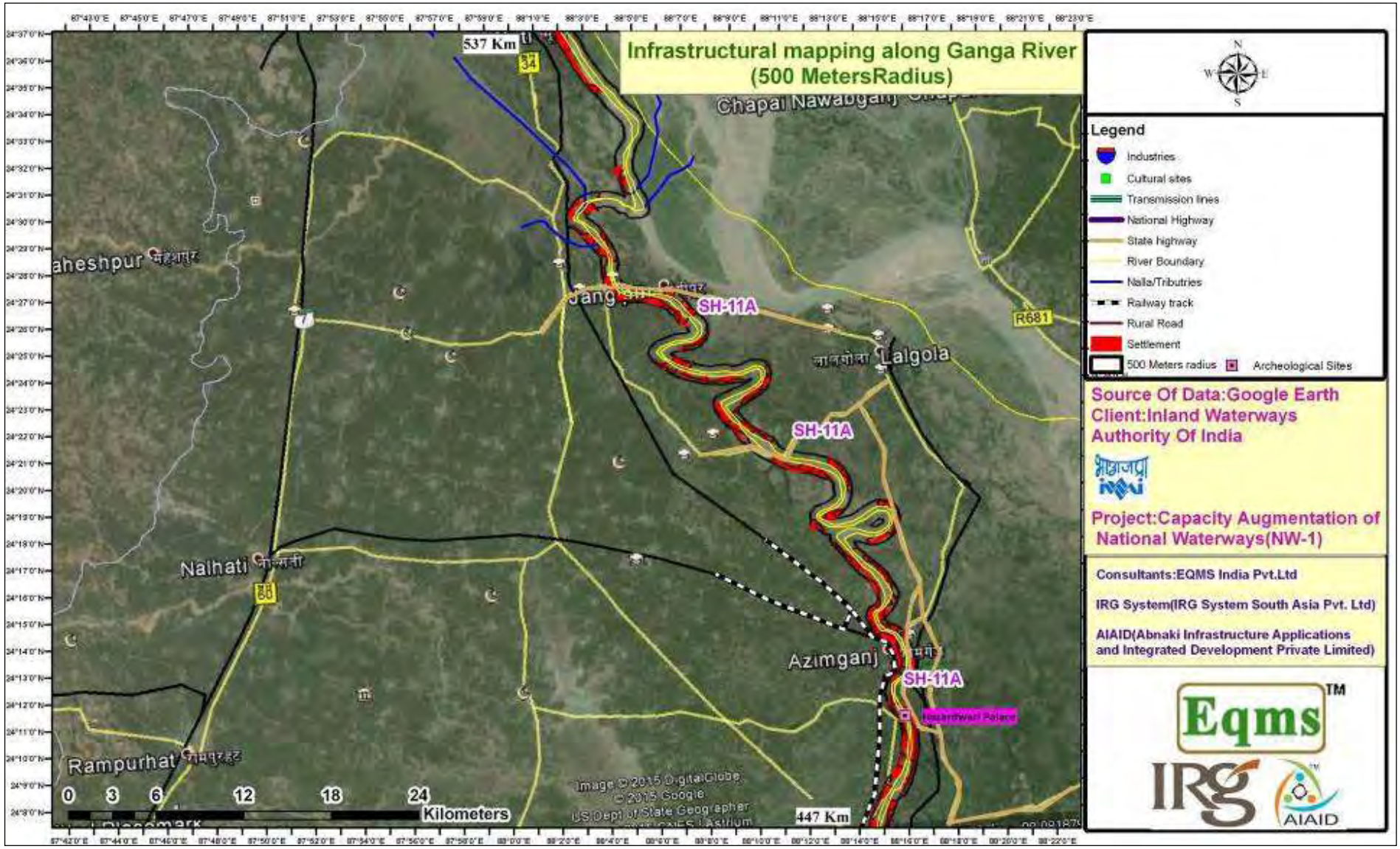


Figure 4.55 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 447-553 km**)**

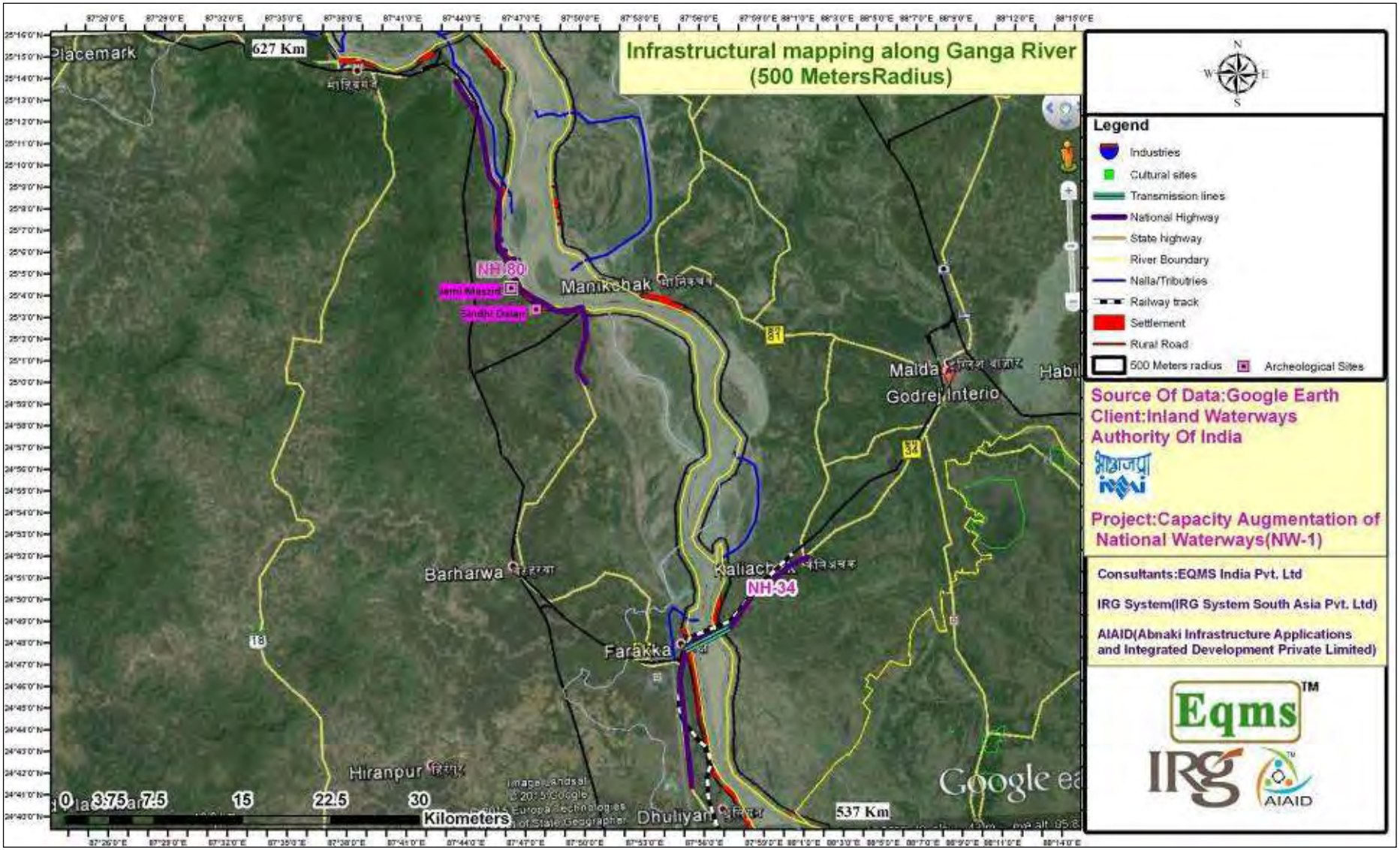


Figure 4.56 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 553-627 km**)**

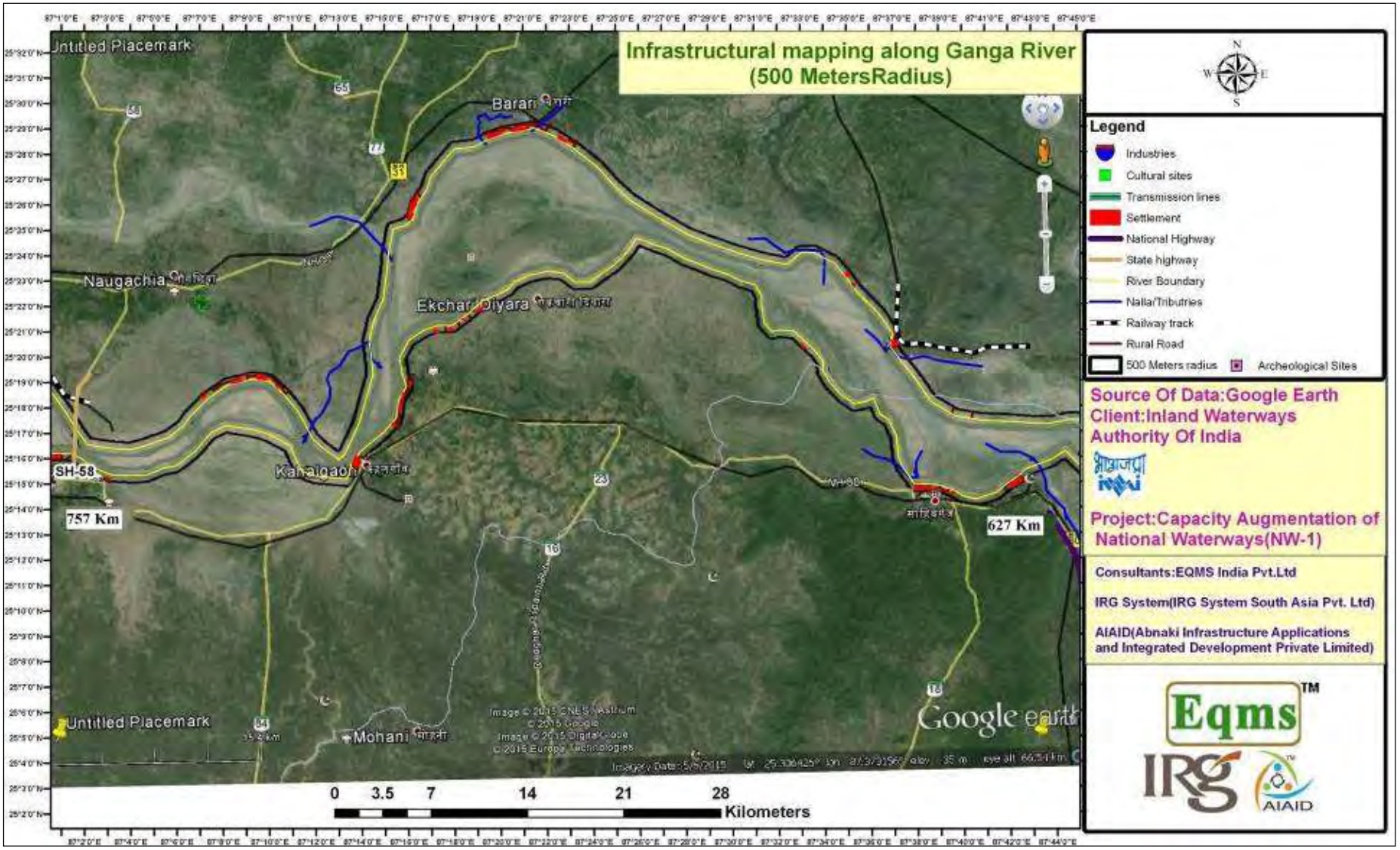


Figure 4.57 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 627-750 km**)**

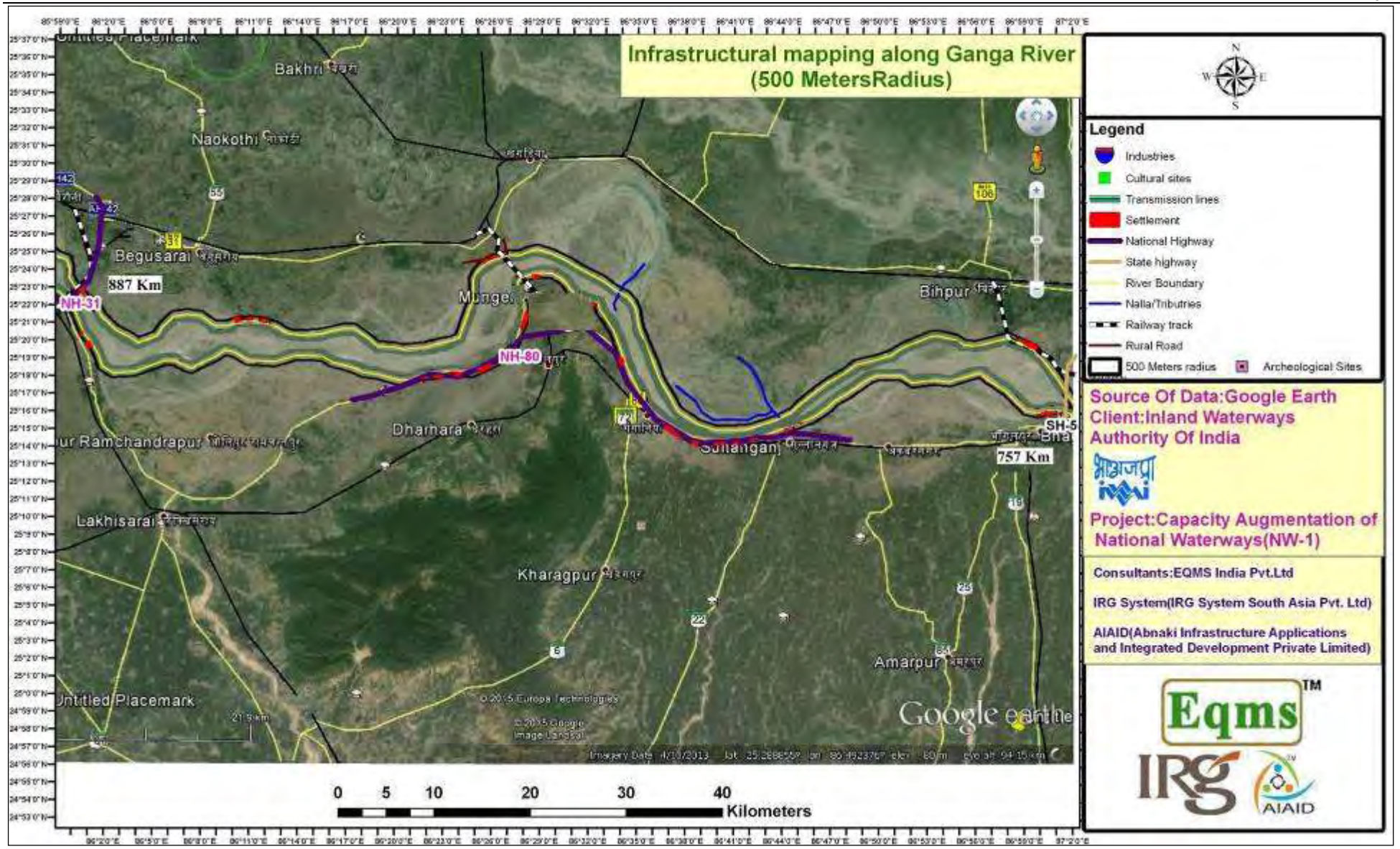


Figure 4.58 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 750-887 km**)**

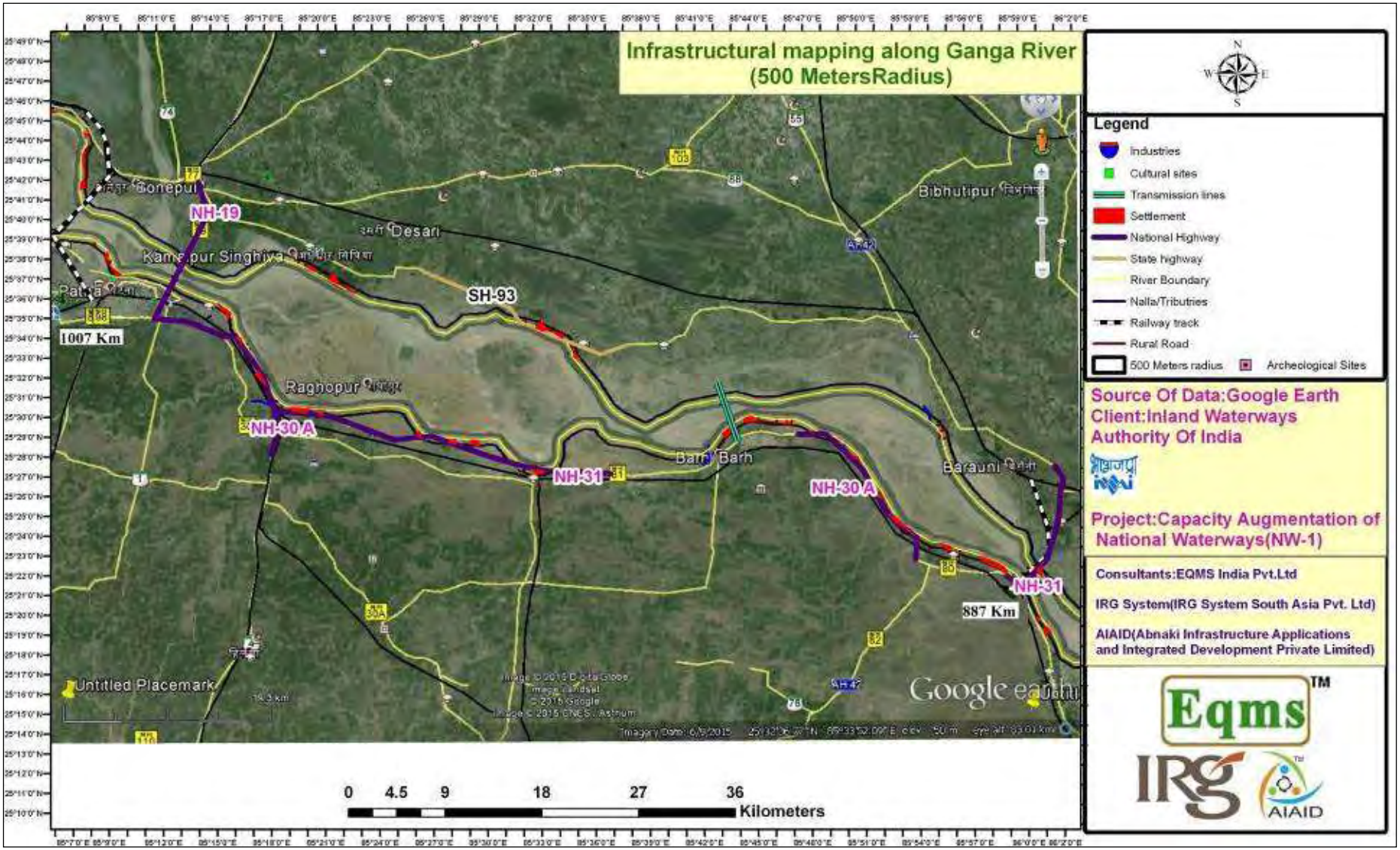


Figure 4.59 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 887-1007 km)

Figure 4.60 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1007-1147 km)

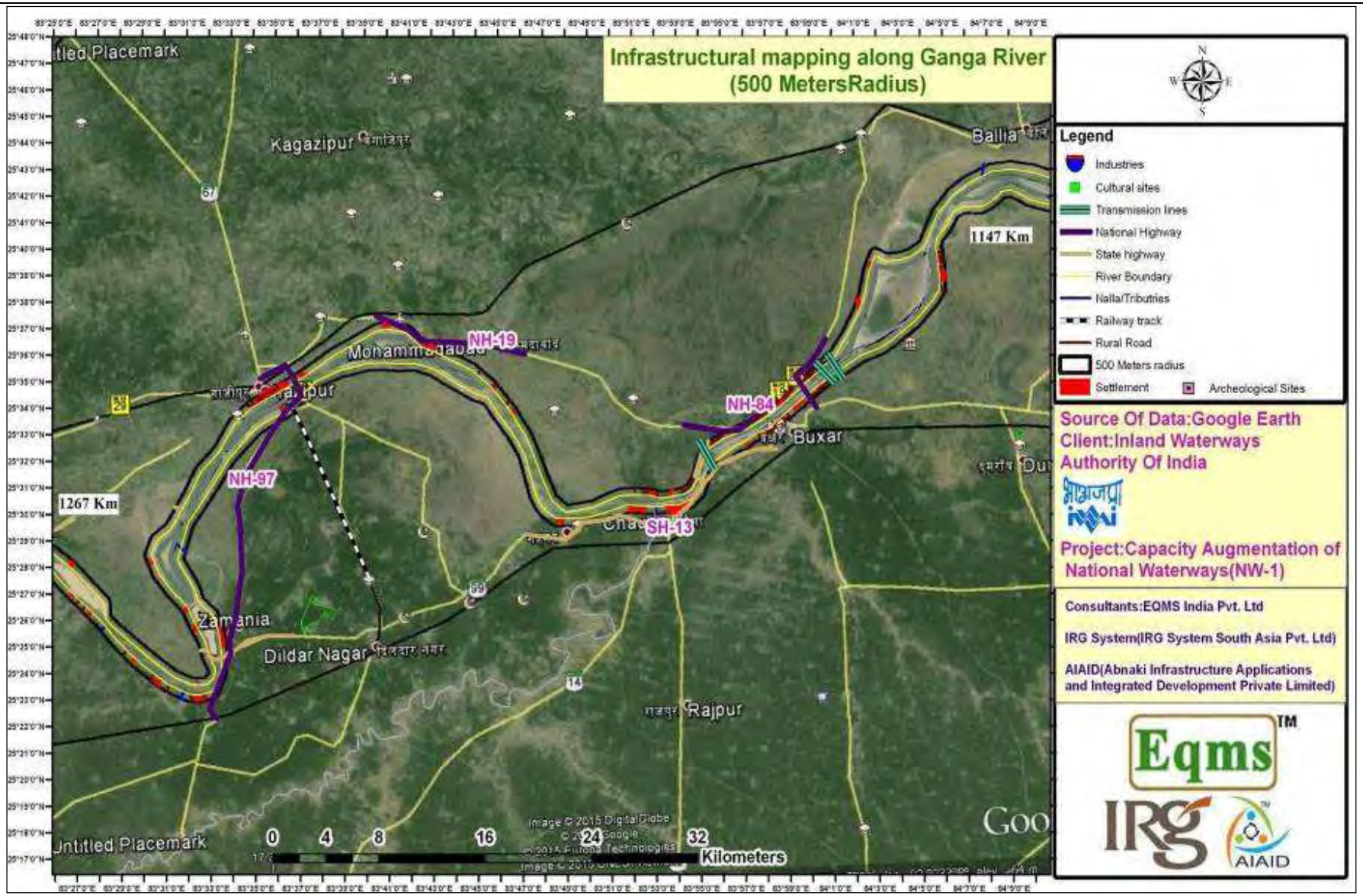


Figure 4.61 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1147-1267 km)

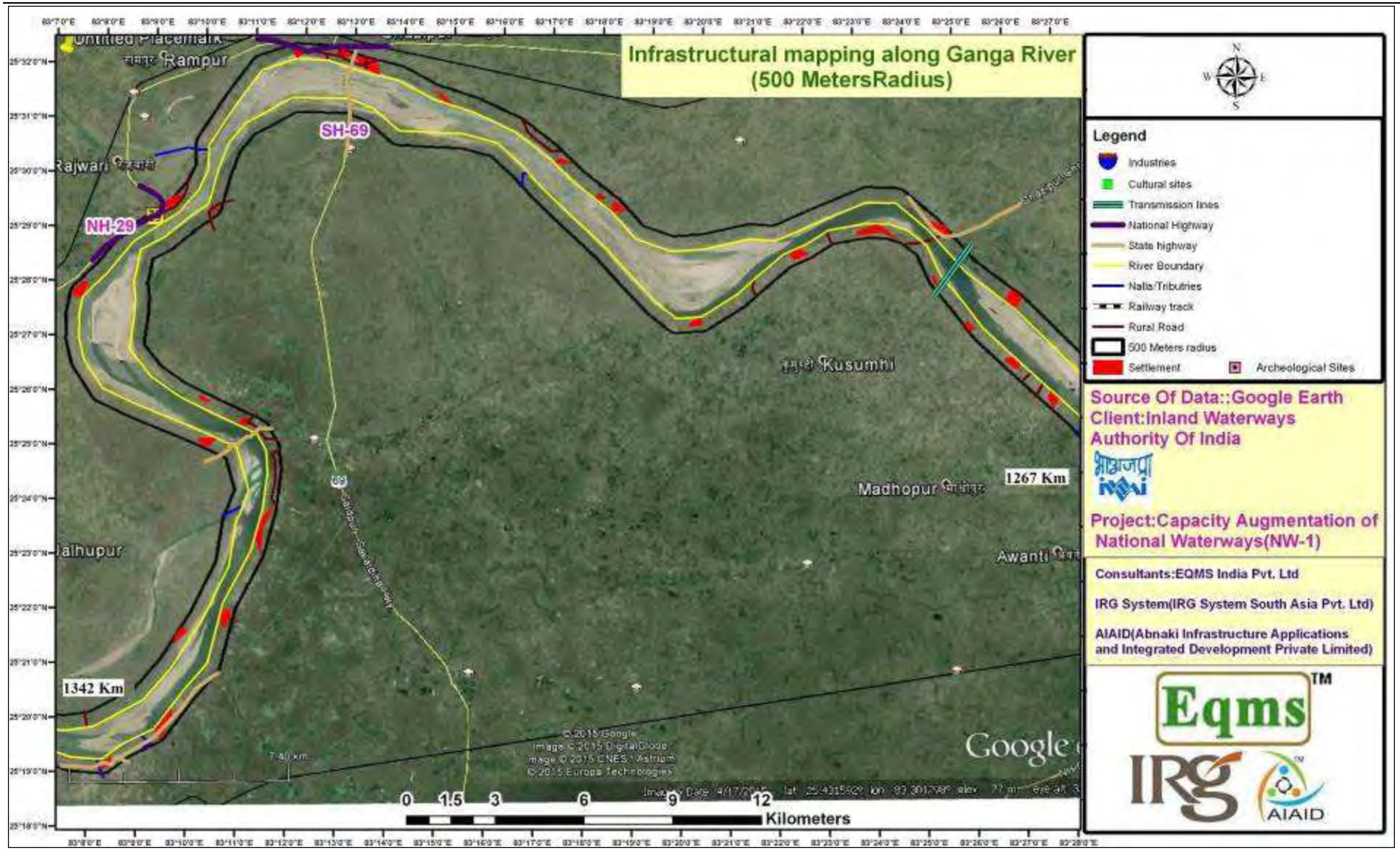


Figure 4.62 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1267-1342 km)

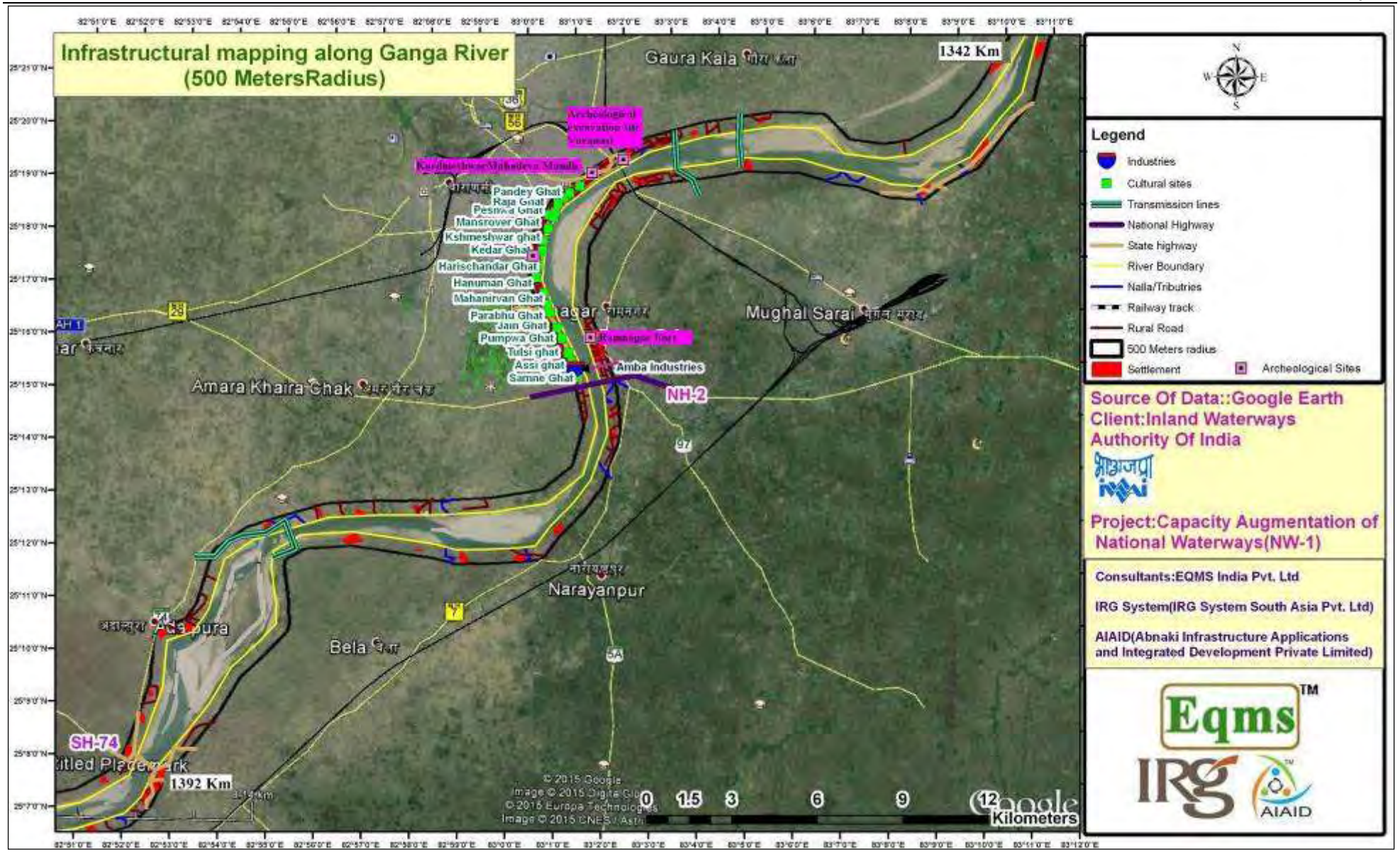


Figure 4.63 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1342-1392 km)

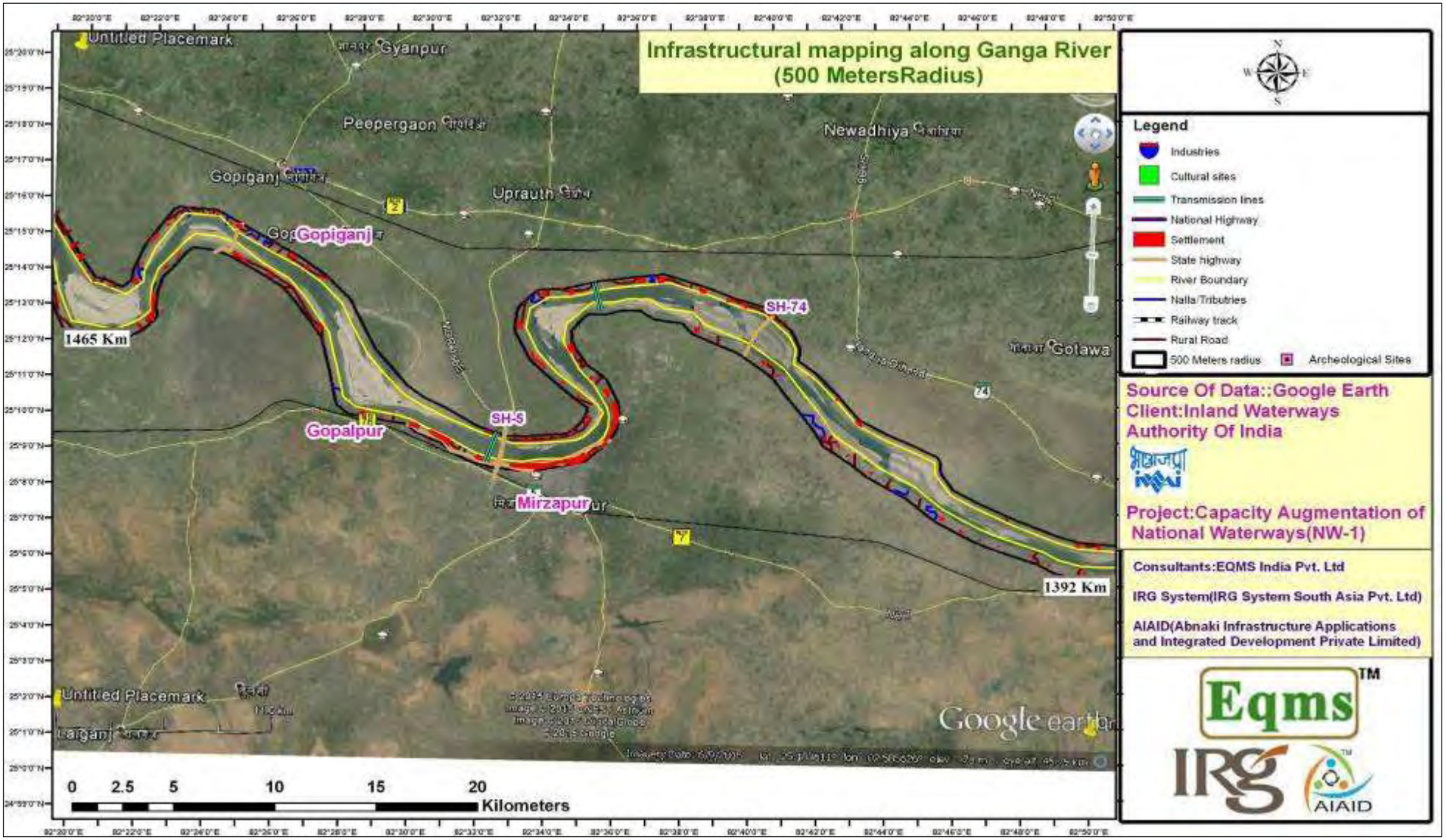


Figure 4.64 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1392-1465 km)

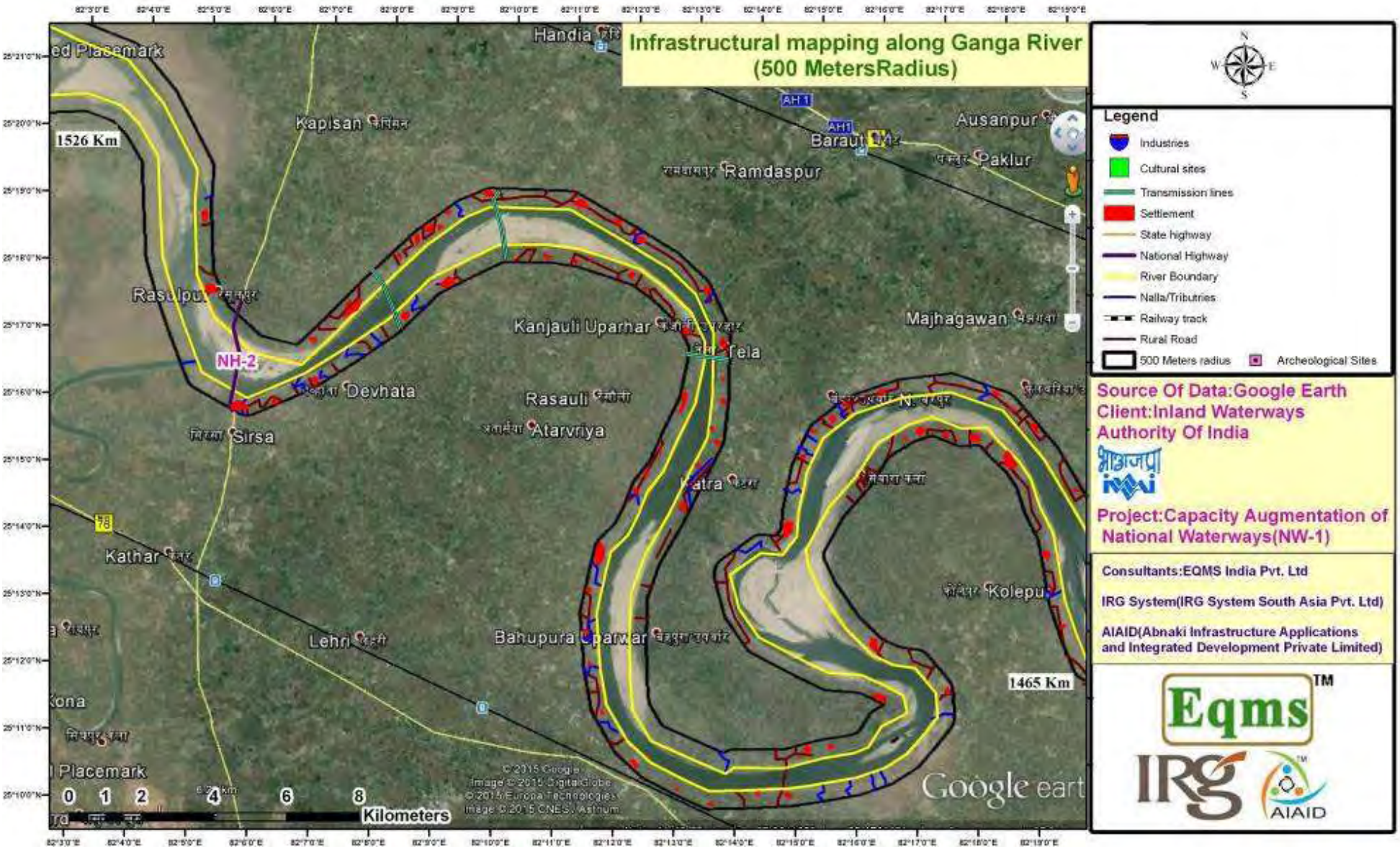


Figure 4.65 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1465-1526 km)

Figure 4.66 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1526- km)

4.8.6. *Cultural Activities and Religiously Important Places along NW-1and Important Festivals*

Ganga river is worshipped in India and holds an important place as it is considered sacred and holy river in Hindu religion. Hindu people believe that holy dip in river Ganga washes their sins. This dip is considered more important at religious places at Allahabad and Varanasi located along NW-1. Hindus also believes that that bathing in the river on certain special occasions and periods causes the forgiveness of sins and helps attain salvation. People also travel from distant places to immerse the ashes of their kin in the waters of the Ganga. This immersion also is believed to send the ashes to heaven. Various festivals are organised on the bank of rivers at different places and different period. These festivals attract very large crowds and may have bearing even on movement of barges in NW-1 during festival periods. The list of culturally and religiously important places with its festivals along the NW-1 is given at **Table 4.46**.

Table 4.46 : Culturally and Religiously Important Places with Fair and Festivals

S.No.	City	Place	Fairs & Festivals
1	Allahabad	Sangam	**Kumbh Mela:** The confluence of the 3 rivers Ganga, Jamuna and the sacred and mythological river Saraswati at Sangam is considered to be quite auspicious for the Hindu community. It is said that when Lord Vishnu carried a pot or Kumbha of Nectar or Amrita, a fight broke out among the gods. In the milieu, four nectar drops fell on the earth at the four place which are known as the Tirthas and include Nasik, Haridwar, Prayad and Ujjain. These places are therefore considered as place where the mortal humans can pass on to a celestial world form the human world. In each of these locations, there is a kumbha mela held but on the 12th year, the mela is organized in Allahabad as it is considered the most sacred of the Tirthas. The Greatest Kumbha Mela is held in Allahabad which is also known as Maha Kumbha Mela and is the biggest fair related to religious practices. **Magh Mela:** Apart from the Maha Kumbh and another Kumbh mela by the name of Ardh Kumbh, there is the Magh Mela.

			Maha Kumbh is held every 12th year in the city of Allahabad which is a sacred city in the state of Uttar Pradesh. As because the Magh Mela falls during the period of Magh months of Jan and Feb, so the name has been given. During this period, the devotees take a holy bath at the confluence of the 3 rivers believing that the waters will wash away their sins.
2	Varanasi	Ghats	There are more than 100 Ghats along the Ganga river at Varanasi (steps leading to the water of the Ganges). The banks of the Holy River at Varanasi are the most preferred cremation grounds.
		Ghats	**Panch Koshi Parikrama:** This parikrama starts and finishes at Manikarnika Ghat and has the great importance in ancient Parikrama of India. The devotee will pass through the five great places that's why it has named so behind this. The five places of which the devotees have to round up and complete his Panch Koshi Parikrama are Kardmeshwar, Shivpur, Rameshwar, Bhimchandi and Kapildhara. **Ganga Mahotsav**: This festival is being celebrated in the months of October and November which is the tourism festival of Varanasi that is being celebrated from Prabodhani Ekadashi to Kartik Purnima (November month) ending by a dance presentation at Ganga Mahotsav. The rich cultural heritage of Varanasi is being reflected by this festival. Besides various cultural programs and the boat racing the martial arts are also presented. This festival also corresponds with another traditional festival of Dev Deepavali in which all the Ghats of Varanasi are enlightened by thousands of Diyas. **Dhrupad Mela:** This mela is basically a music festival that is organized on the Tusli Ghat for five days (Feb or March month) in which the renowned artists of the area give their performances. This mela is especially famous among the foreign tourists.
3.	Bihar & Jharkhand	Ghats	**Chatth Puja:** Chhath is an ancient Hindu festival dedicated to the worship of the Lord Sun in November month and is mainly celebrated in Bihar and Jharkhand on the banks of Ganga.

4.8.7. *Tourism*

The river is of great cultural and religious significance for the whole Indian peoples. All of this makes the Ganges a must for all tourists who wish to encounter all of India's diverse beauty in terms of both culture and nature. There are many cities along the banks of NW-1 specially Allahabad, Varanasi and Kolkata which are important from tourism prospective and attract thousands of religious and non-religious tourists every year. Varanasi, a pilgrim place for Hindus and Buddhists alone attracts over one million pilgrims every year followed by Allahabad.

4.8.8. *Existing Waste Management Facilities along NW-1*

The municipal and bio-medical waste management facility is available at select cities only along the entire stretch of NW-1. Common Hazardous waste facility is available only at Haldia in NW-1 area. The status of these facilities in select cities along the NW-1 is described below:

Allahabad (Uttar Pradesh): Currently, the local body of Allahabad Municipal Corporation collects and dispose its the municipal solid waste through Allahabad Waste Processing Company Pvt. Ltd (AWPCPL at Solid Waste Disposal Site (SWDS) located near Kareli which is about 4 km away from the Allahabad railway station and functions on composting technology. The compost that is produced from this plant will be supplied to local agricultural farms.

Municipal solid waste treatment facilities in Varanasi (Uttar Pradesh): Varanasi Municipal Corporation (VMC) currently collects municipal waste and dispose to unorganized dumping site located 20 Km away from the city in Karsada. Construction of a treatment plant and organized landfill site is planned under JNNURM.

Bio-medical waste treatment facilities in Varanasi (Uttar Pradesh): Varanasi Nagar Nigam has established Common Bio Medical Waste Treatment Facility (CBWTF) at 310-MohanSarai, National Highway and is well managed.

Solid waste disposal Facilities in Patna (Bihar): Solid waste management is an overall responsibility of the Municipal Corporation as per Bihar Municipal act 2007 and MSW (management & Handling) rules 2000. Patna Municipal Corporation (PMC) is responsible for development of municipal waste land fill sites but it has yet to develop an organized land fill site. At present municipal waste is dumped to identified unorganized dumping sites. Bihar Urban infrastructure development Corporation Ltd.(BUIDCO) has also initiated the process of an integrated Solid Waste Management process plant at Patna on PPP mode with power generation capacity of 8 MW electricity.

Solid waste Disposal in Bhagalpur (Bihar): No organized or bio medical waste disposal facility is available in this city.

Solid waste disposal facilities in Kolkata (West Bengal): About 95% of total waste generated in Kolkata Municipal Corporation (KMC) area is disposed at Dhapa landfill site and the rest at Garden Reach dumping ground. 700 TPD compost plant is set up by M/S. Eastern Organic Fertilizer Ltd. with technical back up of Excel Industry, Mumbai. Plant was set up and commissioned in the year 2000 and operated at 200 – 250 TPD capacity till 2003. Since 2003 Eastern Organic Fertilizer has stopped operating the plant because they are unable to sell the compost with reasonable profit margin and failed to meet their commitments towards KMC.

Haldia (West Bengal): The first Common Storage, Treatment and Disposal Facility (CSTDF) for hazardous waste under the Public Private Partnership (PPP) have been developed at Haldia. It is a joint venture project of Haldia Development Authority (HDA) and M/s Ramky Enviro Engineers Limited. In April 2003, the HDA and M/s Ramky Enviro Engineers Limited formed a joined venture company under the name and style as M/s West Bengal Waste Management Limited to develop and operate the integrated waste management complex for taking care of the industrial hazardous wastes of West Bengal. Apart from these, the facility will also deal with the biomedical waste as well as municipal solid wastes for the adjacent municipal areas.

4.8.9. *Water Born Diseases*

Waterborne diseases increase where standards of water, sanitation and personal hygiene are low. Contaminated drinking-water is a frequent cause of diseases such as cholera, typhoid, viral hepatitis A and dysentery, malaria, dengue. The extent and effect of water born diseases in the states traversed by NW-1 are given at **Table 4.47** to **Table 4.50**.

Table 4.47 : Epidemiological status of Malaria in 2010 and 2011 in the States Traversed by NW-1

States	Year	Population	Cases	Deaths
West Bengal	2010	84908	134795	47
	2011	98922	66368	19
Jharkhand	2010	32187	199842	16
	2011	32928	160653	17
Bihar	2010	103230	1908	1
	2011	103483	2643	0
Uttar Pradesh	2010	188015	64606	0
	2011	194373	56968	0

Sources: National Vector Borne Disease Control Programme

Table 4.48 : State-Wise Dengue Cases and Deaths in the States Traversed by NW-1

No. Sl.	State	2008		2009		2010		2011	
		Case	Death	Case	Death	Case	Death	Case	Death

1	West Bengal	1038	7	399	0	805	1	510	0
2	Jharkhand	0	0	0	0	27	0	36	0
3	Bihar	1	0	1	0	510	0	21	0
4	Uttar Pradesh	51	2	168	2	960	8	155	5

Sources: National Vector Borne Disease Control Programme

Table 4.49 : Kala-azar cases and deaths in the States Traversed by NW-1

State	2007		2008		2009		2010		2011	
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
West Bengal	1817	9	1256	3	756	0	1482	4	1962	0
Jharkhand	4803	20	3690	5	2875	12	4305	5	5960	3
Bihar	37819	172	28489	142	20519	80	23084	95	25222	76
UP	69	1	26	0	17	1	14	0	11	1

Sources: National Vector Borne Disease Control Programme

Table 4.50 : AES/JE (Viral) Cases and Deaths (2006 – 2011) in the States Traversed by NW-1

Sl. No.	Affected States/UTs	2006		2007		2008		2009		2010		2011	
		Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
1	Uttar Pradesh	2320	528	3024	645	3012	537	3073	556	3540	494	3490	579
2	Bihar	21	3	336	164	203	45	325	95	50	7	821	197
3	Jharkhand	0	0	0	0	0	0	0	0	18	2	303	19
4	West Bengal	0	0	16	2	58	0	0	0	70	0	714	58
	Total (India)	2871	663	4110	995	3855	684	4521	774	5167	679	8247	1169

Sources: National Vector Borne Disease Control Programme
(Japanese Encephalitis (JE), Acute Encephalitis Syndrome (AES)

4.8.10. *Archeologically Protected structures (within 300 m of NW-1)*

The archeologically protected structures/monument[42] located within 300 m of NW-1 is listed at **Table 4.51** and **Figure 4.67**.

Table 4.51 : Archeologically Protected area around 300 m of NW-1

No.	Name	Latitude& Longitude	Place	Distance from NW-1 km	Direction from NW-1

[42]As per Indian regulation no construction activity can take place within 300 m of archeologically protected monuments/ structures/site without written permission from archeological department.

1	Kardmeshwar MahadevaMandir	25°19'13.13"N 83° 1'20.91"E	Varanasi, UP	0.24	W
2	Ramnagar, fort,	25°16'9.17"N 83° 1'28.17"E	Varanasi, UP	0.04	East
3	Archaeological excavation site, Varanasi	25°19'33.72"N 83° 2'4.47"E	Varanasi, UP	0.13	North
4	Manmahal and observatory	25°18'27.83"N 83° 0'38.55"E	Varanasi, UP	0.04	West
5	Sindhi Dalan	25° 3'15.32"N 87°49'51.17"E	Rajmahal, Jharkhand	0.3	West
6	Jami masjid	25° 4'25.73"N 87°46'39.01"E	Mangalhat, Jharkhand	0.14	West
7	St. John's Church	22°34'11.38"N 88°20'45.27"E	Council house street, Kolkata, WB	0.3	East
8	Temple of Gour Chandra and Krishnachandra at Chatra (Gaur Chandra Ghat)	22°45'48.96"N 88°20'13.76"E	Hoogly, WB	0	West
9	Hazardwari Palace	24°11'10.27"N 88°16'5.73"E	Murshidabad, WB	0.03	East

St. John's Church Kolkatta	**Hazardwari Palace Murshidabad**
Jami masjid Mangalhat, Rajmahal	**Sindhi Dalan, Rajmahal**
Kardmeshwar Mahadeva Mandir, Varanasi	**Archaeological excavation site, Varanasi**

Ramangar Fort, Varanasi	**Manmahal and observatory**

Figure 4.67 : Photographs of Archaeological& Cultural sites within 300 m of NW-1

Chapter 5. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

5.1. Introduction

Environmental Impact Assessment helps in identifying the likely impacts due to project activities for all stages of the project viz, design, construction and operation stage. Impacts are quantified using established practices, tools and mathematical models followed by identification of mitigation measures to mitigate the impacts to acceptable levels.

The project "Jal Marg Vikas" (NW-1) is a kind of a programme comprising of various infrastructural interventions such as construction of terminals, navigational lock, river training works, bank protection works, dredging for maintaining LAD, development of navigational aids and operation of barges. Project is at planning and feasibility stage. Impact analysis has been carried out for all proposed activities[43] under NW-1 and for all three broad aspects of environment namely physical, biological and socio-economic aspects. Key issues identified requiring greater attention are related to impact on aquatic ecology, impact on sensitive species namely Dolphins and Turtles, Water pollution, cutting of trees at intervention sites, noise and air pollution from barge movement and terminal operations, change in land use, dredge disposal, earth management at terminal sites, water availability and quality and socio-economy aspects.

5.2. Impact Identification

As is true with any major development project, NW1 development activities having many interventions, will interface with various environmental and social resources including air, surface and ground water, aquatic and terrestrial ecology, soil, hydrology, river morphology besides, social and cultural resources. Major activities identified during pre-construction, construction and operation phases which may cause impacts on the pristine ecological and/or socio-economic resources include activities such as site clearance/land acquisition, construction of different interventions, piling activities, material handling & transportation maintenance dredging and vessel movement. Adopting the requisite qualitative and/or quantitative (modelling) all potential impacts were assessed to further ascertain the significance of each likely impacts of the NW-1 development during all three design, construction and operation stages. Valued Environmental resources were identified during site visits to NW-1 and proposed intervention sites on which the incremental impacts due to NW1 activities were superimposed to assess the significance of impacts on valued environmental and socio-economic resources. Thereafter, cost-effective but appropriate mitigation measures are

[43]Three terminals namely Ramnagar at Varanasi, Sahibganj, and Haldia and Farakka lock are the four firm up interventions. Separate EIA has also been prepared for these interventions. Outcome of these EIAs has been included in this report as well.

No barrage is proposed for NW-1. DPR consultant has indicated a need of barrage for the operation of NW-1 between Varanasi and Allahabad. Since IWAI do not want to construct any Barrage on NW-1 NW-1 is likely to operate between Haldia to Varansi at this stage.

proposed to mitigate impacts and bring back the residual impacts within acceptable thresholds. An EMP has been designed to ensure the effective implementation of proposed mitigation measures (refer chapter 7). Identified impacts of the project activities on the environment and social components are given below in **Table 5.1** against each major activities associated.

Table 5.1 : Impact Matrix for NW-1

S. No.	Activities	Impacts	Negative Impact				Positive Impact		Specific Applicability in the Planned Components	Broad mitigation approach applicable to all similar impacts caused at various intervention sites under Jal Marg Vikas Project
			Short Term	Long Term	Reversible	Irreversible	Short Term	Long Term		
A	**Pre-Construction Phase**									
i	Site Clearance & Preparation	Removal of Vegetation. Loss of green cover including trees.		√	√				Major Tree felling is required in case of Sahibganj terminal project among the current planned interventions. The requisite compensatory plantation is proposed to compensate the loss.	Removal of vegetation like shrubs, herbs and some trees may be unavoidable at different intervention sites. Permission from forest department in UP and West Bengal and District Authorities in Bihar and Jharkhand is essential prior to cutting of trees besides, compensatory plantation to be carried out as per respective state policies.

		Impact on aesthetic values of project site	√		√				Restoration and rehabilitation of all such locations occupied or used for construction purposes immediately after the given task(s) is over	The aesthetic values of different intervention site may be disturbed due to construction activities Provision of project design to align the Restoration and rehabilitation of all such locations occupied or used for construction purposes immediately after the given task(s) is over
		Impact on microclimatic status caused due to tree cutting	√		√				--	The air pollution and GHG emission from different terminal and jetty sites will increase due to increased local traffic and/or tree cutting. Dedicated approach roads and improvement of haul roads should be considered to minimize the traffic congestion. Traffic management should be undertaken to avoid peak hours.

		Impact on Eco Sensitive Areas		√		√			Eco sensitive areas of Kashi Turtle Sanctuary and Vikramshila Dolphin Sanctuary are identified as restricted areas. No intervention is proposed in these areas to avoid any impact on these sensitive areas.	No intervention is proposed in eco sensitive areas to avoid any impact on these sensitive areas.
		Utility Shifting and Safety	√		√				Shifting of utilities is required in Sahibganj, and Haldia.	To be carried out during prior or during construction but without disrupting service to public.
		Change in Land Use	√		√				Change in land use from agriculture to industrial in all identified locations except at Haldia	Necessary permission from the area development authorities and local bodies to be obtained prior to development
		Change in Topograp hy	√	√					Filling of site is required at Haldia,	Natural drainage pattern to be maintained by provision of adequate drainage
ii	Acquisition of Land	Displacem ent of People (R & R)		√	√				Land acquisition in case of Sahibganj, and Varanasi	Due compensation and other support to be provided to affected families as per RAP.

		Loss of Livelihood		√	√				Land acquisition in case of Sahibganj, and Varanasi	Shall be given adequate compensation and alternate livelihood options and assistance as suggested by people during public consultation
B	**Construction Phase**									
i	Construction of Terminal	Loss of Top soil		√	√				Top soil shall be preserved and used for land escaping and green belt development at site or other locations.	The top soil shall be preserved and used for landscaping purpose and shall be given to farmers in nearby areas, if asked by them

		Soil contamination due to spillage of material	√		√				Provision made for Sewage Treatment plant, maintenance waste collection and treatment before reuse. Concreted floor for storage of fuel and oils Excavated earth shall be reutilized to the extent possible in the construction activity and balance will be used for road construction or disposed for designated places like mines in case of Sahibganj.	Clean-up operations shall be taken up immediately after spillage. Debris and excavated earth should be disposed as per defined plan.
		Surface water contamination	√		√				Turtle sanctuary lying at app. 2.3 km distance from the Varanasi terminal site and the waters near Sahibganj terminal supports dolphins. Thus the utmost care should be taken at these locations to minimize surface water pollution and impact on these species.	Measures should be taken to prevent contamination of run-off and mixing of contaminated run-off with River.

		Air pollution	√		√				Habitations are located close to the site at Sahibganj Terminal site. Provisions are made for air dust pollution on land or water during material handling, loading and unloading.	Measures to be taken to minimize air pollutant generation by minimizing usage of DG sets, using low Sulphur diesel, implementing proposed air pollution control measures etc. No air pollution causing activities should be carried out in upwind direction of any settlement or sensitive area

		Noise pollution	√		√				Habitations are located close to the site at Sahibganj Terminal site. Measures are proposed for noise reduction.	Measures to be taken to minimize noise levels by DG sets & other machinery/equipment provided with acoustic enclosures. Noise causing activities should not be carried out close to settlement areas and during night hours.
		Increase in Traffic-Congestion	√		√				Measures are proposed to avoid traffic congestion where required	Traffic management required so as to avoid traffic jams if any such situation arises.
		Temporary change in Aesthetic (Unpleasant view)	√		√				Restoration and rehabilitation of the areas occupied or used for construction purpose immediately after use is over.	Restoration and rehabilitation of the areas occupied or used for construction purpose immediately after use is over.
		Impact on Health & safety of Workers and people in nearby areas	√		√				provision to minimize exposure to Workers. Use of PPEs and safety precautions defined.	Exposure to pollutants will be only during construction phase. Mitigation measures shall be taken to minimize pollutant generation

		Social impact	√		√		√		--	Exposure to pollutants, loss of land, loss of livelihood, displacement etc., all are negative impacts. These can be minimized taking suggested mitigation measures Generation of employment is positive impact of the project

		Impact on Aquatic Ecology	√		√				Impacts anticipated at all the intervention locations due to proposed construction, and pilling activities. Adequate preventive measures are proposed to minimize the impacts.	Measures should be taken to prevent contamination of run-off and mixing of contaminated run-off with River.
		Felling of Trees-Reduction of vegetation cover		√	√				Provision are made for compensatory tree plantation should be carried out as per State Forest Policy	Compensatory tree plantation should be carried out as per State Forest Policy
		Bank-bed erosion: River Training Shore/scour Protection Works-		√		√			Adequate shore & scour protection measures should be taken at Sahibganj terminal, Varanasi terminal and Farakka Lock site	Required at various stretches along the NW-1 to maintain navigation channel. Shore/scour protection works may be required at the proposed civil intervention sites as per requirement to prevent bank and bed erosion
C	**Operation Phase**									

i	Movement of Vessels/Barges, loading and unloading activity, storage of material, transportation of material via road &railway, and Maintenance Dredging Operations	Microclimate and GHG emission		√		√		√	GHG emissions are likely to be increased in the areas near the vicinity of the proposed civil interventions like jetties and terminals due to increased traffic movement. Also tree cutting is envisaged at proposed intervention development sites especially Sahibganj. Both the factors together may contribute in micro climatic changes in the area. For the same compensatory plantation should be carried out minimum as per state forest policy, installation of mechanical transportation mechanism for unloading & loading of barges and development of thick peripheral and avenue plantation. GHG emissions may also increase due to operation of dredgers (fuel based)	Overall GHG emissions will be reduced due to shift of freight from road/rail to waterways and thus improving the microclimatic conditions as waterway movement cause least emission generation when compared to road & rail. Thus reduced GHG emissions will contribute in reducing the enhanced anthropogenic climate change.

		Air Quality (material handling and spontaneous fire in coal stockyards)		√		√		√	Air emissions near the proposed civil intervention sites like jetties & terminal are like to increase due to increased vehicular movement and removal of the vegetation near the intervention sites. Air emissions are expected to be generated from dredgers.	Air emissions in overall NW-1 stretch will reduced as the vehicular movement and fuel burning in transportation of cargo will be reduced significantly due to shift of cargo from road/rail to waterways. In addition to this it is made mandatory to have thick green belt area and avenue plantation at all proposed intervention sites.
		Economic Development & Generation of Employment						√	Yes. Development of proposed interventions and dredging operations will generate employment option for skilled, unskilled and semi-skilled people.	Development of project overall will bridge the gap between demand and supply due improved cargo transportation efficiency. Thus this will increase the manufacturing capacity of the industries generating more employment directly & indirectly.
		Infrastructural development						√	Proposed civil interventions will attract the infrastructural development in close vicinity	--

		Increased Run-off & alteration of natural drainage pattern		√	√				Development of the proposed interventions will increase the paved surfaces and thus the run-off will increase and natural drainage pattern will be altered. However, storm water drainage network is design so as to collect and reuse the water for dust supersession at the terminal itself.	Provision shall be made for rain water and collection and reuse. Provision shall be made for peripheral drains for redirecting the rain water flow to maintain natural drainage pattern around the intervention sites.
		Noise Pollution		√	√				Increased noise generation anticipated at proposed intervention sites like terminal, jetty and lock site due to increased vehicular movement & material handling but the noise can be managed by taking proposed noise management measures in sections below. Noise is also likely to increase due to dredging activities. Provision is made to green belt is made as natural barrier at site in additional to other feasible mitigative measures	Provision shall be made for thick green plantations at terminal sites as natural noise barrier. Other noise reduction at source measures should also be taken as feasible.

		Surface Water Pollution	√		√				Zero discharge option is proposed at all terminals site to minimize water pollution from the site. Dredging poses threat to surface water quality due to release of sediments however these being non-contaminated as per test results, impact is expected to be confined to small area around the disposal sites. .	Degraded water quality due to barge movement, release of waste/waste water from barges/ballast water/material spillage during accident/collisions/maintenance hubs/workshops etc. Proposed water quality management measures should be taken to prevent/minimize the impacts

		Ground Water		√		√			Extraction of ground water may be required at locations where civil interventions like terminal/jetty are proposed. Extraction should be as per CGWB guidelines. Ground water recharge should be done as per CGWB guidelines.	Ground water may get polluted if the dredged material is disposed or stored on land
		River Hydrology		√		√			Shore protection and scour protection measures will be taken at proposed civil intervention sites. These may have some impacts on river hydrology Dredged material can also be used for river protection works if feasible reducing requirement of construction material	Bend correction and river training works are required and are proposed at many locations to maintain the navigation channel. These measures may have some impact on the natural river hydrology.

		Health & Safety		√	√				Increased air emissions and degraded water quality may have significant impact on health of working population and population residing in nearby areas of proposed interventions. Impact will be limited to locations where interventions are proposed and are manageable if proposed mitigation measures are implemented. Dredging operations can pose accidental and health risks for workers and waterway users	--
		Soil Erosion and Contamination		√		√			Proposed civil intervention works enhances the probability of erosion of bank and scouring of bed. River bank and bed protection measures should be taken and are proposed at Sahibganj terminal, Farakka lock & Varanasi terminal.	River training works may be required at different locations such as bend correction locations at NW-1.

		Terrestrial Ecology						√	A thick green belt and avenue plantation shall be carried out at all the sites of proposed interventions. Survival rate of the planted species within the terminal site and at other compensatory plantation site will be maintained to minimum 70%.	--
		Aquatic Ecology		√	√				Aquatic ecology will be impacted at the locations where civil interventions and river training works are proposed. Dredging works will lead to disturbance of aquatic ecology due to removal of sediments dwelling benthic community, and high underwater noise.	Aquatic ecology of entire NW-1 may be impacted due to plying of barges, spillage of material from barges, dredging and disposal of dredged material, and river training works. Measures as suggested in EMP shall be undertaken so as to prevent the impacts on aquatic ecology of the area
		Aesthetics						√	Will be improved due to development of infrastructure, green belt and other facilities.	--

5.3. Impact Assessment of NW1

'Jal Marg Vikas" NW-1 project has many components namely Terminal construction, navigation lock construction, maintenance dredging, river bank protection, river training, Ro-Ro jetty construction, navigational aids and barge operations. Some components have already been finalised and some are under finalisation stage depending on the feasibility. The finalised components are terminals at Varanasi, Sahibganj, & Haldia and navigation lock at Farakka. Other terminal sites and intervention are being finalised. This EIA reports covers impact associated components of NW-1 (finalised or planned components both). Output of EIAs prepared for finalised components is used as reference input carrying out impact assessment of all components. Impact assessment has been carried out for all design, construction and operation stages of the project implementation. Impact has been separately carried out for dredging, barge movement, intervention constructions, and climate change. The impact is assessment is presented under following four major groups head.

A. Impacts due to Maintenance Dredging for maintaining minimum LAD in navigation channel
B. Impact due to Vessel Movement
C. Impact on Climate Change due to NW1
D. Impacts due to Civil Interventions

A. Impacts due to Maintenance Dredging for maintaining minimum LAD in navigation channel

5.4. Impacts due to Maintenance Dredging & Dredge Sediments Disposal Operations of NW-1

NW-1 aims to maintain navigation channel width of 64m and side slope of 1:10 from Haldia to Varanasi. Maintenance dredging is an essential continual activity for navigation channel to maintain the requisite LAD in different NW1 stretches to facilitate smooth and efficient navigation. Maintenance dredging is to be carried out periodically as per requirement during project initiation as well as during entire operation phase of the project. To meet the objective of project, IWAI though wanted to maintain LAD of 3 m in entire NW-1 but for optimizing the dredging requirement certain minimal LAD are defined for different stretches of NW1 as indicated below:

- Haldia to Farakka (544 km) : 3 m (naturally available LAD)
- Farakka to Barh (347 km) : 3 m
- Barh to Buxer (233 km) : 2.5 m
- Buxer to Varanasi (18 km) : 2.2 m
- Varanasi to Allahabad : No maintenance as no operation is proposed at this stage

The above LAD rationalisation will reduce dredging requirement from 31.08 million cubic meter at 3m LAD to 15.76 million cubic meter which amounts to reduction of more than half of dredging volume there by reducing the impact to the extent more than 50%. Apart from

maintenance dredging for navigational channel, additional dredging for terminals/jetties are also required. No significant dredging is envisaged at Varanasi and Sahibganj terminal. However, additional dredging to the tune of 3-6 million cubic meter may also be required at Haldia terminal site to give it 24X7 accessibility. These additional dredging are required to ensure perennial navigability for whole year at terminal sites.

Table 5.2 indicates the stretch where dredging is planned with corresponding associated environment, cultural and social sensitivities of the respective river stretches. Impacts of dredging operations in NW-1 are assessed considering the respective sensitivities.

Table 5.2 : Impact Identification Matrix for Maintenance Dredging

Stretch **(Stretch length in KM)**	**Dredging Quantity in cum**	**Important Aquatic Ecology Zone** **(distance and direction from NW-1)**	**Important Avi-fauna sites** **(distance and direction from NW-1)**	**Archaeologically Sensitive Locations within 300 m from NW-1 on each side (distance and direction from NW-1)**	**Locations Having Cultural & Socio-economic Importance**	**Likely Impacts and Remarks**
Haldia to Farakka (544)	16,62,592	Hilsa Sanctuary (Within NW-1)- at 4 locations	Farakka Barrage and adjoining area (Surrounding NW-1)	St. John's Church (300 m, E) Temple of Gour Chandra and Krishnachandra at Chatra-Gaur Chandra Ghat (0 m, W) Hazardwari Palace (at 30 m, E)	None specific	No significant dredging proposed within this stretch hence, no significant impact anticipated. However, 0.1 – 0.2 mn cum of sediments are required to be dredged at Haldia Terminal site only. Its disposal will have associated impacts.
Farakka to Barh (347)	56,18,132	Vikramshila Gangetic Dolphin Sanctuary (VGDS) of River Ganga (Within NW-1	Udhwa Lake Bird Sanctuary (9 km, W)	Sindhi Dalan (at 300 m, W) Jama Masjid (at 140 m, W)	Community Temple at Sahibganj Terminal site (proposed to be shifted)	No dredging is proposed at Vikramshila Gangetic dolphin

		bout 60 Km long stretch)	Bird Area - Vikramshila Gangetic Dolphin Sanctuary (within river stretch) Mokama Taal -Barah Wetlands (Along NW-1) Kurseala River Course and Diyara Flood Plains (along river)			sanctuary and within 10 km radius of sanctuary area. Kurseala is within 10 km radius of VGDS. Impact of dredging on avifauna may be due to noise which gets attenuated beyond 500 m of dredging locations to the prescribed day time ambient noise level of 55 dB(A) for residential areas. Noise impact on avifauna of Udhwa sanctuary thus is considered minimal. Mokama Taal is close to river and its avi fauna can be impact from dredging noise. Dredge material in this stretch not found contaminated. Its disposal in river is

						likely to have impact on aquatic ecology and water quality.
Barh to Patna (64)	22,87,099		None	None	Ghats at Patna	Non as no sensitivity associated. Dredge material in this stretch is not found contaminated. Its disposal in river is likely to have impact on aquatic ecology and water quality.
Patna to Buxar (169)	32,62,123		Danapur cantonment area (at 2 km, S)	None	None specific	Impact of dredging on avifauna may be due to noise which gets attenuated beyond 500 m of dredging locations to the prescribed day time ambient noise level of 55 dB(A) for residential areas. Noise impact on avifauna of Danapur Cantonment zone thus is considered

						minimal. Dredge material in this stretch not found contaminated. Its disposal in river is likely to have impact on aquatic ecology and water quality.
Buxar to Varanasi (187)	29,30,650		None	None	None specific	Dredge material in this stretch not found contaminated except marginal higher cadmium as per US standard at two locations. However, this level is also well below the aquatic sensitivity analysis reported by Canadian guidelines44. Its disposal in river is likely to have some impact on aquatic ecology and water

[44]There are no Indian Standard for Bed sediment levels and aquatic sensitivity. In absence of Indian standards assessment is carried out against international standards and guidelines.

						quality.
Varanasi to Allahabad (236)	Nil	Kashi Turtle Sanctuary (within river water about 7 km stretch)	None	Kardmeshwar Mahadeva Mandir (at 240 m, W) Ramnagar, fort (at 40 m, E) Archaeological excavation site, Varanasi (at 130 m, E) Manmahal and observatory (at 40 m, W)	Ghats (0 m, W)	No impact anticipated on these archaeological sites and Kashi Turtle Sanctuary as no dredging is proposed in this stretch.
Total (1547)	1,57,60,596 (option 2)	--	--	--	--	
Total Dredge Quantity (if LAD is maintained 3 M through the stretch)	3,10,79,576 (option1)					

Dredging quantity substantially increases under option 1 primarily between Buxer to Varanasi and Varanasi to Allahabad. Nature of impact in both the cases remains the same except that duration of impact will increase between Patna to Allahabad. Since IWAI propose to implement option 2 only at this stage, impact analysis is presented in the following section considering option 2 itself. CSD dredgers are primarily proposed to be used for dredging. Plough dredgers can be used for shallow areas if required but such situation are likely to be very minimal. Dredge material is proposed to be disposed to faster flowing water downstream, to side of the working dredgers or to secondary channel or redundant channels. No dredge material is proposed to be disposed outside the river except in case of Haldia terminal. Impact is anticipated only on the following components of environment only considering the environmental sensitivity presented at **Table 5.2** above, the nature of dredgers and dredge disposal method proposed:

- Impact on Physical Environment: on Water Quality and Land
- Impact on Ecological Environment: On aquatic Ecology and Avi Fauna
- Impact on Socio-Economic Environment: Cultural, Archaeological and Livelihood of Fishing community

5.4.1. Impact of Dredging and Dredge Sediment Disposal on Physical Environment:

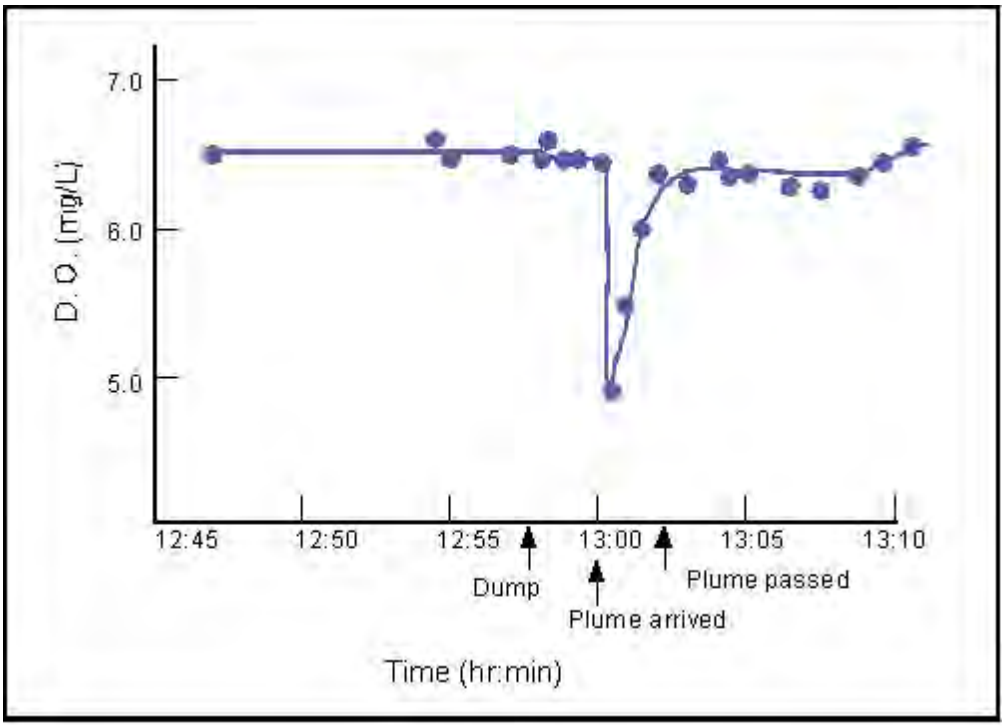
5.4.1.1 Impacts on Water Quality

Impacts due to Dredge Disposal in water as slurry:

Impacts on water quality due to dredging activities are variable in space and time depending upon the turbidity and suspended solids levels and are domination in light transmittance of river water, reduced DO, changes in salinity, temperature, pH, availability of river water nutrients, and heavy metals/chemicals. Most significant change in water quality results due to the spread of dredged materials plumes[45] resulting in changes in river water characteristics as mentioned above.

DO Level: Dredging leads to re-suspension of the oxygen deficient sediments. When these sediments come in contact with the water, the oxidation results thereby reducing the DO of the river water. As per a study in US about effect of river bed sediments (dredged material) disposal on dissolved oxygen in river, the dissolved oxygen level comes down suddenly by 2 to 2.5 mg/l for maximum of 2 minutes only at the dredge plume arrival point which regains the DO level within maximum of 3-4 minutes as plume passes. (refer **Figure 5.1**)

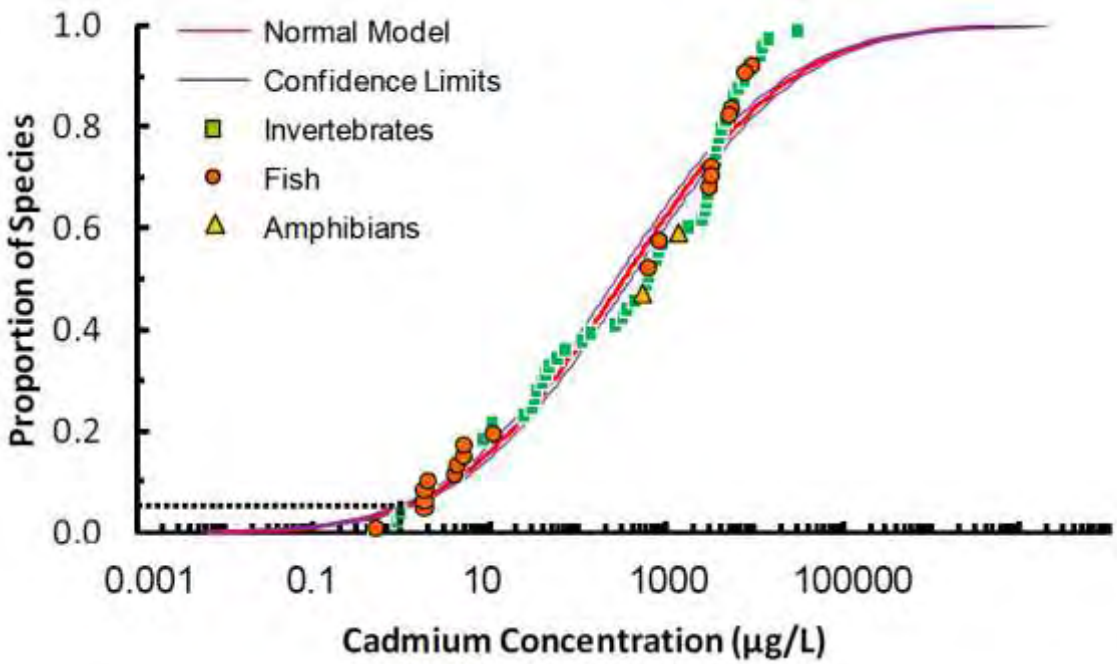
[45]As per planning CSD dredgers are likely to be used in most cases and dredge river bed sediments are proposed to be disposed about 200m away from dredging point through a pipe in flowing water channel in slurry form.



(Source: Water Quality Aspects of Dredging and Dredged Sediment Disposal byG. Fred Lee & Associates, California)

Figure 5.1 : Oxygen Depletion Rate vs Time for Dredge Disposal

Heavy Metals and Chemicals Toxicity: In case the sediments dredged are contaminated with heavy metals or toxic chemicals then there may be chances of dissolution the heavy metals/pesticides/chemicals in the water resulting in degradation of water quality. However as per analysis of different river bed sediments carried out across the NW-1 at probable maintenance dredging locations, reveals that the river bed sediments are non-toxic except in Allahabad to Varanasi and Varanasi to Buxer stretches where Cadmium level is found marginally higher compared to US standard (refer **Figure 4.22 to 4.25 and Table 4.24**). However, this higher level is unlikely to have toxic effect on aquatic life considering the sensitivity level to cadmium exposure (short terms at LC_{50} level) to aquatic life as per Canadian Guidelines and presented at **Figure 5.2**



(source: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, 2014)

Figure 5.2 : Short-term Species Sensitivity Distribution (SSD) for Cadmium in Freshwater derived by fitting the log-normal model to the short-term LC50s of 62 aquatic species.

Pesticides Presence: The river bed sediment test results (refer Table 4.24) indicate presence of pesticide in traces and much below the safe limit defined by USA. The pesticide presence will not have any significant impact on river water quality due to very low pesticide concentration and high dilution available in river. In anoxic sediments, sulphur occurs in forms of sulphides, which gets oxidized to sulphate ions leading to reduction in DO and decrease in pH of the water which may results in slight increase of acidity. Acidic waters are generally corrosive in nature. Aquatic species ranging from planktons to large fishes are sensitive to river water pH and can strive in specific pH range only. However, considering the very large volume of water and with dilution effect pH is unlikely to change to acidic level.

Turbidity and Ferrous Effect: Hydraulic dredging involves slurrying the sediments with water in a one-part sediment to four-parts water mixture where this mixture is typically then proposed to be pumped as a slurry through floating pipe for disposal to flowing water channel away from (about 200 m) from dredging site. This dredging and disposal action will lead to increase in turbidity around dredging point and at disposal point.

To analyse the effect of dredging on turbidity by CSD, primary data analysis was carried out for at varying distance before and after the dredging point. These results are presented at **Table 4.23.** It establishes that turbidity of water increases substantially

close to dredging point but it reduces with distance and almost get normalise at a distance of 700 m from dredging point. The instantaneous suspended sediment concentration due to disposal of dredge slurry results in the plume of fine and coarser sediments. The plume is dispersed over a significant distance by the river flow at the point of disposal which also leads to increased sediment dispersion. Coarser sediments settle much faster and at shorter distance. Fine sediments also settle faster due to the presence of iron in dredge sediments. Iron in sediments exists in a ferrous form[46]. Upon contact with waters containing dissolved oxygen, it is rapidly oxidized by the dissolved oxygen to ferric iron which precipitates as ferric hydroxide. Freshly precipitated ferric hydroxide has a large surface which can sorb (act as coagulant) significant amounts of a wide variety of constituents released from the sediment in water. While they are released, they are rapidly taken back to the sediments by the ferric hydroxide scavenging. Ganga river carry high sediment load and its aquatic life is accustomed to high sediment level of river. The most of fishes' activities are found in 15-30 cm depth of the river. The fishes' activities may be impacted depending on the depth of discharge of dredge sediment slurry in the flowing river. The impact is likely to be minimal considering the quality of dredge sediments. This impact on aquatic life/water quality will vary depending on the concentration of constituents in sediments. The impact assessment carried out is based on the constituent analysis carried out by us at current level. The disposal of dredge sediment can result in the burial of aquatic organisms leading to their death. Various studies show that many organisms that live in sediments are able to migrate through appreciable depths of sediments dumped on them depending on the oxygen level in water. With the proposed mode of disposal in slurry form sudden burial level is unlikely to arrive and aquatic organism will get enough time to migrate.

Impact due to Dredge Disposal on shore or nearby land: On land or on shore disposal of river bed sediment, as proposed near Haldia terminal, has the potential to impact water quality. When the dredged material is disposed on land in form of slurry, excess water drains back to the water body. This excess water may contain significant sediment load and constituent of land surface which may pollute the water quality and

[46] Lee et al. (1978) and Jones and Lee (1978) as part of the Corps of Engineers Dredged Materials Research Program (DMRP) conducted extensive laboratory and field studies at dredging and dredged sediment disposal sites located in many parts of the US. They found that as long as the sediment water slurry was oxic (contained dissolved oxygen) that of the over 30 chemical parameters they measured, including heavy metals, a variety of organics, and other constituents, only ammonia and manganese were released from the sediments. However, if the slurrying of the sediments with dredging site water took place in the absence of dissolved oxygen (anoxic), a large number of constituents were released to the water. This pattern of release under anoxic conditions and no release under oxic conditions is strongly supportive of the role of ferric hydroxide in acting as an efficient scavenger for constituents released from the sediments. Lee (1975) pointed out that it is important to distinguish between the scavenging ability of freshly precipitated ferric hydroxide and aged ferric hydroxide precipitate. While freshly precipitated ferric hydroxide has a high sorption capacity, aged ferric hydroxide has limited sorption capacity and will release constituents sorbed at the time of formation of the ferric hydroxide, especially if it has become dry. This is an important phenomenon that occurs in some confined dredged sediment disposal projects that leads to the potential for water quality problems associated with this method of dredged sediment disposal.

also may affect the shallow water area of the river which may even be breeding or spawning ground.

In case situation arise for disposal of dredge sediments on river banks or land, the impact intensity would vary depending on the site sensitivity. For example, location of Eco sensitive receptors, presence of places of cultural importance, presence of spawning and breeding grounds, presence of archeologically protected places.

Mitigation Measures

Mitigation measures are proposed considering for the action required at design and operation stage of the project.

- Attempt shall be made to minimizing and optimizing the dredging requirements by effective assessment and study of the Thalweg profiles of the river. This can be achieved some of the following measures:
    - Increase use of bandalling which helps in diverting the flow of river towards the channel and reduces the quantity of dredging
    - Low draft vessels should be deployed which will reduce the requirement of dredging
- Dredged material shall be checked for toxicity and contamination prior its disposal onshore for prevention of contamination of water and its impacts on aquatic life. Standards for judging onshore & off-shore disposal of dredged material are given in Annexure 5.1.
- Dredging should not be carried out during very low flow seasons so as to minimize the dispersion of fine sediments
- Usage of silt or air bubble screens/curtains should be explored to minimize the sediment release during dredging operations. Silt/air bubble screens can hang from surface floats or stands attached to the bottom and held upright by sub-surface floats (PIANC). The use of silt curtains is reported to considerably reduce the loss of suspended sediments from the dredge area, by up to 75% where current velocities are very low. However, they are generally ineffective in areas with high current velocities which exceed 0.5 m/s (UK Marine SACs Projects).
- To minimize the sediment dispersal during disposal of dredge sediments, it should be place as close to the bed possible preferable at a level of 1m above the bed to minimise the dispersal of sediments.
- Provision shall be made of emergency response equipment like floating blooms to deal with any emergency of oil spills or leakages. Regular servicing and maintenance of dredgers should be taken up so as to prevent any leakage of the dredged material. Leakage detection of the sediment transportation pipe shall be carried out regularly to prevent any sediment loss and water pollution at leakage location. Corrective actions should be taken immediately after detection of such leaks.

- Cutter head of CSD should be selected according to material to be dredged so as to maximize the dredged material transport from dredging point to suction mouth and prevention of sediment loss and re-suspension.
- Ratio of cutter revolutions and pump velocity should be adjusted to ensure that cutter advancement rate is not greater than the ability of the suction pump to remove the material that is cut. This will prevent the suspension of the dredged material.
- Dredge cuts and lifts should be designed so as to prevent undercutting of material and hence a collapse of material locally at the cutter head, leading to an increase in the sediment being disturbed by dredging.
- If dredge material is found contaminated at any particular location that it should be disposed off shore. Off-shore disposal of dredged material should be carried out only at approved TSDF site such as approved TSDF site of Haldia Dock Complex at Sagar.
- Dredge material if disposed on river banks or on land caution should be exercised as per the Dredging and Disposal Management Plan for NW-1 given at Table 7.1.
- If dredged material is disposed on land, then the care should be taken that the tail water is collected and made free from sediments prior to its discharge back to surface water body. Regular monitoring of the excess water should be carried out for TSS level for assessing the efficiency of sediment trap.

5.4.2. Impact of Dredging and Dredge Sediment Disposal on Ecological Environment

5.4.2.1 Impacts on Aquatic Ecology

Impact on aquatic ecology is assessed for different scenarios as given in the following section:

Changes in Diversity of Benthic Habitat: The impacts on diversity may range from abundance of certain species of the prevailing community or even habitat community. itself Such changes in diversity may be caused due to change occurring in river hydrodynamics and chemical or physical characteristics of river bed sediments of the impacted area. As during dredging the settled sediments are dredged thereby impacting the whole range of flora and fauna which dwells in the river bed sediments. Once the sediment organisms are dredged and removed along with the sediments the dredging process may even cause mortality of benthic organisms. However, recolonization of habitats after dredging at the site may initiate soon after dredging but it may take significant rehabilitation time though the benthic organisms are essential components for river health as being ingredients of the aquatic food chain. Rate of rehabilitation of fresh colonies is highly variable as it is governed by characteristics of remaining sediment portions. Faster recoveries have been observed in finer sizes sediments and of less saline character. Diversity rich and stable benthic habitat is most unlikely wherever regular maintenance dredging is required (which is the case here as suspended solids get quickly settled on the bed) of the river beds in the stretches such as adjoining the terminal berths and river bed of navigation channel having lower LAD warranting regular

maintenance dredging. However, it may be pertinent to point out that the habitat loss caused may not significantly impact the river ecological health because the maintenance dredging is confined to navigational channel of 64 m width in comparison to the total width of the Ganga river on the such locations. Dredging activity will not have significant impact on the larger mobile faunal species such as fishes, dolphins, and turtles. The impact assessments carried out based on under water modelling of dredging noise indicated that the noise impacts on these species for their behavioural changes may not be significant. Because these organisms normally move away from the dredging spots resulting in high underwater noise generation. In any case mortality of these aquatic species due to dredging is not anticipated. Besides, in case minimum LAD is maintained in the channel, then it also facilitates the movement of these aquatic species as enough space is available to avoid any injury from barge movements[47].

Increased Noise Levels: Noise generation due to dredging operations also disturb the aquatic life either leading to behavioural changes, tissue/gill injury, temporary loss of habitat for the dredging period or mortality (rarely) due to dredging operations. Noise generation during dredging operations is of order of 160-180 d(B) for CSD category of dredgers. Behavioural disturbance criteria for Dolphins & turtles from any continuous noise exposures are 177 d(B) and 150 d(B) respectively[48] . In addition, no dredging operations are proposed within or in vicinity of Kashi Turtle Sanctuary and Vikramshila Dolphin Sanctuary that minimise the possibility of the impact of dredging on such vital sensitive organisms. However, in addition various mitigation measures are still proposed to further minimize the impact of dredging on aquatic species. As per U.S. Fish and Wildlife Service (USFWS), sensitivity level for injury in fishes is 186 dB for fish size of >2gm and 183 dB for <2gm. Thus the dredging operations noise will not lead to any injury to the fishes. Also it is likely that fishes and other moving organisms will move away from the source of disturbance and since the dredging activity is short term, the aquatic fauna will move back after the disturbance is removed.

Increased Sediment Load/Turbidity: Bothdredging as well as in-stream (dumping) disposal of dredged sediments have potential to increase the sediments or turbidity load of river water due to generation of sediment plumes during the dredging and disposal operations. Increased suspended sediments can affect filter feeding organisms, such as shellfish, through clogging and damaging feeding and breathing equipment (Brehmer 1965; Parr et al 1998). Similarly, young fish can be damaged if suspended sediments become trapped in their gills and increased fatalities of young fish which have been observed in heavily turbid water (Wilbur 1971). Adult fish are likely to move away from or avoid areas of high suspended solids, such as dredging sites, unless food supplies are increased as a result of increases in organic material (ABP Research R701 1997). Suspended sediment due to dredging operations in the water column blocks available

[47] Impact Analysis on "Ecology, Flora and Fauna including Fish and Fisheries due to Movement of Barges Carrying Coal Through National Waterway-1, Sagar to Farakka, ICAR-CIFRI

[48] As per Environmental Impact Statement of South of Embley Project.

light for photosynthesis, reducing benthic primary productivity and inhibiting the ability of benthic plants to recover from dredging impacts. However, the effect of suspended sediments and turbidity in open environment like river are generally short term (<1 week after activity) and near field (<1km from activity)[49]. There is only need to be concern if sensitive species are located in the vicinity of the maintained channel. Since river width is wide enough compare to 64m wide navigational channel, it is anticipated that aquatic life will get accustomed fast to regular activity phenomenon of the river and adjust their behaviour accordingly.

Release of Locked Pollutants in Bed Sediments: Sediments settled on the bed may have trapped toxins, chemicals and pollutants which are trapped in them and are not affecting the water quality. The most important among the toxic pollutants are pesticides, and heavy metals. However as per analysis carried out for river bed sediments, sediments are not contaminated as covered in previous section. Therefore, any significant impacts on water quality/habitat-health of aquatic species are not anticipated.

Disposal of Dredged Material in Aquatic Environment: Disposal of dredged material may lead to burial of existing benthic community at the location of disposal and Submerged Aquatic Vegetation (SAV) on the river bed, leading to mortality of buried community. In case of high turbidity and disposal heap is below the photosynthetic depth (adequate light penetration) then SAV cannot recover. However as discussed above, impact of suspended sediments and increased turbidity is of temporary being confined to disposal location besides of short term in nature.

Increased Depth During Dredging: In shallow waters, the light necessary for photosynthesis penetrates to the bottom of the water column. The LAD proposed is 3 m so the availability of sun light at bottom for clean river water will supports the growth of SAV and algae. SAV at the bottom provides shelter and food for young fish and helps reduce turbidity by resisting water flow and thus, allow sediment generated during dumping to settle out. The benthic algae are an important component of food chain and serve as a food source for some fish species. When the water gets too deep (below 6 feet/1.8 m) the available sun light decreases and plants growth is restricted.as it can no longer photosynthesize in the deep channel area.

Mitigation Measures

Certain measures proposed under previous sections are applicable for mitigating the impacts on aquatic ecological as well. These measures are not repeated here. Only additional measures are proposed below:

- Dredging plan including timeframe should be prepared for each stretch prior initiating dredging activity. No dredging should be undertaken within VGDS,

[49].As per UK Marine SACs Projects assessments

Turtle sanctuary. No dredging shall be carried out in winter season (November to February) along Mokama Taal to minimize impact on aquatic species and avifauna.

- Dredging operations should not be carried out during the breeding and spawning season of the valued aquatic species which is from June to August (Monsoon season). Bends and meandering locations are the most potential breeding grounds and are indicated at Figure No. 4.41 to 4.45.
- Dredging if required to be taken at critical stretches (Turtle and Dolphin Sanctuaries) as mention above then dredgers should be provided with turtle and Dolphin deflectors. This would prevent the sucking of the animals (fish or turtle) swimming nearby. But such dredgers are inefficient and costly.
- Measures like provision of bubble curtains or creation of agitation in water should be carried out prior carrying out dredging operations so as to provide avoidance time and let the species move away from drudging point. and to prevent any injury/mortality. Dredging operations should be halted in case of sighting of aquatic mammal in adjoin locations.
- Contractors should submit SOPs and action time chart with risk management plan prior to any dredging work. Dredging sub-contractor should follow the defined safety procedures to avoid accidents and spills, and IWAI should ensure that other vessel users are provided with adequate information and instruction to avoid conflict with the dredgers.

5.4.2.2 Impacts on Avifauna

Dredging and dredge Sediment disposal activities may also have certain impact on the avifauna having its habitats identified as Important Bird Area (IBA) located close to or along shallow waters areas of the river (Refers Chapter for IBA locations). However, the dredging impact will be localized and will be confined within the impact zone (may be of 500 m or less) and duration of dredging only. Avifauna is disturbed during dredging periods due to high noise levels, reduction in availability of aquatic food such a fishes in dredging stretches and increase in various human activity at dredging sites. Noise level of the order 80 dB(A) is expected to be generated from dredging operations. Apart from dredging effect, disposal of dredged material in mud flats and reed land which are habitat of the migratory and other water birds, may also impact the aquatic birds. The most impacts will be confined to initial period only as on later stage avifauna will gets acclimatized to the situation.

Mitigation Measures

- Dredging operations should be restricted primarily to day time, i.e. 6:00 am-10:00 pm only to minimize noise impacts on the avifauna near Important Bird Areas listed at **Table 4.32** and located close to river.
- Dredgers should be equipped with the noise reduction/masking equipment to reduce the noise generation inside and outside water. Noise from dredgers can

be reduced at source (dredger) by isolation of exhaust system, by keeping engine room doors shut and by shielding.

5.4.3. Impact of dredging on Socio-Economic Environment

As per analysis and planning no dredging is proposed near the important cultural areas/Ghat (Refer Table 5.2 for list of Ghats**).** Placement of dredgers in river may disrupt the fishing activities, however dredging activities at any particular location will be for short duration and thus the impacts will not be significant. Dredging operations generate noise of 80 dB(A) which can create discomfort for the population residing on the banks specially in the night time. Dredging operations required manpower for carrying and controlling dredging operations. Thus generation of employment for skilled, semi-skilled and unskilled labour can be taken as positive impact of dredging operations. Dredging operations will enable navigation of the barges in the waterway throughout the year thereby increasing the IWT mode of transportation. This will have positive socio-economic impact in terms of employment generation.

Mitigation Measures

- Dredging operations should be restricted primarily to day time, i.e. 6:00 Am-10:00 Pm only to minimize noise impacts on the residents of nearby settlements. Dredgers should be equipped with the noise reduction/masking equipment to reduce the noise generation
- Dredgers should be placed in consultation with the fishermen so as to minimize the impact on their equipment/gears and their fishing activities
- Dredging should not be carried out in the areas close to Ghats in Varanasi and buffer of 2 km should be maintained for dredging during time of religious gatherings during Chat and Kumbh festivals.
- In case contaminated dredged material is disposed on land, then it should be disposed at approved TSDF sites to prevent any harm to community residing in nearby areas. One of such approved TSDF site is located Sagar (Haldia Dock Complex site)
- Material to be disposed on land may create nuisance odour due to exposure of anaerobic sediments with air. Thus if land disposal is involved than disposal site should not be in upwind direction of any settlement area or sensitive locations like hospitals, schools etc.
- Log book should be maintained for recording the accidents at site/mortality of the any marine mammal should be maintained. Analysis shall be carried out to assess the reason for the accident/mortality and measures should be taken to prevent repetition of the event.
- Contractors having experience of dredging and well trained staff should only be allowed to carry out dredging. This will help in prevention of spillage of dredged material or any accidents during the dredging operations
- Dredging plan should be prepared by contractor and submitted to IWAI for approval prior to carrying out dredging operations. Dredging plan should be

reviewed considering its location w.r.t environmental sensitive locations/archaeological locations/cultural festival/pollution influx in the area/dredged material quality & texture/available depth etc. as given in this EIA report and through local sources and past experience.

- Contractors should submit method statement & risk assessment plan prior to carrying out any dredging work. Dredger should follow the defined safety procedures to avoid accidents and spills, and IWAI should ensure that other vessel users are provided with adequate information and instruction to avoid conflict with the dredgers.
- Post-dredging monitoring of the sediment nature, rate of sedimentation shall be made part of contractor's job as best dredging practise. This will provide information which can be taken into consideration before the next maintenance dredge is carried out.
- Re-use of dredged material should be explored if dredged material is not contaminated. Economically and environmentally feasible options can be adopted to minimize the dredge spoil burdens. Some of such measures include
    - Dredged sediment can be used for beach nourishment/development of artificial beach/deposition on shoal & thus enrichment of habitat
    - Dredged material can be explored for its usage for coast/bank protection purpose/flood protection
    - Use of dredged material can be explored for land filling, as construction material for road foundations, dikes, mounds, noise/wind barriers.

5.4.4. Summary of Impacts of Dredging with Significance evaluation

The summary of dredging is given at **Table 5.3**.

Table 5.3 : Summary of Environmental Impacts Due to Dredging Operations

Activity	Potential Impacts	Direction		Significance	Mitigative	Duration		Location		Magnitude		Extent	
		+ve	-ve			LT	ST	Direct	Indirect	Large	Small	Wide	Local
Dredging	Loss of benthic biota		√	M	No	√		√			√		√
Sediment disturbance	Settlement of suspended solids		√	M	Yes		√		√		√		√

	Attenuation of light in water column		√	L	Yes		√		√		√		√
	Dispersion of contaminated sediments		√	L	Yes		√	√			√		√
	Degradation of pelagic habit		√	L	Yes		√		√		√		√
	Impact on Fishing & boat movement		√	L	Yes		√	√			√		√
Operation of dredgers	Increased ambient noise level		√	L	Yes		√	√			√		√

Leakage of sediments during transportation	Increased turbidity over sensitive inshore habitats		√	M	Yes		√		√		√		√

B. Impact due to Operations (Vessel Movement)

5.5. Impact of Barge Movement

Barge movement impacts are anticipated during entire operational phase of the project. Under NW1, it is proposed that vessels of maximum length 110 m, beam 11.4 m, draught 2.5 m-2.8 m and air draught of 9 m will ply in the waterway channels. As per current planning, vessels of 1500-2000 DWT are planned to ply between Varanasi & Haldia. Speed of these vessels will range from 5-10 knots (2.7 knots in sanctuary areas). IWT mode is however, most environment friendly mode of transportation when compared to other modes like rail & road but still has significant impact on physical, biological and socio-economic environment.

5.5.1. Impact of Barge Movement on Physical Environment

5.5.1.1 Impact on Water Quality

Impact due to Discharge of Waste/Sewage and solid from Vessels: The vessels moving in waterway generates both black & grey waste water. Black water include sewage, wastewater from toilets and medical facilities, which can contain harmful bacteria, pathogens, viruses, intestinal parasites, besides many other harmful ingredients. Discharge of these black wastes untreated or inadequately treated can cause bacterial and/or viral contamination of agriculture produce, fisheries, causing risks to public health. Nutrients in sewage, such as nitrogen and phosphorus, promote excessive algal blooms, which consumes oxygen in the water and can lead to fish kills and destruction of other aquatic life. However, in this project majorly freight vessel are expected to ply. Few passenger vessels may also ply. Thus the quantity of sewage to be generated will not be large. Also it will be made mandatory that no vessel/ship can discharge its wastewater into the river. Grey water is wastewater from the sinks, showers, galleys, laundry, and cleaning activities aboard a ship. It can also contain a wide range of contaminants, including even fecal coliforms, detergents, oil and grease, metals, organic compounds, petroleumhydrocarbons, nutrients, food waste, medical and dental waste (EPA). Grey water has potential to cause adverse environmental effects because of concentrations of nutrients and other oxygen-demanding materials in particular.

Solid waste generated on a ship includes glass, paper, cardboard, aluminium and steel cans, plastics and maintenance waste. It can be either non-hazardous or hazardous in nature. Solid waste that enters the water body becomes aquatic debris, and can then pose a threat to aquatic organisms, humans, coastal communities, and people that use the river water.

Impact Due to Usage of Anti-fouling Paint: Antifouling paints with toxic content can affect the aquatic life though to a very limited extent.

Impact Due to Settlement of Dust from Materials handling: Dust may settle on the surface of river during loading & unloading and operation of barges if appropriate preventive measures are not opted for. This dust will increase turbidity in water, and will impact the water quality and aquatic life.

Mitigation Measures

- All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only. Standards for discharge of wastewater & garbage from barges is attached as **Annexure 5.2 & 5.3.**
- Material having potential to generate the dust like coal, sand stone aggregates should be transported under covered conditions to minimize dust generation and its settlement on river surface. Terminals should have facility to control dust pollution during barge loading and unloading actions.
- Provision of oil water interceptors with the bilge tank to separate oil prior discharge of bilge water into river. Bilge water should be discharged as per MARPOL requirements. Bilge water tank should be maintained as per MARPOL requirement. Standards for discharge of oily waste is attached as **Annexure 5.4**
- Usage of non-toxic and non TBT containing anti-fouling paints for painting vessel
- Immediate/quick clean-up of oil/other spills shall be undertaken in case of accidental release and ship owners should be liable for the same.
- Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible
- IWAI should develop the stringent norms to be followed by vessel operators and shall develop the system of penalizing based on polluters pay principle in case the standards are not met or violated
- Ship design (of capacity > 5000 DWT) should be as per MARPOL and should be provided with double hulls/double bottoms. Speed of oil carrying vessels should be maintained to prevent accidents due to high speed.
- Vessels should not be washed or cleaned at terminal/jetty facility and washings should not be discharge at the terminal/jetty location. Standards for discharge of washing water as per MARPOL is given in **Annexure 5.5.**

5.5.1.2 Impact on the River Bank & River Bank Structures

A moving vessel generates waves of varied intensity depending on vessel's speed, hull shape, and draft. The river Ganga has wide width and navigational channel mostly to be confined in middle reached of the river. Bank erosion impact due to vessel movement is anticipated minimal except at Farakka feeder canal which has smaller width and has eroding banks and at bends or at narrow stretches of river.

Mitigation Measures

- Restricting the ship speed in the stretches where river is narrow and in feeder canal to prevent impact on the river banks.
- Regularizing the barge speed to 7-8 knots in bending areas so as bank erosion can be reduced
- River bank protection works should be carried out at the bank locations which are prone to erosion. Opt for the bank protection measures in feeder canal to maintain the speed of the barges.
- Provision of cautionary signage at the navigational hazard locations

5.5.1.3 Impact on Air Quality

Exhaust gases from vessel are source of air pollution and GHG gases. However, vessels emit least emissions compared to the air, road and railway modes. The impact on air quality due to vessel movement is anticipated insignificant considering the emission levels and projected vessel traffic. However, an estimation is carried out to arrive at the total emission load from the movement of vessels and corresponding load for transportation of similar amount of cargo by rail and road. Emission levels are calculated for transportation of cargo for about 19000 metric tonnes cargo movement per day for phase I of NW-1 between Haldia to Varanasi[50]. Assessment has been carried out based on emission factors and emissions associated with different mode of transportation for pollutants NOx, SO2, CO, PM & HC. The comparative analysis is shown at Table 5.4. The analysis indicates that IWT transport while will have least emission load (air pollution) amongst all the three mode of transport and will rather have positive impact in the nearby areas due to model shift and corresponding reduction in emission load (air pollution) of rail or road transport.

Table 5.4 : Comparative Analysis of Air Pollution Levels between Rail, Road and IWT

A. Emission Comparisons for NOx, SO2, and CO						
Mode of Transportation	**Emission Factor for NOx (g/tonne km)**	**Emission Load per day for NOx (Tonne /day)**	**Emission Factor for SO2 (g/tonne km)**	**Emission Load per day for SO2 (Tonne /day)**	**Emission Factor for CO (g/tonne km)**	**Emission Load per day for CO (Tonne/day)**

[50]The average of phase I cargo movement in NW-1 between Varansi to Haldia is about 19000 MT. For calculation purposes and considering worst case scenario, it is assumed that 19000 MT cargo will travel full lenth of NW-1 between Varansi to Haldia. The length considered between Varansi to Haldia will vary from one mode to another mode of transport. The length is considered as 1311Km, 1037 Km, 1065 Km for IWT, Rail and Road respectively.

Railway (Diesel Engines)[51,52]	0.4	7.78	0.18	3.50	0.15	2.91
Road [53]	1.37	27.38	0.18	3.59	0.54	10.79
IWT (For inland vessels)[54]	0.26	6.39	0.04	0.98	0.11	2.70
B. Emission Comparisons for PM and HC						
Mode of Transportation	**Emission Factor for PM (g/tonne km)**	**Emission Load per day for PM (Tonnes /day)**	**Emission Factor for HC (g/tonne km)**	**Emission Load per day for HC (Tonne /day)**		
Railway (Diesel Engines)	0.07	1.36	0.07	1.36		
Road	0.22	4.40	0.38	7.59		
IWT (For inland vessels)	0.02	0.49	0.05	1.23		

Material to be transported through NW-1 includes building construction materials like sand, stone aggregates, coal, textiles, fertilizers etc. Some of these commodities have potential to generate the dust majorly sand, stone aggregates, coal etc. This dust is required to be managed to prevent air quality degradation during transportation and high wind conditions.

Mitigation Measures

1. Material having potential to generate the dust like coal, sand stone aggregates should be transported under covered conditions.
2. Air emissions from the vessel should be under the prescribed limits as per MARPOL and the standards (refer **Annexure 5.6** for standards). Regular maintenance of vessels engine and propellers. IWAI should develop the stringent norms to be followed by vessel operators and shall develop the system of penalizing based on polluters pay principle in case the standards are not met or violated
3. Adoption of cleaner fuels such as low sulphur bunker oil as per USEPA norms, 2000 (sulphur content is 0.25% for diesel oil and 2.7% for residual oil) or switching to LNG based vessels55

[51] Table 14: Rail Air Pollution Emission, in g/tonne-km (sources: Kurer, 1993-Table 5), The Environmental Effects of Freight, Organization for Economic Co-operation and Development, Paris

[52] Air Quality Monitoring Research Association of India "Air Quality Monitoring Project-India Clean Air Programme (ICAP), CPCB/MoEF & EPA emission factors for rail locomotives, commercial.

[53] Table 9: Truck Air Pollution Emission, in g/tonne-km (sources: Kurer, 1993, Table 5), The Environmental Effects of Freight, Organization for Economic Co-operation and Development, Paris

[54] Table 7: Emissions from vessels Travelling on Inland Waterways (sources: Dutch data from the Centraal Bureau voor de Statistiek, Shoemaker and Bouman, P. 57 US data from US EPA (September 1985), p. II-3.2), The Environmental Effects of Freight, Organization for Economic Co-operation and Development, Paris

[55] IWAI has initiated a talk with international agencies to design LNG based vessels for plying in NW-1 as per the requirement/dimensions of NW-1. A study has been carried out by Department of Engineering & Architecture, university of Trieste55 to assess the feasibility of LNG usage as fuel in IWT. As per the study LNG usage is advantageous due to associated less SOx

5.5.2. Impact of Barge Movement on Ecological Environment (Aquatic Ecology)

5.5.2.1 Impact due to vessel speed and movements

Aquatic mammals are subjected to threat of collision by vessel speeds causing injury and death. Dolphins, fishes moving in river can collide with the moving vessels which may cause them injury and even mortality. To minimise the chances of collision, restricted vessel speed of 2.7 knots (5 kmph) is proposed within VSGDS and in Kashi turtle sanctuary. Even in low speed danger still exists for juveniles of dolphins and other fishes which can get trapped / entangled with propeller's blades leading to injury or death.

5.5.2.2 Impact of Ballast Water Discharges

Ballast water discharges by vessel can have a negative impact on the aquatic environment. Bulk cargo carriers use a huge amount of ballast water, which is often taken in from the coastal waters from one region and may be discharged at the next location. Such Ballast water typically contains a variety of biological materials, including plants, animals, viruses, and bacteria from the sea water intake location. As blast water may have various non-native, nuisance, invasive, exotic species that can cause ecological imbalance and economic damage to the receiving aquatic ecosystems besides certain human health problems. Since NW1 is an inland waterway transport project with movement of vessel only within same aquatic river environment no impacts due to ballast water discharges are anticipated. Though coastal vessel arrives Haldia Terminal but loaded with coal and thus will not require to discharge any ballast water. Therefore, no impact due to ballast water discharge is anticipated.

5.5.2.3 Impact on Aquatic Ecology due to Spillage of Oil/material in the River:

Materials like coal, oil, building construction material, textiles, fertilizers etc. are proposed to be transported through the waterway. In case of accidents these materials can spill in the River and may pollute the water quality and may have significant impact on aquatic ecology. Oil spills are well known to cause significant harmful impacts on sea aquatic ecology as the oil leaks form a thin film floating over the sea water and thereby breaking contact between sea water & air (DO reaeration). This floating oil enters the gills of fishes and other organism and block the gills, skin pores and may impact the normal functioning of the aquatic organisms. Impact of oil spills on various aquatic organisms is summarised below:

- **Plankton:** Oil spills can lead to plankton kills. The recovery of plankton will be however quicker through repopulation of the community by fresh planktons from adjacent areas not affected by oil. Eggs and larvae of fishes, crustaceans and

emissions (0.00154 g/kWh which complies with SECA-Sulphur Emission Control Area Requirements), low NOx emissions (1.42 g/kWh), lower cost than diesel and gasoline, higher energy content when compared to diesel and gasoline (Refer Table 5.6), easy availability, lower bunkering price, lower fuel consumption & lower maintenance costs compared with a Diesel engine, lower noise generation and also price of LNG is not variable and is locked under long time contracts. As per the market study in the above mentioned study LNG can help in enhancing the IWT sector. However some of the disadvantages of LNG based vessels involves increment of investment cost by 10-20% due to provision of LNG storage tank onboard, fuel piping system and additional safety measures and inadequate or no LNG bunkering facility availability including LNG terminals, ship supply networks

molluscs which are highly sensitive to even low concentrations of PHc (10-100 µg/l) and aromatics (1 - 5 µg/l) in particular will be severely affected. However, it is unlikely that any localised losses of fish eggs and larvae caused by a spill will have discernible effect on the size or health of future adult populations.

- **Benthos:** These organisms have limited movements and hence, are more vulnerable to oil spills. If the thick weathered oily mass spread on intertidal areas, immediate mortalities of organisms in the zones of physical contact are expected. Sub-tidal benthos of shallow waters might also be killed or tainted if the sinking residue affects their habitats. If the residue persists for longer time in the sub-tidal or intertidal segments due to poor circulation, the recovery will be delayed. Thus, the benthic organisms near to the berth area will recover slower than the organism away from berth area due to poor water circulation near the berthing area.
- **Fishes:** A large oil spill can temporarily reduce the fish catch from the area as fish might migrate from the affected zone. Limited mortality may also occur particularly when the oil concentrations in water go abnormally high. Fishes are sensitive to oil and tend to avoid petroleum. Often fishes get tainted and unpalatable but become normal when the ambient PHC level approaches the baseline which is expected within a few days. The area which is the breeding and nursery grounds for a variety of fish and shell fish, large scale mortality of eggs and larval stages of several economically important groups may occur if oil is transported to these habitats during major accidental oil spill. Local fishermen may get affected by getting either contaminated fishes/crabs/larvae etc. or poor catch.

5.5.2.4 Impact on Behavioural Response of Aquatic Organisms Due to underground Noise Generation from Vessels

Cargo vessels generate substantial broadband underwater noise from their propellers, motors, auxiliary machinery, gear boxes and shafts, plus their hull wake and turbulence. Diesel motors produce more noise than steam or gas turbines, but most long distance (low frequency) noise is generated by the ‘hissing’ cavitation of spinning propellers. Noise generation from the ship movement is continuous type of noise generation. Noise generation from ship movement (1500-2000 DWT) vary from 110-140 d(B). This order of noise generation may have impact on behaviour of various aquatic organisms and may lead to other injuries like tissue injury, temporary & permanent hearing loss. However physical impact on aquatic species is not anticipated as the aquatic species moves away from the source of disturbance (barge) and usually do not come close. But impacts of this level of noise can be on behavioural responses and audiometry of aquatic species, turtles and dolphins in particular. These are analysed and presented in the following sections:

A. Impacts on Behavioural Response of Aquatic Organisms and on Auditory System of Dolphins Due to Noise Generation from Moving Barges

This assessment has been carried out considering the outputs of various studies vs noise and using mathematical techniques (underground noise modelling) to assess the expected noise from vessel movement in IWT in NW-1. The studies references are presented first followed by noise modelling outputs followed by impact on auditory System of Dolphins.

Study by Southall et al. (2007)[56] and Environmental Impact Statement of South Embley Project: A review of various studies into behavioural disturbance in high-frequency cetaceans from continuous man-made noise was carried out. As per review it was concluded that not all behavioural responses are equally significant. Behavioural changes may be relatively minor and/or brief, have the potential to affect important behaviours such as foraging, breeding and resting. Study concluded that the behavioural changes to levels below 120 dB re 1 µPa were relatively minor or brief in case of harbour porpoise. Significant and sustained avoidance behaviour was recorded when noise levels exceeded 140 dB re 1 µPa in case of harbour porpoise. *For turtles and Dolphin this level is 150 dB and 177 d(B) respectively.*

Study by Kelkar (2008)[57] into the habitat use and distribution of the Ganges River Dolphin in the VGDS. As per the study it was concluded that the number of motorised boats and boat noise were not significantly correlated with dolphin encounter rates. Small boats equipped with outboard engines can produce source levels in the order of 160 dB re 1 µPa at 1 m, with the received levels of over 120 dB re 1 µPa at 1 m up to 500 m. *Although the study results suggest that boat noise is not displacing dolphins*, it is not conclusively showing that such noise levels do not impact Dolphin behaviour.

Study "Acoustics in marine ecology-vessel noise effects on dolphin communication -Vol. 395: 161–175, 2009 doi: Under this study sound source levels of various vessel types at different speeds are measured which are given at Table **5.7.** The vessels which will be diploid in the NW-1 passing through Sanctuary areas (VGDS & Kashi turtle sanctuary will be 4 stroke engine vessels and propose to move with speed of 2.7 knots (5 kmph) within the sanctuary areas. *Thus as per this study one can conclude that from this source the noise level to be generated from the vessels will be in range of 110-139 d(B).*

Table 5.5 : Vessel noise at different speeds

Vessel, speed	SL (0.2–40 kHz)	SL (2–12.5 kHz)
	dB re 1 µPaRMS at 1 m	dB re 1 µPaRMS at 1 m
2-stroke, 2.5 knots	112 ± 1.0	108 ± 3.0
4-stroke, 2.5 knots	110 ± 2.6	106 ± 2.2

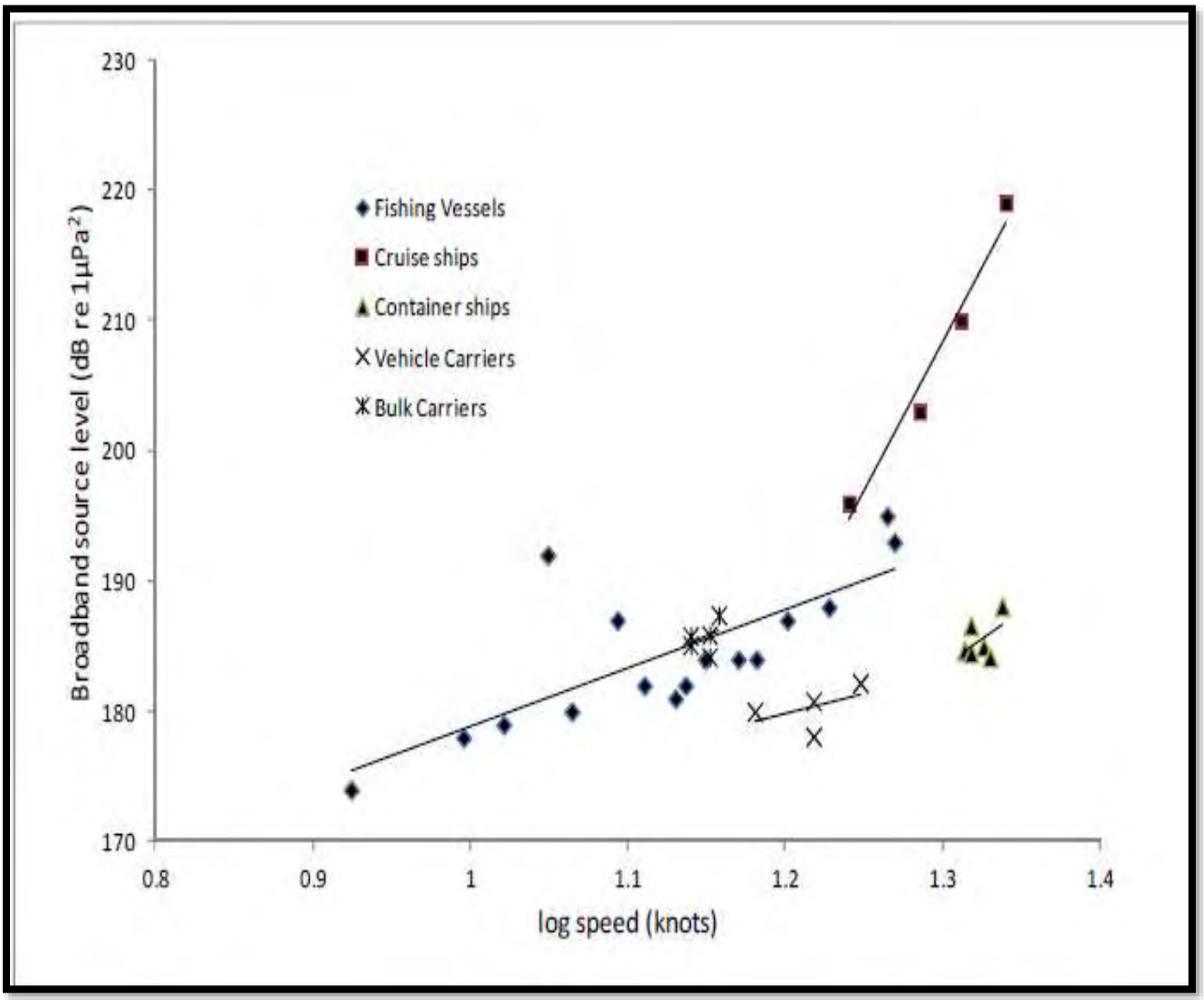
[56] Southall et al. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33(4).

[57] Kelkar, N. (2008). Patterns of habitat use and distribution of Ganges river dolphins Platanista gangetica gangetica in a human-domintaed riverscape in Bihar, India. Master Thesis, Manipal University, Centre for Wildlife Studies, Bangalore

2-stroke, 5 knots	139 ± 1.0	132 ± 3.0
4-stroke, 5 knots	138 ± 2.6	134 ± 2.2
2-stroke, 10 knots	149 ± 0.6	146 ± 0.6
4-stroke, 10 knots	152 ± 0.3	144 ± 0.5

(Source: Acoustics in marine ecology' (Vessel noise effects on dolphin's communication -Vol. 395: 161–175, 2009doi: 10.3354/meps08204)

Study by Renilson M, Leaper R & Boisseau O, May, 2013, "Hydro-acoustic noise from merchant ships-impacts and practical mitigation techniques": As per this study presented the relationship of vessel speed vs noise generation from vessel and same is shown at **Figure 5.3**.



Source: Renilson M, Leaper R & Boisseau O, May, 2013

Note: 2.7 Knots or 5 Km/h = 0.43 log speed (knots)

Figure 5.3 : Broadband source levels against log10 (speed in knots) for different ship types

Vessels to be used for material transportation from the NW1 terminal can be considered under category of bulk carriers. Ship movement speed in the sanctuary areas is to be restricted to 5 km/h only. The above given graph *it is established that the noise level generated from bulk carriers moving with speed of 5 kmph (2.7 knots) will not be more than 130-140 d(B)* (arrived based on extrapolation of above graph).

Study by Plon, S, Koper, R.P., and Endangered Wildlife Trust: This study establishes the noise level generation from different vessel types. The noise level from different types of vessel is given in **Table 5.6**. But no relation between the noise generated with the speed of vessel is highlighted in this study.

Table 5.6 : Noise Level from Different Type of Vessel

Sound sources	Types of sound	Pulse duration (sec)	Main Frequency (KHZ)	Source sound level d(B)
Cargo vessels	Continuous	n.a.	0.0-0.5	195
Small vessels	Continuous	n.a.	1.0-10.0	160-170

(Source: Plon, S, Koper, R.P., Endangered Wildlife Trust)

Based on above studies it is established that bulk vessels moving at a speed of 2.7 knots (5 kmph) generates noise of range 130-140 d(B). However, considering the variation upper limit of 160 d9B) is also considered underwater noise modelling assessment.

Under Ground Noise Modelling: Noise are the mechanical waves and the energy content dissipates in surroundings with the distance of the waves movement. Noise level received by the receiver is not of same intensity as the noise intensity at the source. There is always a propagation loss associated with the noise transmission distance. Thus noise received can be written as follows:

RL = SL-PL

RL- Received noise level

SL- Source Sound Level

PL-Propagation Loss

PL can be estimated using simple equation PL = Nlog10 (R), where N is scaling factor and R is distance of receptor from source. N values differ for different environments. For the convenience here N value is taken for shallow water environment in reference with the study by Kongsberg Maritime Limited on “underwater noise propagation modelling and estimate of impact zones for seismic operations in the Moray Firth”. As per this study propagation loss is high in shallow waters due to strong interface with the surface of the river bed. N values for shallow waters vary from 15-20.

For noise modelling purpose minimum noise levels considered are 130 d(B) due to barge movement and maximum noise levels are taken to be 160 d(B) (20 d(B) more than highest noise levels as per reference studies above to consider worst case scenario). Considering the noise level variation from 130-160 d(B) and N value variation from 15-20, noise level modelling has been carried out at different receptor distances of 22.5 and 15 m from the centre line of the ship. The results for noise level modelling are presented in **Table 5.7**

Table 5.7 : Noise Level Modelling Result

Source Sound Level (SL)-dB	**130**	**160**	**130**	**160**	**130**	**160**	**130**	**160**
Scaling Factor considered (N Value)	15	15	20	20	15	15	20	20
Distance of receptor (R)in meter	22.5	22.5	22.5	22.5	15	15	15	15
Propagation Loss (PL)	20.25	20.25	27	27	17.7	17.7	23.6	23.6
Received Noise Level in dB by receptor	109.75	139.75	103	133	112.3	142.3	106.4	136.4

Output of Underwater Noise Modelling: An estimation is carried out to assess distance of achieving the safe threshold noise level of 150 d(B) for turtle and 177 d(B) Dolphin from behavioural consideration prospective as per EIA Study of "South of Embley Project" sited above. The same is given at Table 5.10 for scaling factor of 15 and 20 N. It is concluded that noise level of 150 d(B) can be achieved at distance less than 4.6 m from centre of the ship for turtle. However, the maximum beam of ship which will ply in waterway is 11.4 m. *Thus possibility of occurrence of organism at 4.6 is comparatively less.*

Table 5.8 : Distance estimation for achieving 150 d(B) of noise from centre of the vessel

Description	**Scenario 1-considering N Value 15**		**Scenario 2-considering N vale 20**	
	For Turtles	**For Dolphins**	**For Turtles**	**For Dolphins**
Threshold Safe Noise Level -dB	150	177	150	177
Source Sound Level (SL)-dB	160	160	160	160
Safe Distance-R (m)	4.6	Noise level generated are less than the threshold safe level	3.16	Noise level generated are less than the threshold safe level

Impact on Auditory System of Dolphins Due to Noise Generation from Moving Barges: When the dolphin 's auditory system is exposed to a high level of sound for a specific duration, the sensory hair cells begin to fatigue and do not immediately return to their normal shape (NRC 2005)[58.] This causes a reduction in the hearing sensitivity, or an increase in hearing threshold. If the noise exposure is below some critical sound energy level, the hair cells will eventually return to their normal shape. This effect is called a temporary threshold shift (TTS) as the hearing loss is temporary. If the noise exposure exceeds the critical sound energy level, the hair cells become permanently

[58] NRC. (2005). Marine Mammal Populations and Ocean Noise - Determining When Noise Causes Biologically Significant Effects. National Research Council, National Academies Press

damaged and the effect is called permanent threshold shift (PTS). **Table 5.9** below summarises the noise exposure criteria adopted for assessing hearing damage (PTS or TTS) and behavioural effects on the Ganges River Dolphin from vessel noise. The noise exposure criteria are based on the review presented by Southall et al. (2007) and also adopted by NOAA (US National Oceanic and Atmospheric Administration) in 2011. which were discussed above.

Table 5.9 : Noise exposure criteria for physiological (PTS and TTS)

Impact	**Noise exposure criteria**
Permanent threshold shift	SEL 215 dB(M) re 1μPa^{2}s
Temporary threshold shift	SEL 195 dB(M) re 1μPa^{2}s

Source: NOAA & Bangladesh Regional Waterway Transport Project 1-ESIA Report, BIWTA

However, noise generation anticipated from vessel movement in NW-1 (1500-2000 DWT) is between **110-140 d(B) which is below the noise exposure criteria to cause PTS/TTS in dolphins.** *Thus impact on auditory systems of dolphins is not anticipated due to noise generation from barge movement.*

B. Impact Due to Masking of Biological Important Noise of Aquatic organism by Noise Generated from Moving Barges

Another impact of high noise level generated from moving barges is masking of biologically important sounds. These sounds may interfere with communication and social interaction and cause changes in behaviour as well. The zone of masking impact will be highly variable and depends on many factors including the distance between the listener and sources of the signal and masking noise, the level of the signal and masking noise, and the propagation of noise from the signal and masking source to the listener. It is however important to note that masking of communication and echolocation signals naturally occurs by the ambient noise environment. Man-made noise causes additional masking of a signal only when it is of a higher level than the ambient environment within the species 'critical hearing bandwidth at the signal's dominant frequencies. Echolocation clicks produced by the Ganges River Dolphin have dominant energy around 65 kHz (Sugimatsu et al., 2011)[59]. This is well above the dominant frequency range of most man-made noise, including pump noise. Masking of echolocation signals is therefore not a significant issue for most man-made sources (Richardson et al., 1995). ***Thus it can be concluded that noise generation due to barge movement is not anticipated to interfere with echolocation ability of Ganges Dolphins***. The Ganges River Dolphin is likely to produce communication signals, such as whistles, squeals or clicks, based on communication signals produced by other river dolphins. These signals generally have energy at much lower frequencies than the echolocation clicks, i.e. as

[59] Sugimatsu et al. (2011). Annual Behavioral Changes of the Ganges River Dolphins (Platanista gangetica) Based on the Three Long-Term Monitoring Seasons using 6-Hydrophone Array System. IEEE Symposium on and 2011 Workshop on Scientific Use of Submarine Cables and Related Technologies, (pp. 1-7). Tokyo

low as 1-6 kHz. **Communication signals are therefore more likely to be masked by man-made noise than echolocation clicks**. Noise reduction measures will help in minimizing the noise generation from barge movement and will minimize masking of communication signals generated by dolphins.

Mitigation Measures

1. Vessel speed shall be restricted to 2.7 knots in VSDS and Kashi turtle sanctuary areas to reduce the noise generation from propeller. Hooting should also be prohibited in sanctuary areas.
2. Vessel shall be fitted with the dolphin reflectors
3. Usage of non-toxic and non TBT containing anti-fouling paints for painting vessel
4. Provision of propeller guards with vessel to minimize injury to the aquatic fauna
5. Barge/vessel movement will be restricted to the designate route only over the Sanctuary area to minimize noise disturbance of Aquatic life.
6. If any aquatic mammal spotted, then the measures should be taken to push it away through sirens/signals and creating noise signals.
7. If any accident of aquatic mammal occurs, then that should be reported to IWAI for rescue action through wild life or forests departments.
8. All vessels should follow MARPOL for managing their liquid and solid waste. No vessel should discharge the liquid and solid waste in the river. All waste shall be discharged at vessel repair facility only. IWAI should develop the stringent norms to be followed by vessel operators and shall develop the system of penalizing based on polluters pay principle in case the standards are not met or violated
9. Material having potential to generate the dust like coal, sand stone aggregates should be transported under covered conditions to minimize dust generation and its settlement on river surface.
10. Provision of oil water interceptors with the bilge tank to separate oil prior discharge of bilge water into river. Bilge water should be discharged as per MARPOL requirements. Bilge water tank should be maintained as per MARPOL requirement.
11. Immediate/quick clean-up of oil/other spills to prevent damage on aquatic organisms shall be undertaken and ship owners should be liable for the same. Facilities should be made to ensure quick rescue and clean-up operations in case of accidents
12. Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible
13. Regular maintenance of vessels engine and Propellers.
14. River training works should be carried out at the bank locations which are prone to erosion to minimize sedimentation & impact on water quality &aquatic organisms
15. Adequate depth to be maintained to prevent grounding under low flow conditions. Information on available depths should be conveyed to the navigators through online systems by IWAI. River Information System being developed by IWAI will serve this purpose.
16. Maintaining flood plains & riparian corridors wherever possible and limit potential damage to the navigation channel. Restricting the project activities in breeding and

spawning ground of the fisheries which are majorly the bends in the meandering river.

17. Design measures like bandalling and design of groin should be considered which can reduce the dredging requirement and help in meeting depth, width and steerage needs and reduces dredging requirement
18. Modern design vessels having low draught say 2 m instead of 2.5 m for equal payload should be procured by IWAI for transportation. Modern vessel- better technology vessels or with retrofits with quieting techniques to reduce further the noise generation (specifically cavitation's noise).
19. Regular patrol and inspections should be carried out to monitor the activities in waterway. Also regular monitoring of environmental attributes as proposed in environment planning plan of this should be carried out for the waterway to keep track of the condition of the environmental attributes

Enhancement Measures:

20. Support for promoting fish productivity through setting up or supporting existing fish nurseries. Also providing training and awareness support through reputed institutes or experts like CIFRI for better fishing techniques.
21. Provision of supporting Studies for conservation of Dolphin and other sensitive studies shall be made.

5.5.3. *Impact of Barge Movement on Socio-Economic Environment*

5.5.3.1 Impact *on Health & Safety*

Vessel movement**(Shipping**operations) are subjected to various threats of accidents related to natural disasters like flood or cyclonic and operational like Collison, fire, spillages.

Natural Hazard: River Ganga is snow fed river and is perennial in nature and floods every year. Thus threats to navigation are anticipated during the heavy flow and flood like situation especially to smaller vessels. Also Haldia is located in coastal region and is prone to cyclonic threats. Haldia is classified as high cyclone risk zone as per Cyclone Hazard Map of India. Thus it is mandatory for vessels to adopt the measures and prepare emergency preparedness plan to handle emergency situations like floods and storms.

Operational Hazard: There is also existence of various man-made navigational obstacles which pose threat to navigation such as presence of critical brides (ref Chapter 3), presence of siphon to extract water for irrigation scheme in Farakka feeder canal, presence of pylons, meandering of river, change in river course, variable depths, sharp bends. However, all these threats can be reduced and managed by physical interventions and operational controls such as provision of night time navigation system, maintenance dredging, adequate and efficient river information system, vessel tracking system, Electronic Charts Display Information System - ECDIS, and Automatic

Information System – AIS. Most of these measures are already under implementation by IWAI in some stretches of the NW-1 and there is proposal of extending these facilities to entire NW-1. However, there are still possibility of collision, fire and spillages which can impact water quality and aquatic life both significantly depending on the material being transported. The effect can be more severe in case of transportation of petroleum products. This can also have effect of health of crew and nearby habitats.

Mitigation Measures (Safety Measures)

- Also record of the accidents should be maintained regularly by IWAI, analysis of each accident should be carried out by IWAI to know the reason for accident and preventions should be undertaken so as not to repeat the same cause
- Adoption of SOLAS for maintaining the safety in vessel. Safety equipment, safety boats, lights, and signalling system should be as per the requirement of SOLAS
- Provision of storm shelters and other infrastructure should be provided for vessel in waterways to manage the severe weather conditions like storms, floods.
- Minimum passing distance between vessel and from vessel to the banks must be ensured for safe traffic conditions
- Establishment of signalling system and patrol services by IWAI
- Vessels licensed by IWAI and meeting the specified norms by IWAI shall only be allowed to ply in the waterway
- Regular echo-soundings to be carried out by IWAI to identify LAD in different stretches and draw Thalweg profiles of various stretches. This information should be made available to the users through online system
- Proper River information system, electronic charts display system, vessel tracking system automatic information system etc. should be developed by IWAI for its users. RIS system is already developed by IWAI for Haldia to Farakka stretch and RIS system implementation is under process for Farakka to Patna. Work for Patna to Varanasi is also under consideration. Installation of DGPS for maintaining positioning and communication system. This is already in place for NW-1
- Maintenance of buoys, beacons, signs, gauges & limiting the shoals through maintenance dredging. Marking of navigation channel through beacons and communicating information about the navigation channel monthly to fishermen and the expected timing or frequency of barges to fishing community so as they can be pre-informed and he damage to their boats and gears can be reduced. Barge movement schedule should be prepared in advance and should be shared with the fishermen
- Carrying out river training works at critical bend locations and provision of cautionary signage at the navigational hazard locations
- Provision of Radar navigation during night time and low visibility timing
- Installation of navigation lights to make channel visible and painting beacons & bays with refractive paints for enhancing night time visibility

- A direct investigation of accidents through an interactive system may serve the purpose of both developing an authentic and reliable accident database and updating the current faults
- Sensors and hooters should be fitted with vessel which can notify the closeness of another ship or any other potential matter which can cause accident.
- Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible
- Enhancement of fishing in the area by boosting and funding fish nurseries and provision of better fishing aids
- There should be 24-hour functional dedicated disaster management cells/ control rooms established along the waterway for monitoring movement of barges and to deal with emergencies.
- Provision of backup medical facility for rescue operations. This can be arranged through tie up with hospitals located along the NW-1

5.5.3.2 Impact on Livelihood of Fishing Communities

Fishing is major occupation of the people of the nearby villages. The monthly average income of the fisherman ranged from Rs.4000 to 7000 in Allahabad to Patna stretch. However, in Varanasi stretch the most of the fisherman is engaging in boating and ferry services and earning more than fishing. In lower zone (Farakka to Haldia) the average income of fisherman is slightly high and ranging between 7000 to Rs. 10,000. The income is higher in lower zone (Farakka to Haldia) because of higher catch and high value fish (mainly Hilsa) in the catch.

As per study carried out by CIFRI “Impact analysis on Ecology, Flora and Fauna including Fish and Fisheries due to movement of Barges carrying coal through National waterway no. 1 (Sagar to Farakka)”, it is found that barge movement significantly impact the fishing operations in that stretch resulting in reduction in their income. Thus similar nature impacts are anticipated due to the project. Stretch downstream of Farakka is already impacted due to existing barge movement. Impacts on stretch upstream of Farakka are anticipated to be comparatively lower than the stretch downstream. Fishing is done using large nets placed across the river in areas near Farakka and downstream of Farakka, whereas in areas upstream Farakka fishing is done near the bank areas using small size mesh gill net, traps and hooks and lines.

Mitigation Measures

- Barge/vessel movement will be restricted to the designate navigation route only. Maintenance of buoys, beacons, signs, gauges to mark the navigation channel
- Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the damage to fishing gears and boats.
- Marking of navigation channel through beacons and communicating information about the navigation channel monthly to fishermen and the expected timing or frequency of barges to fishing community so as they can be pre-informed and the

damage to their boats and gears can be reduced. Barge movement schedule should be prepared in advance and should be shared with the fishermen

- Regularizing the barge speed to 7-8 knots in bending areas so as bank erosion can be reduced due to barge movement resulting in lesser turbidity, enhanced planktonic growth and thus increased fish yield.
- River training works should be carried out at the bank locations which are prone to erosion to reduce the turbidity in shallow areas and its impact on fish yield.
- All measures to reduce the water quality pollution & to prevent damage to ecology due to barge movement as proposed above should be adequately addressed and implemented so as to minimise impact on fish yield due to the project.
- In case of damage of fishing nets, fishing crafts and other gears of fishers, arising due to barge operation, appropriate and quick compensations may be given to the aggrieved fishers.
- The barges may be fitted with powerful searchlight and may sound horn so that fishermen can realize arrival of barge at least from 500 m-1 km away to prevent damage to fishing nets
- Regular consultations to be carried out with the fishing communities to get their feedback on the impact due to barge movement on fishing and problems they are facing

Enhancement Measures

- Support shall be extended in terms of supporting setting up fish nurseries for improving fish productivity and training awareness of fishermen for better fishing techniques through institute of repute like CIFRI.

5.5.3.3 Impact on Socio-Cultural Aspects

Barge movement though restricted to the defined navigation channel but have potential to impact and interrupt the fest and festivals and other day to day activities being carried out or performed at river by the people. There are several festivals which are being celebrated at River Ganga and several rituals being performed at River by people. These activities are also likely to be impacted due to increased barge movement. Some of the important festivals are Kumbh at Allahabad (Jan-Feb), Ganga Mahotsav at Varanasi (Oct-Nov), Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March), Chatt at Bihar & Jharkhand (Oct-Nov) and Ganga Sagar Mela at Sagar (January). Thus it is essential that barge movement should be regularized at these locations during these festivals so as to prevent social conflicts. Apart from this there are about 100 ghats at Varanasi used for various purposes like bathing, idol immersion and asthi visarjan. Cremation ceremony is performed at several locations along the bank of river. Also locals of nearby villagers (both males and females) bath in river. Due to barge movement there could be uncomforting for the female bathing in the river. Barge movement may bring certain social conflict if appropriate and timely measures are not put in place.

Mitigation Measures

- Vessel movement shall be restricted or regularise during the identified major festival period as listed under description of Environment chapter 4.
- No waste in form shall be discharged by vessel in the river.

Enhancement Measures

- Support for establishment of small enclosed areas dedicated for female bathing in every village along the NW-1 to allow female maintain their privacy.
- Support for improving cleanliness and at existing ghats at Varanasi and other locations
- Provision for improving selected Ghats as per the demand raised during public consultation.

C. Impact on Climate Change

5.6. Impact on Climate Change of Jal Marg Vikas Project

5.6.1. *Climate Change Scenario in India:*

Generally, IWT is considered more energy efficient and emit less CO_2 per ton-km performance compared to other two transport modes namely road or rail transport modes. The average emissions from IWT mode range from 25 gr CO_2/ton-km to 70 gr CO_2/ton-km. Whereas from road transport by truck it varies from 60-120 gr CO_2/ton-km and in the case of rail mode it varies from 20-80 gr CO_2/ton-km depending upon fuel use transport capacity etc. In the case of IWT the variations are due to fleet structure, age and engine of vessels, fuel use, market conditions etc. All these factors are associated with IWT system efficiency which can be planned and managed to make the IWT system more efficient. Besides, the impacts of climate change are required to be managed depending upon the events occurring due to the changes in climate taking place. This type of mitigation management is known as Adoption need in IWT facilities. For example, as per World Bank report on impacts of changes in climate in India are concerned, the erratic behaviour of Indian monsoon has become a reality and is considered to be the major manifestation of climate change impacts in India. The frequency of droughts or short spells of heavy rainfall events are now being experienced at much higher rate. It is pertinent to mention that agriculture productivity is life line of India. An abrupt change in the monsoon could precipitate a major crisis, triggering more frequent droughts as well as greater flooding in large parts of India. Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa and Chhattisgarh. At 2.5°C warming, melting glaciers and the loss of snow cover over the Himalayas are expected to threaten the stability and reliability of northern India's primarily all glacier-fed rivers, particularly the Indus and the Brahmaputra. The Ganges will be less dependent on melt water due to high annual rainfall downstream during the monsoon season. As per WB reports downward trend of river flow of the Indus, Ganges, and Brahmaputra rivers alone could significantly impact irrigation, affecting the amount of food that can be produced in their respective river basins thereby adversely impacting livelihoods of millions of people (209 million in the

Indus basin, 478 million in the Ganges basin, and 62 million in the Brahmaputra basin in the year 2005). The Indus and the Ganges-Brahmaputra-Meghna Basins are the major trans-boundary rivers, and the increasing demand for water is already leading to tensions among countries over water sharing (World Bank).

5.6.2. *Impact of Jal Marg Vikas Project on Rate of Emissions of GHG:*

Any transport system viz rail, road and IWT has emission of GHG. It is also well established that different mode of transport has different intensity of GHG emission. The analysis given below present the GHG emission levels in all the three mode of transport for similar quantity of cargo movement for transportation between Haldia to Varanasi. This analysis also presents the possibility and benefit of transport model shift from Rail, road to IWT. CO_2 is the main GHG gas which contributes maximum to the warming of atmosphere and increased CO_2 concentration is one of the major driver of climate change. Fuel burning also emit the CO2. GHG emission from IWT is assessed in the form of CO_2 emissions. CO_2 emissions are calculated based on reported emission factor under various studies. The likely emission level of CO_2 is presented at **Table 5.10**.

Table 5.10 : Comparative assessment of GHG (CO_2) emissions from Various Modes of Transport

Mode	CO2 emissions (gCO2/ NTKM)	Avg. Cargo transportation between Haldia and Varanasi in Phase I (tonnes/day)	Distance Considered to be travelled (Haldia to Varanasi)	Net CO2 emissions (Tonne/ day)	Net CO2 emissions (Tonne/yr)	%Ranking
Road 60	38.1	19000	1065	770.95	281396.75	IV
Railways (Diesel)61	11.9		1037	234.46	85579.98	III
Railway (Electric)	11.22		1037	220.67	80545.86	II
Inland vessels of 1900 DWT and dimension - 110X11.462	6.4		1311	159.41	58187.42	I

Note: The emissions calculated are only for the section where material transportation will be taken through IWT, i.e. Haldia to Varanasi. Emissions from source of material to the initial point[63] are not considered in any of the mode. These emissions will be common in all the road, railway & IWT mode.

[60]Promoting Low Carbon Transport in India, UNEP, "Infrastructure for Low Carbon Transport in India: A case study of the Delhi-Mumbai Dedicated Freight Corridor, IIM Ahmadabad

[61]Promoting Low Carbon Transport in India, UNEP, "Infrastructure for Low Carbon Transport in India: A case study of the Delhi-Mumbai Dedicated Freight Corridor, IIM Ahmadabad

[62]Workshop Inland Navigation CO_2 emissions "Energy efficiency of inland water ships-and how to improve it", DST, Germany

[63] Initial point is referred to as start point of each mode, i.e. Road, railway & IWT in section from Haldia to Varanasi.

In addition to above calculations GHG emissions, which will be generated due to material transportation within the terminal site, is presented at **Table 5.11.**

Table 5.11 GHG (CO_2) emission generation within terminal due to material transportation

S. No.	Terminal Facility	Capacity of Terminals in Phase I (Million metric tonnes)	No. of trucks (15 MT) required to carry the material-2 way movement	Distance to be travelled by trucks within terminal site for material transportation (km)	Standard for CO2 emission by trucks post 2000 of 6000 cc engine capacity (g.km)	GHG Emissions (tonnes/day)	GHG Emissions (tonnes/yr)
	Varanasi	0.5	92	184	762.3964	0.07	25.67
	Haldia	1.57	544	0.45		0.19	68.09
	Sahibganj	2.24	818	0.7		0.44	159.39
Total GHG (CO2) Emissions						0.7	253.15
GHG Emissions by IWT estimated in Table 5.10						159.41	58187.42
Total GHG Emissions through IWT Mode						160.11	58440.57

The GHG emission from IWT is estimated to be 58440.57 tonnes per annum which is the least amongst all the other mode of transport. These emissions can be further reduced by design and operational measures. The anticipated model shift will also help in reducing the GHG from RAIL and Road transportation system.

Mitigation Measures

- Adoption of modern designed vessels to be operated having more load carrying capacity and less draught requirement.
- Operating the freight vessels at slow speeds to increase the fuel efficiency and reducing the emissions.
- Adoption and strictly adhering to the standards as prescribed by MARPOL for managing the emissions.
- Switching to LNG based vessels. LNG is not only cleaner but have comparatively higher calorific value than gasoline and diesel.

Impacts of Physical Interventions

5.7. Impacts on Physical, Biological & Social Environment Due to Design, Construction and Operational Phase Activities of Proposed Civil Interventions in NW-1

[64] Air Quality Monitoring Research Association of India "Air Quality Monitoring Project-India Clean Air Programme (ICAP), CPCB/MoEF & EPA emission factors for rail locomotives, commercial.

Civil interventions proposed under the project includes terminals, locks, Ro-Ro jetties, passenger jetties, river training works, bed and scour protection works, bend correction works, and barge maintenance slipway. These interventions involve civil construction activities and associated operational activities depending on the nature of intervention for barges/vessels movement such as loading and unloading activity at terminals. These interventions will have three major phases, i.e. design/pre construction, construction and operation phases. Activities during these phases will have interaction with the various components of environment and will have associated impacts. Most of the impact will be common in nature for different civil interventions. However, some impacts will be specific to nature and location of the intervention. EIA studies have been carried out for four already finalised interventions namely Varanasi terminal, Sahibganj terminal, Haldia terminal and Farakka lock. Outcome of these EIA studies have been referred at respective places in the combined impact assessment below. While impacts of proposed interventions are presented together, impacts assessment of individual interventions has to be re-assessed once intervention is planned and its activities and components are finalised. Impacts during different phases of interventions' construction and operation on physical, biological and socio-economic environment are presented in the following sections:

5.7.1. *Impact on Micro Climate of NW1:*

5.7.1.1 Impacts During Design & Construction Phase

Impact during design and construction phase can be co-related with the increased CO_2 emission due to the associated activities. CO_2 emissions increase is also associated with various other NW1 project activities such as burning of fossil fuels in the vehicles, DG sets and construction equipment & machinery and cutting of existing vegetation. CO_2 being one of the most potential GHG will contribute in increasing GHG concentration and associated increased average temperature/climate change phenomenon. At this stage the proposed facilities include 3 terminal sites and 1 lock site to be developed. No major tree cuttings are anticipated with the development of Farakka lock site, Haldia terminal site and Varanasi site. However, app. 500 trees are to be cut for development of Sahibganj terminal site. Cutting of app. 500 trees may lead to sequestration of app. 855 tons of carbon.

Mitigation Measures:

1. Planning and design of the project layout should be done so as to minimize the clearance of existing vegetation and felling of trees
2. Permission from DFO should be taken prior undertaking any tree cutting. Compensatory plantation should be carried out as per state forest policy. Apart from compensatory plantation additional plantation should also be carried out so to recover the Carbon sequestration earlier. Considering average life cycle of trees as 30 years, the number of trees to be planted against loss should be 30 times to recover in one year, but, it is not feasible practically, thus ratio of compensatory plantation should be kept as much as possible. In case of Sahibganj terminal project,

compensatory plantation will be carried out in ratio of 1:7 (1:2-mandatory & 1:5 additional). Thus 3500 trees (1000-mandatory & 2500-additional) will be planted in place of 500 trees cut. Plantation of additional 2500 trees will help in recovering Carbon sequestration in 5-6 years in place of 6-7 years.

3. In terms of Carbon value, trees of high Organic Carbon contents[65] need to be planted more for faster recovery of C loss.
4. Project design should incorporate usage of low embodied energy building & construction material, energy efficient electric equipment, water conservation fixture, and rain water harvesting measures to make project energy efficient and sustainable and to minimize the associated emissions and discharges.
5. Minimizing the resource requirement and waste generation through best management practices like re-use, reduce, recycle and recover.

5.7.1.2 Impacts During Operation Phase

Operation phase of these interventions will not have any significant impact on climate change drivers or climate change. However, GHG emissions are expected due to transportation of material to & fro from terminal site, material handling within the terminal sites, operation of the machinery/equipment/pumps and operation of DG sets. Though these emissions will not be significant enough however these may increase in a situation like traffic congestions if to and fro or on terminal traffic is not managed effectively. The Inland transportation will result in overall GHG emission due to model shift from rail and road to IWT as per analysis carried out in section 5.6.

Mitigation Measures

- Management of the traffic carrying cargo to be received at the terminal/jetty site by fixing the hours and route of transportation
- Development of adequate road/rail infrastructure for transportation of material to & fro from terminal/jetty site to minimize the emission generation due to traffic congestion
- Usage of low sulphur diesel/CNG based vehicles to transport the material
- Adoption of energy efficient machinery for material handling & barge loading to minimize energy consumption
- Adoption of 4Rs, i.e. Reduce, Re-use, Recycle and Re-use for material use and fuel consumption
- Ensuring survivability of the plantation within site and at other locations under Jal Marg Vikas project to minimum 70%.
- Adoption of clean energy options like solar energy, designing building to obtain green building rating of Platinum level etc.

5.7.2. *Impact Due to Natural &Other Occupational Hazard*

[65] Mid-term and long-term rotational species like Jamun and Aam (Mango) are referred. These are species with life span ranging from 20 to 100 years approximately

Natural hazard anticipated at the site are floods, cyclones and earthquake. As per seismic zone map of India, India is divided into 4 seismic zones, i.e. zone 2, 3, 4 &5. Zone 2 is least hazard zone and zone 5 is most hazardous zone. NW-1 traverses through 4 states namely: Uttar Pradesh, Bihar, Jharkhand and West Bengal. As per seismic zone map of India, these states fall under category III & IV, i.e. moderate and high damage risk zone. Thus it is essential to take this in consideration while designing the structure of proposed intervention so as the site can withstand the earthquake of moderate and high intensity.

All the interventions will be developed along the river thus are prone to the flooding. The intervention shall be designed considering the 50 years return HFL level of the river. Finished level of both the off-shore & on-shore structures should be above the HFL of river to prevent the flood hazard. Bunds/levees should be constructed along the stretches which floods heavily leading to high damage. At Haldia terminal site, embankments are already developed along the river by Haldia Dock Complex thus the site is not prone to flooding. Further flood protection measures are proposed at the site.

Another natural hazard associated with the project is cyclone. Only the Haldia site is prone to cyclone. As per cyclone hazard map of India, region lies in very high cyclone prone area. Also the tidal variations are high in Haldia region. Thus safety and prevention measures should be included in project design to minimize the damage due to these events. Cyclone threat is not anticipated at any other planned or proposed civil intervention site.

Apart from above natural disasters other occupational disasters may also occur at the site like electricity fire, fall/trip, injury, fire in stored oil etc. These hazards can be mitigated if adequate emergency preparedness plan is in place and followed during emergency situation.

Mitigation Measures:

- Structure design of the building should be prepared considering the seismicity of the area and building should be designed for one higher seismic zone.
- All structures should be designed above the HFL of the river for 50 years return flood period.
- Adequate fire-fighting facilities/infrastructure should be provided at each intervention site
- Mock drills should be conducted for the workers to handle various emergency situations like floods, earthquake, cyclones etc.
- Emergency response cell should be developed for each site to take care and handle the expected emergency situation
- Emergency collection area and emergency control room should be provided at the site. Display of emergency contact nos. should be made in the emergency room and

at other site locations. Emergency cell should be comprising of personnel well trained in health & safety management at sites

- Fuel should be stored in isolated location in HDPE tanks along with firefighting facilities provided at all fuel storage locations.
- Entry to high risk area like electrical panels, control room, HT lines, fuel storage area should be restricted only for authorized & trained personnel
- Ensure availability of the first aid & ambulance facility at each site
- Tie-ups with the local hospitals of the area to handle various emergency situations
- Regular supervision and maintenance for adequacy and intactness of the flood control measures provided at each site
- Nearest cyclone shelter should be notified to all the workers at the site
- Regular health check-ups should be conducted for the workers at site to detect the occupational hazards if any.

5.7.3. *Impact due to Shifting of Existing Utilities*

Utility shifting may be required to be carried out at the sites where civil interventions are proposed. No utility shifting is required at Varanasi terminal. However, at Farakka site a FBP road will require to be realigned and at Haldia site existing ammonia pipe line of Tata Chemical plant and a road to Mitsubishi plant are required to be shifted. Shifting of these utilities may cause substantial inconvenience to users depending on the nature of utility to be shifted.

Measures:

- Shifting of any utility should be carried out prior to the start of construction and with consent of users to minimize the disturbance to them.
- Users shall be pre-informed about the shifting of utility and support should be provided to users for alternate arrangement as feasible to minimise inconvenience to existing users.

5.7.4. *Impact on Land Environment*

5.7.4.1 Impacts during Design and Construction Phase

Typical impact associated with land environment component during design and construction stage of implementation of proposed civil interventions are listed below

- Change in land use
- Land acquisition
- Change in topography
- Loss of agricultural land and/or fertile agricultural soil
- Soil quality deterioration due to spillage of fuel/paint, disposal of muck or soil contamination with other construction material

Development of terminals/jetty or other proposed structures under NW-1 can be in general classified under industrial/transportation infrastructure. The implementation of these intervention will cause changes from pristine land use class. At Varanasi, Farakka

& Sahibganj site land is under agricultural use thus land use will be changed. However, Haldia site currently lie within industrial zone of Haldia Dock Complex and no changes is anticipated. However, additional land acquisitions are involved at Varanasi & Sahibganj Terminal sit. In the cases of Haldia terminal and Farakka lock the additional land required belong to respective existing users like Haldia Dock Complex and no acquisition of additional land are required.

Private land area of 5.685 ha and area of 61.38 ha (151.71 acres@ 44.92 ha/111 acres) in phase I will be acquired for Varanasi terminal and Sahibganj terminal respectively. Apart from private land 19 acres of Government land will also be used for development of the Sahibganj terminal. Entire private land at Sahibganj terminal is under agricultural/orchards/settlement use. However, implementation of the proposed interventions will lead to change in land use category and also the land cover of the sites.

Varanasi site is slightly undulating with elevation varying from RL+74.0 to RL +77.0. Sahibganj site is highly undulating with level difference of 16 m and elevation range within 30-56 amsl. Excess unused muck of 12.1 lakh cum will be generated at the Sahibganj site. Haldia terminal site is a low lying area with elevation variation of 4-9 m amsl. Site requires additional filling of 3.3 lakh cum to achieve the desired level above HFL of Hoogly river. Farakka lock site is also undulating with elevation variation of RL+13-RL+29 m. To achieve the requisite level of 28.44 m so as the site is above HFL excess muck of 7.63 cum will be generated from the proposed Farakka site. So such preconstruction land levelling tasks will disturb the natural topography of the site.

Excavation and filling tasks at site will lead to the loss of precious top soil. As the soil of the intervention sites being from agricultural lands thus site development tasks will lead to a loss of fertile top soil. Such land use or topographical changes are permanent in nature but the resultant impacts will not be significant once mitigated properly as the project is to be implemented keeping the overall associated economical gains of the region.

Construction waste (debris, unused iron bars or damaged support structures, quarry dust etc.) if discarded or duped in river in an uncontrolled manner may affect soil of the site or river water quality. The various categories and quantities of fuel oil shell be stored at site then occurrence of accidental fuel spillage or leakage cannot be ruled out which eventually will contaminate the adjoining soil strata. Such soil contamination can be severe in case of voluminous leakage.

Movement of construction vehicles and equipment may also lead to soil compaction on haulage roads as well as nearby areas. Soil may also be contaminated due to inappropriate disposal of used oil or various liquid/solid wastes, (lubricating oil and fuel spills, waste oil and lubricant and vehicle/equipment washing effluent etc.) and oily solid waste (fuel filters, oily rags) are also likely to be generated from repair and maintenance of transport vehicles, construction equipment and machinery. Soil may also be

contaminated due to inappropriate and untreated disposal of domestic solid waste and sewage from construction camps. But such surface soil contamination types will be short term confining to construction period only and thus may be insignificant in nature but appropriate mitigation/management is warranted.

Apart from this construction dredging will be required for construction of off-bank structures like berths & jetties. Construction of jetty at Sahibganj will require dredging of 0.15 million cum of river sediments and construction of jetties & berths at Haldia will require dredging of 0.1-0.2 million cum river sediments. The river dredge material is not found contaminated (refer Table 4.59 for dredge material quality) and shall be disposed-off by the contractor at site as per norms proposed under mitigation. Uncontrolled disposal of large quantity of dredged material on the banks may contaminate the productive site or aesthetic of disposal area. However, the dredged sediments can be used as fillers (for cut and fill tasks for land levelling) where ever required.

Mitigation Measures

- Excavation and filling tasks should be carried out in parallel so as to minimize the soil erosion. Unusable debris material should be suitably disposed at pre designated disposal locations, with approval of the concerned authority.
- Compaction of soil shall be undertaken by controlled sprinkling the water to minimize the surface runoff and erosion.
- Agricultural land shall not be selected for setting up construction camps, borrow area (if any), plant site or any other construction purpose
- Well-designed water sprinkling to be carried out for dust suppression
- 15 cm of top soil layer shall be stripped off prior to excavation and shall be stored separately in covered condition and used for landscaping purpose at a later stage. This should be stored in the form of the heap with the slide slopes covered with grass
- Remaining excavated soil shall be used for filling purpose and left over shall be stored in covered conditions for use in future for construction of approach road & railway connectivity and mine rehabilitation located at 4-5 km from site. The soil storage location shall be identified in advance in consultation with PWD which is likely to construct the approach road.
- Dredge soil shall also be either utilised for construction activity or disposed along with excavated soil to the identified debris disposal site
- Fuel shall be stored in HDPE containers on paved surfaces with provision of catchment pit to prevent soil contamination from oil spillages.
- Arrangement should be made for segregation of municipal solid waste into recyclable and non-recyclable waste
- Non-recyclable waste generated should be disposed regularly through authorized agency. Recyclable waste should be sold to authorized vendors
- Construction waste generated should be segregated at site into recyclable, reusable & rejected fraction. Recyclable should be sold to authorized vendor,

reusable waste should be stored at site for usage and rejected fraction should be disposed at designated sites by the municipal authority

- If no debris or waste disposal site exists in the area then a site should be identified by contractor for debris disposal, should be approved by IWAI and should be used & manage for the same as per the Debris Management Plan
- Septic tank or mobile toilets fitted with anaerobic treatment facility shall be provided at construction camp
- Aggregates will be sourced from existing licensed quarries. Copies of consent/ approval / rehabilitation plan for a new quarry or use of existing source will be obtained by DBOT contractor and submitted to IWAI.
- Geometric adjustment shall be made if required and technically safe to minimise cutting of the tree for rail & railway construction. Separate provision shall be made for compensatory tree plantation if any tree cutting is carried out for construction of road & railway link[66].
- Hazardous waste like used oil from DG sets shall be stored in HDPE containers and shall be stored on paved surfaces in isolated location to prevent its spillage and contamination of soil. Used oil shall be disposed through authorized vendors only.
- Movement of construction vehicles shall be restricted to the designated haulage roads only to prevent compaction of soil in other areas
- The earth stockpiles to be provided with gentle slopes to prevent soil erosion.
- Sedimentation tanks shall be provided with storm water drain to arrest the sediments and these sediments shall be removed and stored with remaining excavated soil
- Provision of cross drainage structure like culverts shall be made in the access road if required to maintain the natural drainage pattern and prevent soil erosion.
- Provision of side drain shall be made in access road if required to prevent water logging.
- Shore protection works like stone pitching, and geo-textile matting along the bank and construction of stone apron in the river to prevent the scouring of banks shall be undertaken
- Bio-turfing of embankments shall be made enhance the slop stabilization
- Wash-off from concrete mixing tanks and wash from washing area shall not be allowed to enter the soil. This wash shall be collected through drains into tanks and concrete shall be settled, collected, dried and re-used in the site again.

5.7.4.2 Impacts during Operation Phase

Solid waste to be generated during the site includes municipal waste, dredged sediments, STP sludge, and used oil from DG sets. These wastes can pollute the soil if allowed to uncontrolled interface with soil. These impacts are moderately significant

[66] Approach rroad construction is proposed to be undertaken by other agency PWD and road design shall be evolved by them only. Rail link construction will also be taken up by railways

though the activity may be for short period but impacts may persist for long periods. Hence, appropriate mitigation measures are warranted.

Mitigation Measures

- Fuel shall be stored in HDPE containers on paved surfaces only to prevent spillage of fuels on the soil and thus soil contamination
- Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching, river training structures etc.
- Necessary checks and actions are required wherever there are failures
- Dustbins shall be provided at all the required locations at the site for collection of recyclable and non-recyclable waste. Recyclable waste shall be sold to authorized vendors and non-recyclable waste shall be disposed through authorized agencies and shall not be dumped in open.
- Used oil from DG sets and other equipment shall be stored in HDPE containers in isolated location on paved surfaces and shall be disposed through authorized vendors only and shall not be dumped in open.
- Room shall be provided for storage of E-waste at site and this waste shall be sold to authorized vendors periodically and shall not be dumped in open.
- Bio- medical waste likely to be generated at first aid centre shall be disposed of following the bio medical waste disposal rules.

5.7.5. *Impact on Air Environment*

5.7.5.1 Impacts During Design Phase

Site preparation, vegetation removal and construction material handling are the key air pollution causing activities during this phase of project implementation. Preparation of site involves cut and fill activity to achieve relatively a flat surface for development. Excavation/filling activities and piled up excavated soil will generate fugitive dust emissions. Emissions will also be generated from operation of excavators & levellers. These emissions may increase the concentration of PM (particulate matters) SO_2, NO_x, & CO in the project area. Vegetation existing at site will be removed for developing the project. Bare & loose soil after vegetation uprooting/removal will be exposed to wind and will add on to the concentration of ambient dust levels.

As per baseline study, concentration of air pollutants in the study area are within the prescribed limits as per NAAQS[67] (National Ambient Air Quality Standards., 2009) at all the planned intervention sites and also within 2 km area of the proposed site limits except at Ramnagar which being close to the road bridge. Above mentioned activities

[67]Central Pollution Control Board has notified National Ambient Air Quality Standards for different pollutants. The prescribed limits for relevant pollutants for 24 hourly concentration level basis are as follows:

- Particulate matters of 10 micron Size (PM_{10}) : 100 µ/m^{3}24 hourly average
- Particulate matters of 2.5 micron Size ($PM_{2.5}$) : 60 µ/m^{3}24 hourly average
- Oxides of Sulphur (SO2) : 80 µ/m^3 24 hourly average
- Oxides of Nitrogen (NOx) : 80 µ/m^3 24 hourly average
- Carbon Mono Oxide (CO) : 2 mg/m^{3}8hourly Average

will increase ambient pollutants level (dust or PM, SO_2, NO_x, & CO) temporarily and confined to the localised area. The resultant baseline level is unlikely to increase beyond prescribed NAAQS since dust emission will settle down within short distance of its source and vehicular exhaust emission will be low in quantity

However, cutting of trees will have moderate impact on micro climate as well as air quality of this zone. This impact can be further reduced by minimizing the tree cutting through proper planning and also adopting the compensatory tree plantation activity as per state forest policy.

Mitigation Measures

Provision shall be made for:

- Excavation and filling tasks to be carried out in parallel (at any one site) and in a phased manner. The water used for sprinklers should be controlled to avoid any water pounding.
- Water sprinkling to be used at all dust generating sites to suppress the dust generated.
- Appropriate schedule of aggressive preventive maintenance of excavators/levellers/loaders and other machinery is recommended to minimize the emission generation and enhance their efficiency.
- Top fertile soil layer stripping is to be implementing before excavating the soil and should be stored under covered conditions for usage in landscaping at later stages
- Storage of surplus excavated soil in covered conditions for its use for various construction activities e.g. for filling the low lying/ depressed areas.
- Proper identification and marking should be done for trees to be cut and cutting permission from concerned forests department should be in place before any cutting.
- Compensatory plantation of trees having adequate canopy as per CPCB guidelines should be implemented. The mandatory requirement of 1:2 ratios is to be observed. and additional plantation if required, should also be carried apart from mandatory compensatory plantation as has been proposed in the ratio of 1:5 in the case of Sahibganj terminal site.
- Ensure survival rate of compensatory plantation at a minimum of 70% and for this a periodical monitoring and reporting (at least half yearly interval) is recommended.

5.7.5.2 Impacts During Construction Phase

Construction activities to be undertaken at the planned intervention site may include an administration building, worker's amenity building, internal roads, lighting towers, storage yards, security sheds, berths, jetties, DGPS etc. depending on the facilities to be constructed. All the construction activities lead to generation of dust along with other pollutants. Operation of construction machinery & equipment including transport vehicles, DG sets etc. generate emissions and may increase the ambient concentration

of SO_2, NO_x, PM &CO within the construction site though confining to construction period on that site. But these emissions can be minimized to larger extent by taking the preventive measures. Also transportation of raw materials will generate dust and emissions from the transportation vehicles though for short duration along the transportation route. However, it will be preferable to use locally available construction material so as to reduce the transportation emissions and cost for material transport. Source of construction material for the planned facilities is given below in **Table 5.12** below.

Table 5.12 : Source of Construction Material for Planned Civil Interventions

S. No.	Location	Construction Material Sourcing
1	Haldia Terminal	Stone chips- Pakur quarry in Jharkhand (370 km from site) Sand- Villages Kasthakbali and Barsundra (20 km) and Damodar River (100 km)
2	Farakka Lock	Stone and aggregates- Rajmahal hills (Sahibganj) at app.100 km from site
3	Sahibganj Terminal	Stone and aggregates- Rajmahal hills (Sahibganj) near the site
4	Varanasi Terminal	Stone and aggregates- Sirsa, Mirzapur at app. 45 km from site

Impacts anticipated during construction phase confine to the construction period only which may vary fromapproximately1.5-3 years for each facility. Thus the anticipated impacts are localized and short term. However, for the sites located close to any residential area/habitations comprehensive mitigation planning is warranted as the habitants residing nearby may be affected due to even these short term activities. Mitigation measures recommended to minimize the ambient air pollution (not exceeding NAAQS).

Mitigation Measures

- All vehicles delivering any material particularly any loose and fine materials like sand and aggregates should be covered. Scaffoldings, open dumps of raw material at site or construction debris should be covered with tarpaulin at all construction sites and situations.
- Periodic water sprinkling is mandatory at all site roads particularly the haul roads
- Masks and other PPE shall be provided to people working in high dusty environment and the workers should be educated on the benefits of use.
- Loading and unloading of construction materials should be carried out preferably at designated locations in the respective projects wherein the provisions of water fogging to prevent any dust dispersion around these locations.
- Construction vehicle, machinery & equipment should be regularly serviced and maintained and the vehicles selected for use should comply with emission

standards as per CPCB norms. Vehicles entering the construction site should also carry valid PUC certificate

- Low sulphur diesel should be used for operating DG sets and various other construction equipment(s) if applicable.
- Diesel Generating (DG) set(s) should have adequate stack height as per regulations (Height of stack = height of the building + 0.2 √ KVA.). Here the building height is the building attached to DG.
- Wheel wash facility shall be provided at exit gate of the project site.
- LPG should be used as source of domestic fuel in construction camps instead of wood. Any tree cutting should not be allowed for fuel wood or any other wood requirement for construction.
- Mixing Plant, crushers and batching plant (fitted with adequate stack height) should preferably be located on downwind direction to ensure enough dispersion of their exhaust gases and also fitted with appropriate pollution control devices (where ever mandatory). This construction equipment should ensure preventive measures like usage of low sulphur diesel, provision of adequate stack heights, regular maintenance and regular stack monitoring.
- Ambient monitoring of air quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed mitigation and EMP.

5.7.5.3 Impacts During Operation Phase

Various associated air pollution sources during operation phase will primarily be with proposed civil interventions like terminal/jetties. The activities which may generate emissions at jetty/terminals are primarily due to transportation & storage activities of material (off the river& on-the river), such as loading and unloading of materials at the site (at stock yards and shed area), and loading/unloading of barges. Materials proposed to be transported include large number of diverse items such as cement, fly ash, iron ore, iron ore fines, coal, steel shed, tyres, iron fines, iron ingots, Galvanized steel plain sheets, stone chips, furnace oil, HF HSD, lube oil, boulders, pulses, aluminium block, sand, chips, ship block, log, pulses, manganese ore, petroleum coke, cooking coal, rock phosphate, timber, peas, slag oil, and non-cooking coal as per existing system. Transportation of material like coal, stone aggregates, and sand may generate significant dust emissions if transported in open wagons or stored in open stock yards. Thus these emissions are required to be managed to prevent any air pollution. For management of these emissions, certain mitigation measures are proposed which will significantly reduce the air pollution.

Apart from emission due to nature of cargo, a number of emissions are also due to transportation of such material. Air quality modelling study has been carried out for Sahibganj & Haldia Terminal site to predict the concentration of the pollutants due to transportation activity of cargo material to & fro from the terminal/jetty site.

Air Modelling Study for Sahibganj terminal Site

Capacity of Sahibganj terminal is 2.24 million metric tons per annum or 6788 metric tons per day. App. 400 trucks are estimated to ply both ways from terminal site daily. Transportation of cargo material through trucks will generate pollutants which will impact the ambient air quality at the site as well as on transportation roots. To predict the level of degradation of air quality, air dispersion modelling study has been carried out to predict concentration of PM_{10} (being the most prominent pollutant) at the time of unloading from 400 trucks based on the software AERSCREEN Model 15181. The modelled results show that maximum additive 24 hourly concentration for PM_{10} at a distance of 50 m from storage area will be 27 ug/m^3 due to material loading/unloading activity at site. Graphical projection of dispersion of modelled ambient pollutant concentration during loading/unloading as a function of distance from its source is given in **Figure 5.4.**

As per baseline data, concentration of PM_{10} in nearest village Samdha Nalla is 61 ug/m^3. Considering the same level at project site the resultant concentration level (after adding expected increase in concentration at site) will be 88 ug/m^3, which is still within the prescribed limits of PM_{10} (AAQS, 2009). Thus it is anticipated that the impacts will be low but persist for long periods. Hence, warranting mitigation measures to reduce further.

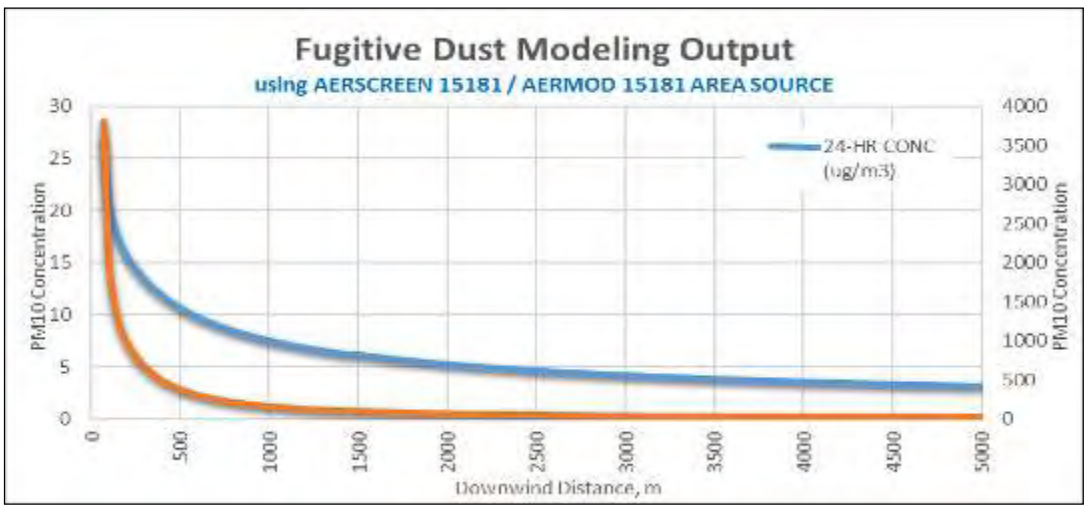


Figure 5.4 : Output of Air Dispersion Modelling-Sahibganj Terminal

Currently at Sahibganj site, provision for barge loading is made through 10 dumpers. These dumpers will lift the material through loaders. Dumpers moves about 150 m within the terminal before unloading this material into hopers of barge loaders stationed at the jetty berth. Assuming that the dumper loading and its unloading to barge hopper the loader deployed generates comparable level of emission rates of dust as from loading/unloading operations at stock yards. Hence, it is also anticipated that the predicted dust level shall be of the order of 27 ug/m^3. This will tend to settle down at river surface and thereby impacts the river water quality. The spread of this dust on river water surface is again a function of wind as well as river flow. Considering the river water

spread upto 50 m is beyond the jetty area. To further reduce the impact on river water quality it is recommended to install mechanical conveyor belt system for loading & unloading of barges which will also enhance the loading/unloading efficiency and reduce time to minimize these emissions.

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Air Modelling Study for Haldia terminal Site

Materials to be transported to the site and from the Haldia terminal site are stone aggregates, edible oil & POL fertiliser and Fly ash. Coal will not be stored at the site and only transhipment is proposed at 5th No jetty. Quantity of the material excluding the coal to be transported to and from the site is 1.57 million MTPA, i.e. 4757.6 MT (metric tonnes) per day. Thus app. 317 nos. of trucks are required for transportation of this material. Total nos. of truck movement (to & fro) will be 2 X 317, i.e. 634 trucks.

Transportation of material through trucks will generate pollutants which will lead to degradation of air quality of the study area. To predict the level of degradation of air quality, air dispersion modelling study has been carried out to predict concentration of PM_{10} at the time of loading & unloading from 634 trucks using the software AERSCREEN Model 15181. The results show that maximum 24 hourly concentration for PM_{10} at a distance of 50 m from storage area will be 21.38 ug/m^3 due to material unloading activity at site. Graphical depiction of dispersion of pollutants to be generated during unloading at various distances from generation source is given in **Figure 5.5.**

As per baseline data, mean concentration of PM_{10} in near site is 29 ug/m^3. Considering the same level at project site the resultant concentration level (after adding expected increase in concentration at site) will be 50.38 ug/m^3, which is still within the prescribed limits of NAAQS, 2009. Thus it is anticipated that the impacts will be moderately significant but long term.

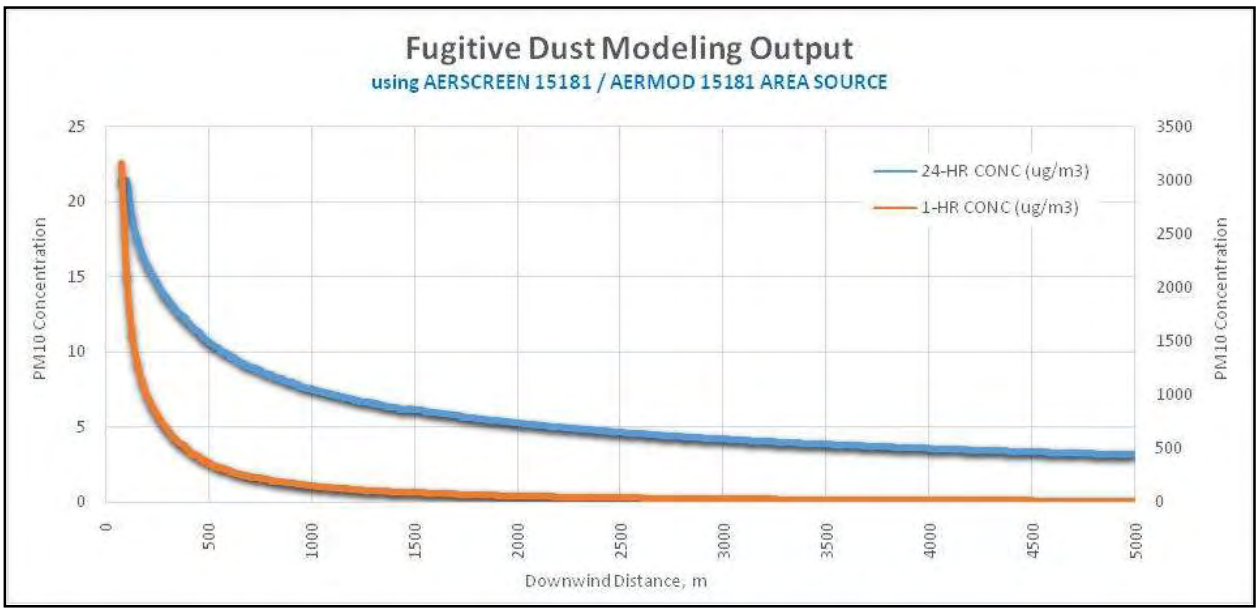

Figure 5.5 : Output of Air Dispersion Modelling-Haldia Terminal

Currently provision for barge loading is made through 10 no of dumpers. These dumpers will lift the material through loaders. Dumpers moves almost 275 m within the terminal and unloaded the material into hopers of barge loaders at the jetty. The dumper loading and material unloading to hopper of barge loader generates similar level of dust as from unloading of incoming material at stock yards. It is anticipated that the predicted dust level shall be of the order of 21.38 ug/m^3. This will tend to settle down at river and effect river water quality considering its spread upto 50 m which is beyond the jetty area. Thus it is recommended to install mechanical conveyor belt system for loading 7 unloading of barges to minimize these emissions.

. Apart from material handling & transportation, other source of emissions at site are:

- Emissions from DG sets
- Emissions due to fire in coal/oil stored at site

DG sets however will be operated only in case of power failure thus expected impact is low & insignificant. But emissions result due to accidental burning of coal/oil or other stored material will be significant & will have significant impact on air quality of the area. Temperature of Varanasi & Sahibganj site is hot which can trigger fire in coal/oil. Thus mitigation measures should be taken to prevent any such accident at the site. However, climate of Haldia site is moderate so such fires are not anticipated at Haldia terminal site. Mitigation measures proposed for managing the air pollution at the planned site are discussed below.

Mitigation Measures

- Material shall be transported in covered vehicles
- Transportation vehicle shall be properly serviced and maintain and shall carry PUC certificate
- Material should be stored under cover sheds only especially coal, sand, aggregates etc.
- Thick green belt shall be developed as per the provision already made in the design and maintained all along the periphery and along the roads. The green belt shall be developed in canopy[68] shape with local species of broad leaf variety.
- Species selected for development of green belt shall also be tolerant to expected pollutants and shall have the ability to adsorb the pollutants. Suggested species are suitable for different areas are also listed under CPCB guidelines for green Belt development[69].

[68] Canopy shape green belt design includes three row of trees with middle tree species gore more in height compared to inside and outside tree species. Each of tree will have wider leaf which forms like a curtain and acts as beerier to dust spread. Dust accumulated over leaf falls down within the site boundary. Similarly external dust gets prevented from entering the terminal site. http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

[69] CPCB guidelines for green Belt development http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

- Water sprinkling should be carried out during all loading and unloading activities and storage period.
- More frequent water sprinkling shall be carried out at coal yard during summer season to prevent spontaneous fire.
- Storage of oil should be as per MSDS and all fire prevention & fighting measures should be provided at site
- It is recommended to provide mechanical conveying system with provision of dust collection system for loading/unloading material from barges
- Monitoring of air quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP

5.7.6. *Impact on Noise Environment*

5.7.6.1 Impacts During Design & Construction Phase

Source of noise pollution during the design and construction phase at the proposed intervention sites are site clearing, operation of excavators/earth moving equipment and leveller, operation of heavy machinery and equipment for construction purpose, loading & unloading of construction material and pilling & dredging activities. Typical noise generation from these equipment as per CPCB are given in **Table 5.13.**

Table 5.13 : Typical Noise Levels of Construction Machinery/Equipment

Construction Equipment for Different Activities	Noise Level in dB(A) at 50 feet
Bulldozer	80
Front end loader	72-84
Dump Truck	83-94
Jack Hammer	81-98
Crane with ball	75-87
Scraper	80-93
Grader	80-93
Roller	73-75
Crane	75-77
Welding generator	71-82
Concrete mixer	74-88
Concrete pump	81-84
Concrete vibrator	76
Air compressor	74-87
Pneumatic rods	81-98
Cement and dump truck	83-94
Front end loader	72-84
Paver	86-88
Truck	83-94
Tamper	74-77

Backhoe	72-93

Source: CPCB

It is evident from the above table that operation of these equipment will generate high noise and will lead to increase in ambient noise level at the site and nearby areas and may impact the health of construction labour and nearby residents. But these equipment will not be operated throughout the day thus noise generation from these equipment is considered to be of intermittent type. By provision of earplugs to the workers engaged in high noise generating activities, impact due to noise pollution can be managed. As per occupation standards, workers' exposure to 90 dB(A) noise level shall not be more than 8 hours. OSHA guidelines shall be followed for exposure to specific noise levels for workers and are listed in **Table 5.14.** Conducting hearing tests for workers also help in monitoring the impact of the higher noise level on workers' health.

Table 5.14 : OSHA noise exposure limits for the work environment

Noise Levels in dB(A)	Permissible Exposure (hours & minutes)
85	16 hrs
90	8 hrs
96	3 hrs 30 minutes
102	1 hr 30 minutes
108	40 min
115	15 min
121	6 min
127	3 min
130	1 min

Source: Marsh, 1991, p.322

As per baseline monitoring, ambient noise levels at all planned sites (Haldia, Farakka, Varanasi & Sahibganj) are within the permissible limits as prescribed by CPCB for residential areas. However resultant noise level (ambient noise level +increase noise levels due to operation of equipment) can be higher than the prescribed limits of CPCB. Thus the high noise levels are required to be managed by taking proper noise level reduction measures. Also noise associated with the construction activity will be restricted to construction period only and thus the impact is short term & temporary. Also noise attenuates with the distance, thus the impact of high noise level reduces with the increase in distance from activity area. Impact on nearby residents due to the noise generated is low in case of all presently planned site as habitations are located at more than 100 m at all the presently planned site. Noise level attenuation with the distance is governed by the following equation.

L2 = (L1 - 20 log D2/D1-Ae-An)

Wherein, L1 and L2 are the noise levels at a distance of D1 and D2 from the noise source;

Ae and An are attenuation coefficient due to environment correction and background respectively.

Apart from above activities piling and dredging activities are to be carried out in river for construction of berths. These activities also generate significant level of noise ranging from 85-90 dB(A). However, this will also be confined to the piling and dredging period. No piling and dredging activity shall be carried out at night time. Noise level generated due to dredging or piling operations are given in **Table 5.15** below.

Table 5.15 : Estimated Noise levels for the piling and dredging operations

Distance from noise source location (m)	Predicted Noise Level	
	Piling operations	Dredging
10	85.00	90.00
30	75.46	80.46
50	71.02	76.02
100	65.00	70.00
200	59.00	64.00
500	51.00	56.00

If mitigation measures are taken, then the noise levels at the site can be reduced significantly and thus the impacts can be minimised.

Mitigation Measures

Provision shall be made for:

- Barricading (Temporary noise barrier) the construction site to minimize the noise level outside the site boundary
- Restriction on Honking at the project site
- Hearing test for the workers prior to deployment at site and high noise areas followed by periodic testing every six months.
- Job rotations systems for workers, working in high noise level areas
- Restriction of high noise generating activity between 6:00 AM to 10:00 PM.
- Periodic monitoring (monthly level) of noise levels to check the level of pollutants and effectiveness of proposed EMP
- Protection devices (earplugs or earmuffs) shall be provided to the workers operating near high noise generating machines. Construction equipment and machinery shall be fitted with silencers and maintained properly. Noise measurements should be carried out to ensure the effectiveness of mitigation measures and develop a mechanism to record and respond to complaints on noise.

- All equipment shall be fitted with silencers/noise mufflers and will be properly maintained to minimize its operational noise. Noise level will be one of the considerations in equipment selection, which will favour lower sound power levels.

5.7.6.2 Impacts During Operation Phase

Noise generation sources during operation phase are primarily loading and unloading of material at site and cargo vessel, movement of dumpers, cargo vessel, operation of backup power generators, pumps and other equipment. However, the main effect on the environmental noise level will be from increased transportation of goods entering and leaving the terminal site. To estimate the increased noise levels generated due to material transportation, noise modelling study has been carried out Sahibganj & Haldia Terminal site. Noise modelling study for the Haldia and Sahibganj Terminal sites are given below.

Noise Modelling Study for Sahibganj Terminal Site

The bulk cargo is anticipated to be carried to the site by trucks, which could result in movement of 800 trucks per day (400 coming and going out, i.e. 400 X 2) considering maximum load. Noise prediction modelling has been carried out for trucks movement in and out of the terminal for material transportation which is expected to increase all along the approach road and terminal area. The maximum noise level generation from these truck movement is estimated to be 77.6 dB (A) which will be attenuated to 65 dB (A) within a distance of 21m. Noise modelling output for movement of transportation vehicles indicating the attenuation of noise with distance is given in **Figure 5.6.**

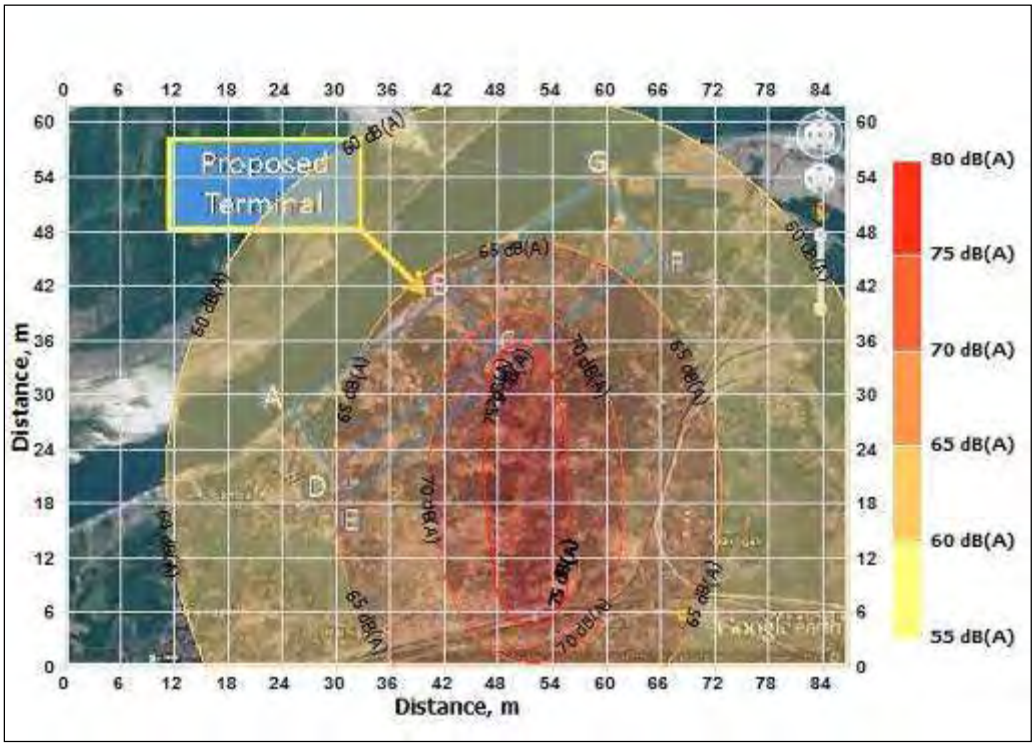

Figure 5.6 : Noise Modelling Output

After development of the project, land use of the site will change from residential to industrial category considering the nature of activities. The permissible noise levels within the site will be occupational standards whereas, outside the terminal area the exposure standards (CPCB guidelines) applicable will be of Industrial area that is 70 dB(A) for night time and 75 dB(A) for day time. Predicted noise level are slightly higher than the prescribed limits of CPCB. Thus impacts due to increased noise level can be significant, if proper mitigation measures are not taken.

Noise Modelling Study for Haldia Terminal Site

The bulk cargo is anticipated to be carried to the site by trucks, which could result in movement of 634 trucks per day (317 coming and going out, i.e. 317 X 2) during the full operational phase. Noise prediction modelling has been carried out for trucks movement (considering 800 trucks) in and out of the terminal for material transportation which is expected to increase all along the road and terminal area. The maximum noise level generation from these truck movement is estimated to be 77.6 dB (A) which will be attenuated to 66 dB (A) within a distance of 27m. Noise modelling output for movement of transportation vehicles indicating the attenuation of noise with distance is given in **Figure 5.7.**

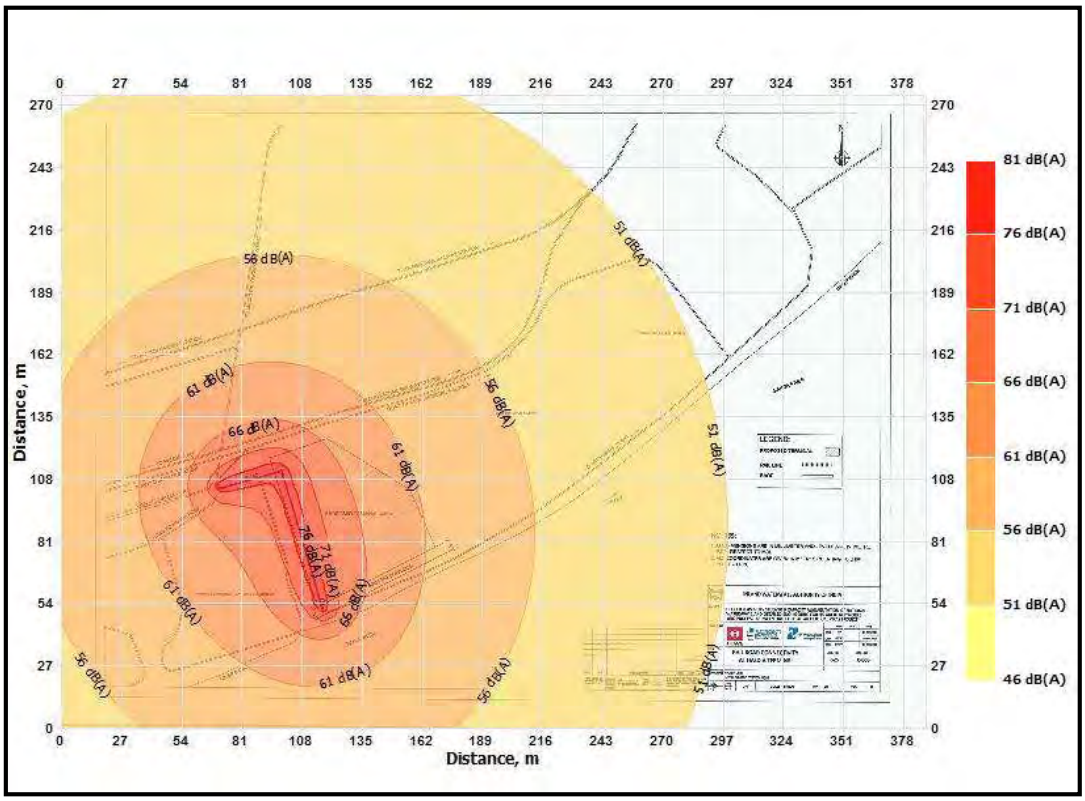

Figure 5.7 : Noise Modelling Output

Land use of the site is industrial and permissible noise levels at present are well within the CPCB standards that is 70 dB(A) for night time and 75 dB(A) for day time. During operation stage these levels are expected to increase due to above mentioned activities. However, the noise levels can be maintained within the prescribed limits of CPCB by undertaking the mitigation measures as listed below. Also measures will be taken to maintain the work zone noise levels as per OSHAS guidelines as given above in **Table 5.22.** Exposure of workers to the noise levels will be maintained as per the OSHAS norms. Further measures listed below will help minimizing the impact on increased noise level during the operation phase.

Mitigation Measures

- Site boundary should be provided which can act as noise barrier
- Earplugs should be provided to workers involved in unloading operations
- Provision of thick green belt along the boundary and roads which will act as noise buffer
- Timely maintenance and servicing of transportation vehicles and the machinery/pumps to be used during operation phase to reduce the noise generation due to friction and abrasion
- Honking shall be prohibited at the project site
- Hearing test for the workers shall be undertaken before employing them and thereafter shall be done after every six months
- Job rotations should be practised for people, working in high noise level areas

- Noise generating activity should restricted between 6:00 am to 10:00 pm.
- DG sets shall be provided with acoustic enclosure
- Monitoring of Noise levels shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP

5.7.7. *Impact on Water (Surface and Ground) Environment*

5.7.7.1 Impact During Design & Construction Phase

Activities involved during design and construction phase are excavation and vegetation removal from the site, construction activities, dust suppression, washing & cleaning and domestic use of construction workers. Water will be required for compaction of the soil, construction activities, dust suppression, washing & drinking purposes of construction workers and can be sourced from authorized private water tankers supplier or municipal supply. Water requirement during construction phase may vary from 30-90 KLD as per the nature of activity involved. For extraction of ground water (if required), prior permission from CGWB should be obtained. All planned sites lie within the safe zone as per CGWB classification except Haldia terminal site. Haldia industrial zone is classified as notified zone by CGWB thus restricting withdrawal of ground water. No ground water will be used for construction purpose at Haldia site. Stage of development of ground water should also be reviewed for other planned site and the source of water should be decided accordingly to minimize the impact.

All the planned sites about the water bodies, but no surface body exists within the planned sites. Thus there is potential of contamination of the water bodies abutting the site due to mixing of run-off and discharge of wastewater generated at construction site. Also due to filling, excavation works at site, natural drainage pattern at site may get disturbed. Thus it is required to keep the site free of debris and contaminants, preventing entry of wastewater in the water bodies and reestablishment of storm water drainage network by provision of well-planned storm water drainage network.

Off-shore activities like piling and dredging operations for construction of berths and jetties have potential to impact river water quality. During piling & dredging operation river bed sediments will be released, increasing water turbidity and suspended soil concentration. If settled sediments are contaminated, then there is also potential of the river water to get contaminated due to mixing of contaminated bed sediments. However as per baseline study, river bed sediments of NW-1 are not contaminated. Pesticides like alpha, beta & gama endosulphan are found but are present in very low concentration. Concentrations of these pesticides are within the limits for both the on-shore & off-shore disposal of these sediments as per Japanese and Canadian standards (Refer **Annexure 5.3**for Standards). No standards are prescribed in India for disposal of river bed sediments. No impact on ground water quality is anticipated during construction phase of the project. Mitigation measures proposed for preventing pollution of the water resources in study area during construction stage of project are given below.

Mitigation Measures

- Excavation shall not be carried out during monsoon season. Excavated areas shall be covered to the extent possible to prevent entry of rainfall run-off in case of rains. Excavation, filling and levelling shall be carried out parallel so as to minimize the exposure of loose soil to wind/water. Levelled areas shall be compacted.
- Garland drains shall be provided around the excavated/activity area so as to prevent entry of run-off from nearby areas to excavated/activity area.
- The storm water drain shall be connected to a collection cum sedimentation pond to arrest the sediments from the run-off arising from construction site.
- Temporary rain water storage structures should be provided at the site to store rain water and this water should be used for dust suppression and construction activities
- Storm water drains shall be provided in the parking areas also and these drains shall be provided with oil & grease trap
- No waste shall be disposed in river or should be littered in areas near the River bank. Site should be cleaned regularly. Proper collection, management and disposal of construction and municipal waste from site shall be made to prevent mixing of the waste in run-off and entering the water bodies.
- Washing of vehicle and equipment shall not be carried out at river or green belt canal or any other waterbody. Washing area should be provided with the storm water drains fitted with oil & grease trap.
- Monitoring of surface water quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP
- No ground water or river water should be used for construction purpose without permission of competent authority.
- Piling of the raw materials & debris shall be avoided at the site. Storage of debris and raw material shall be carried out in paved and covered areas. This will minimize interface of run-off with raw material and debris.
- Septic tank/soak pit shall be provided at site for disposal of sewage from the toilets at site and from the labour camps. Soak pits should not be provided close to water body. In case toilets are provided near waterbody septic tanks along anaerobic digestion tank shall be provided. Sewage shall not be discharged into the River.
- Adequate number of toilets & bathrooms shall be provided to prevent open defecation.
- Wastewater generated from the washing/cleaning area after passing through oil & grease trap & curing area shall be re-used for water sprinkling and wheel washing
- Water use shall be minimized by using RMC, practicing curing by water sprinkling, maintaining flow of sprinklers, covering the water storage tanks to minimize water evaporation, creating awareness for water conservation and regular inspections at site to monitor the leakages in water storage area

- In case RMC is not used then concrete transit mixer should be washed and cleaned daily. Wash from these mixers shall be collected in block work tanks which will allow settling of concrete, removal of aggregates and allowing the waste to wastewater drain. This collected waste concrete can be dried and used for various purposes at site like construction of temporary roads at site.
- Fuel shall be stored in leak proof containers and containers shall be placed on paved surface.
- The piling work in river shall be undertaken during low flow period.
- Turbidity traps/curtains or Geo-Textile synthetic sheet curtain shall be placed around pilling and construction area to prevent movement of sediments and construction waste. Provision shall be made for geo Synthetic Screen for arresting silt flowing down stream.
- Sedimentation tanks shall be provided at the site so as run-off from site shall enter the sedimentation tanks before discharging into the river. Sedimentation tanks will trap the sediments in the run-off
- Natural Drainage pattern of area around shall be maintained to the extent possible
- Dredged soil should not be dumped at river bank area and should be re-used for filling purpose if possible. Dredged sand should be disposed within river only at shoal area/areas of low environmental sensitivity. Off-shore disposal shall be carried out only if sediments are contaminant. One of the site for disposal of the dredged sediments is approved TSDF site of Haldia Dock Complex.
- Preference shall be given to source water from rivers wherever feasible in the project area with due permission from authorities
- Permission shall be obtained from irrigation department in case river water is used and from CGWA/CGWB in case ground water is used.
- No dumping of waste/wastewater in the ground. Hazardous waste (if any) or wastewater shall not be stored in unlined ponds
- Substructure construction should be limited to the dry season and cofferdams may be constructed and utilized to lift the spoil directly out of it and carried to the riverbank for land disposal.
- Restoration of changes in the stream, if any, made during construction to its original level
- Provision shall be made for collection and draining of water for the piling earth. It shall be used for embankment protection or road construction depending on its suitability.

5.7.7.2 Impact During Operation Phase

Water will be required during operation phase at terminal/jetties/lock sites for purpose of consumption, dust suppression, cleaning, washing, cooling and landscaping. Potable water can be sourced from ground water or municipal supply. Permission should be taken for both prior sourcing the water from CGWB or municipal department as applicable. No significant impact is anticipated on water resources as the water

requirement is not very high. Also it is proposed to treat the wastewater generated at site in STP and re-use the treat water for landscaping & dust suppression to reduce fresh water requirement. To further reduce fresh water requirement, it is proposed to provide water conservation fixtures at site. Thus impact on water resources is anticipated to be low. As Haldia is categorized as notified zone by CGWB, it is proposed that ground water will not be used during operation phase of the project at Haldia terminal site. If ground water is used, prior permission will be taken from CGWB.

Run-off from the site will increase after development of the planned facilities due to increase paved areas. However, quality of the run-off in terms of sediments will improve. But the run-off may contain the oil & grease from roads & parking area and dust from storage yards. If water contaminated with this pollutant will enter the river may pollute the water and will impact the aquatic life. This run-off shall not be allowed to discharge to river. Run-off from roof-top is proposed to be recharged into the ground through RWH pits and run-off from paved & green area will be discharged in dump pond. Where the run-off will be retained and the clarified water will be used at site for landscaping, cleaning and dust suppression purpose.

Apart from above sources, maintenance dredging & on-shore dumping of dredged material are another sources which may impact the water quality of river during operation phase of the project. IWAI intends to maintain LAD of 3 m throughout the waterway but looking into the environmental impact of the project, IWAI at present has planned to achieve variable LAD in different stretch. Now IWAI intend to maintain LAD of 3 m from Farakka to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi and no dredging proposed at present beyond Varanasi. This will reduce dredging requirement from 31.08 million cum/year to 15.76 million cum which is more than half the volume there by cutting down impact to more than 50%. Further dredging of 0.1 - 0.2 million cum will be required to be carried out at Haldia terminal site. Dredging & dredge disposal activities have potential to pollute the water quality by increasing turbidity and due to mixing of contaminated sediments with water. Dredged sediments are oxygen deficient and their re-suspension in water lead to oxidation of sediments reducing DO of the water. In some cases, water may also turn slightly acidic due to suspension of anoxic sediments. To minimize the impact on water quality due to operational stage activities and dredging operations, following mitigation measures are proposed:

Mitigation Measures

- Regular checks shall be made for soil erosion and turfing conditions of river training structures for its effective maintenance
- Regular visual checks and cleaning of drains shall be done along the alignment to ensure that flow of water is maintained through cross drains and other channels/streams
- Toilets to be provided with running water facility to prevent open defecation.

- STP to be provided to treat the sewage generated. Treated water should be used for horticulture purpose at the site and dust suppression purpose. STP is proposed to be provided at all the planned terminal sites at Varanasi, Haldia & Sahibganj. Disposal of sewage is proposed to be undertaken through septic tank/soak pit at Farakka lock site as sewage to be generated during operation phase is estimated to be low.
- Storm water drainage system should be provided at the site. Arrangement shall be made to collect the roof water from the building separately into a tank so as this water can be used for horticulture activity directly or can be recharged into the ground. Storm water from other areas like storage yards, stock piles and roads shall be directed into a collection/dump pond. Storm water shall be retained in pond so as to allow the settling of dust and suspended particles in the water, this water should be used for cleaning and dust suppression. Sludge from the dump pond shall be sent for disposal along with other municipal waste
- Storm water drains provided in parking & road areas shall be provided with oil & grease traps
- Monitoring of water borne diseases due to stagnant water bodies
- Drains shall be regularly cleaned and de-silted
- Water conservation fixtures shall be installed in toilets and kitchen area. Some of the water conservation fixtures which can be installed are dual flushing cisterns, sensor taps, low water urinals etc.
- No wastewater shall be received from vessels and vessels should not be allowed to discharge their wastewater and solid waste in river
- No waste/wastewater shall be discharged in river or dumped into the ground
- Fuel shall be stored in leak proof containers and containers shall be placed on paved surfaces
- Dredged soil shall be tested for toxicity, if toxic shall not be disposed back in water and should be send for disposal to approved TSDF site only.
- Oil should be stored in leak proof containers and storage area should be provided with facility of collecting the oil in case of spillage. The storage facility should be so designed that spilled oil shall not enter the storm water and sewage drains or storm water storage pits
- Ship design (of capacity > 5000 DWT at Haldia site for coal transhipment) should be as per MARPOL and should be provide with double hulls/double bottoms. Speed of oil carrying vessels should be maintained to prevent accidents due to high speed. Sensors and hooters should be fitted with vessel which can notify the closeness of another ship or any other potential matter which can cause accident.
- Immediate/quick clean-up of such spills shall be undertaken and ship owners should be liable for the same.
- Crew of the vessel carrying the oil should be competent and experienced so as they can prevent the accidents to happen as much as possible

- IWAI should carry out the inspections of the vessels which are transporting the material to and fro from the terminal.
- Monitoring of surface water quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP

5.7.8. *Impact on Biological Environment*

5.7.8.1 Impacts During Design and Construction Phase: Terrestrial Ecology

Development of the civil interventions will require clearing of the vegetation from the proposed site. No significant vegetation is present at Farakka lock, Haldia terminal and Varanasi terminal site. But app.500 trees are present at identified terminal site in Sahibganj. Mango orchards are present at the planned terminal site at Sahibganj. No wildlife is reported or observed during the visit at the proposed sites. Thus no impact on wildlife is anticipated during construction phase of the project. However, avifauna of the area may be impacted due to loss of their habitat (trees), majorly at Sahibganj site. But the site is surrounded by agricultural land and mango orchards thus sufficient habitat is present for the avifauna. Also it is proposed to plant 3500 trees in place of 500 trees which will be cut for development of the project. Trees proposed to be planted are 7 times the nos. of trees to be cut. Trees after growing up will provide excellent habitat to avifauna and insects. Also it is proposed to develop thick peripheral green belt and avenue plantation at each of proposed civil intervention site. This will help in improving the ecology of the area.

For development of the project, project site may be required to excavated and filled which may impact the micro-fauna & flora residing within the soil. Also riparian fauna/flora is also likely to be affected due to project development but since construction phase is temporary and short term thus it is likely for vegetation to recover after removal of disturbance or completion of construction activities. Thus the impact anticipated due to project design & construction on terrestrial ecology are low-moderate.

Also during the construction of project the transportation of heavy vehicle carrying the construction material will move in the project area. It will generate dust and noise during movement. The dust will be settled on the nearby flora of the roads and adjoining area, and covering the leaf and hence reducing the photosynthetic activity. Noise created due to increased traffic will have impact on the nearby fauna, it may have impact on the nocturnal animals/birds also. However, impact is anticipated to be short term and temporary and will be restricted to construction phase only. Anticipated impacts can be minimized by taking proposed mitigation measures.

None of the planned intervention site is proposed within eco-sensitive zone. Eco-sensitive zones within 10 km radius of the NW-1 alignment are Udhwa lake bird sanctuary, Farakka barrage & surrounding areas, Mokama Taal Wetlands and Kurseala River Course, Diyara Flood Plains and Danapur cantonment area. No impacts are anticipated on flora/fauna of these areas during construction & design phase as no

construction activities are proposed within the river stretch along these areas. Mitigation measures proposed to minimize the anticipated impact on the terrestrial ecology are given below.

Mitigation Measures

- Project layout design shall be in a way to minimize tree cutting
- Permission shall be obtained from forest department prior tree cutting and only the identified and permitted tree shall be cut and remaining shall be maintained properly
- Thick green belt shall be developed at the periphery and along the roads on the project site which will prevent spread of dust and reduce noise propagation.
- Areas reserved for future development at site shall also be made green by growing grass and shrubs and herbs
- Caution sign shall be placed to prevent hunting of animals
- Construction activities shall be restricted to 6:00 Am-10:00 Pm especially noise generating activities.
- Compensatory plantation should be carried out as per state forest policy. Apart from mandatory requirement additional compensatory plantation should be carried out as being done in case of Sahibganj terminal.
- Green belt to be developed should be mainly naturally growing native species of the area. Green belt should be developed as per the CPCB guidelines proposed above climate section.
- Survival rate for compensatory plantation and green belt to be developed at the site shall be monitored regularly and measures shall be taken so as to achieve minimum rate of 70%
- All efforts shall be made to minimise the cutting of tree through design changes. Layout should be designed in a way so as to minimize the tree cutting. Only trees identified for cutting should be cut. Tree cutting should be carried out only after obtaining due tree cutting permission from forest department.
- Workers should not use any timber or firewood as fuel for any purpose. LPG should be made available to workers in construction camp.
- No hazardous material or waste shall be disposed in the other land or nearby area as it may harm the animals, if consumed accidently
- Speed limit will be regulated to prevent any accidents of animals. Regular maintenance of the dumper shall be done to prevent leakage of oil so as to prevent pollution of the soil and impact on fauna and flora dependant on soil.
- Regular Water Sprinkling shall be carried out to minimize dust generation and settling the dust on surface of flora.
- Trees retained at the site (after site clearance) should not be disturbed, cut or harmed in anyway. These trees should be maintained.
- Adequate parking space should be provided within the site for construction vehicle and equipment so as they are not parked in other areas like road side,

others agricultural field, and open areas to avoid any harm to flora of that area due to movement of heavy vehicles.

- Construction camps should not be established inside or near the forest area
- Construction activities and vehicle washing should not be undertaken at the river or any other water body or close to the water body
- Site should be barricaded to prevent entry/trespassing of the animal in the site
- Hunting, poaching and harming any animal (wild or domestic)/birds by any worker or project related person should be strictly prohibited and monitored. Provision shall be made for strict penalty for hunting/harming any animal/birds
- Illumination at the night time should be reduced during the night time (if no activity is going on) as it may disturb the nocturnal animals
- Noise generating activity should not be undertaken during night time to minimize disturbance to animals/birds. Noise levels should be maintained within the prescribed CPCB limits to the extent possible during the day time.
- Workers should not use any timber or firewood as fuel for any purpose. This will minimize the tree cutting requirement

5.7.8.2 Impacts During Design and Construction Phase: Aquatic Ecology

Eco-sensitive aquatic habitats identified within NW-1 are Vikramshila Dolphin sanctuary (Sultanpur-Kahalgaon) and Kashi Turtle Sanctuary at Varanasi. No civil intervention is proposed within these locations. Also it is proposed no dredging/dredge disposal will be carried out within this stretch. Thus impacts anticipated on these eco-sensitive zones during design & construction phase are minimal. However, construction activities like dredging/piling is proposed to be carried out in river stretch along the planned terminal/jetties site. Piling & dredging activities have potential to impact aquatic ecology of the area. Anticipated impacts during construction phase on aquatic ecology for the project are given below:

Impact of Piling/Dredging Activity due to sound Generation on Aquatic ecology:
Pilling & dredging activities will be carried out for construction of proposed off-site facilities like jetties & berths. For the purpose, dredger will be placed in the River which will occupy some physical space in the River. This space was being used by the biotic components of the river. As a behavioural response, instinctively animals at the first encounter avoid approaching the site of unknown object. This is done using echolocation, olfaction or chemo-reception, if the object is not making any sound. If object / machine starts making sound / noise, then all vertebrates through auditory acoustic sense avoid the area which has disturbing range of sound and hampers to the natural acoustic behaviour and physiology of these vertebrate fauna from fishes to dolphins.

Apart from occupying the physical space, dredging and pilling activity will generate significant noise. Exposure to low levels of sound for a relatively long period of time, or exposure to higher levels of sound for shorter periods of time, may result in auditory

tissue damage in fish, though recovery is generally possible within 24 hrs (Popper et al. 2005). Oscillations induced by high sound pressure levels can cause swim bladders in fishes to tear or rupture (Hastings and Popper 2005). Whereas it is possible that some (although not all) species of fish would swim away from a sound source, thereby decreasing exposure to sound, larvae and eggs of fish are often at the mercy of currents or move very slowly. Movement of the fishes and dolphins away from these places makes the place unused for foraging, spawning and local movement. This would cause crowding of organisms at other places and enhanced struggle for space and other requirements, till the disturbance has not ceased/completed.

Mitigation Measures:

- The area in which the construction of the Berth (jetty) is planned, advisable to carefully determine drop sites before anchor placement to ensure that Dolphin and fish communities that could locally still be present in the area are not unnecessarily damaged.
- Before starting piling allow some time to aquatic fauna to displace from the piling area. Bubble curtains can be provided at the time of pilling so as to displace the aquatic fauna prior start of construction activities
- Fish exclusion devises shall be installed in water column around the pile driving area to prevent fish access
- The piling activities must be carried out in shortest possible timeframe as possible
- All the debris should be disposed away from river course as per debris management plan of the project.
- Decisions on method of construction and type of technology and equipment to be used must consider the noise and vibration levels and extent of siltation being generated. Noise and vibration levels must be far below levels that can cause injury to dolphins and other wildlife.
- Noise reducing devices like mufflers, enclosures shall be fitted with the equipment as much as feasible. Noise barriers shall also be installed
- Geo Textile synthetic sheet curtain & turbidity traps shall be placed around pilling and construction area to prevent movement of sediments and construction waste
- Appropriate protocols and procedures must be prepared for sighting of dolphins and other endangered wildlife species within the vicinity of the dredging site. The objective of the protocols and procedures must be aimed at having no or minimal impacts on the respective wildlife species.

Impact of Piling/Dredging Activity: loss of habitat: Large amount of river bed sediment (dredged Material) will be removed for carrying out bank & bed scouring and erosion protection. Bed and bank erosion/scour prevention works involve stone pitching of banks upstream & downstream, concreting of banks, construction of retaining walls/embankments along the river banks, construction of aprons across the river along the length of the proposed terminal/jetty, construction of guide walls in case of Farakka

lock etc. These sediments are in habituated by various benthos (molluscs, arthropods, juvenile fishes, amphibians and reptiles etc.). Removal of these sediments will lead to mortality of these communities. Also the actual habitat will be lost permanently in the activity area due to bed and bank erosion/scour prevention works. Impact on the moving aquatic species is however anticipated to be low as they disperse when any activity is being carried out in the river.

The major impact on larger organism is that the movement routes, spawning activities and foraging grounds of these organisms may be affected. These animals would also struggle for normal conditions due to increased turbidity and increased sedimentation during the dredging activity. Increased sediments and turbidity can impact the aquatic life by reducing visibility, making water coarse, choking gills of fishes etc. Thus measures should be taken to quicken up the dredging and piling activities, minimizing the noise level and controlling the sediments generation. Among the floral components rooted plants will be uprooted and destroyed totally. The primary productivity by phytoplankton will be lowered, on account of lowered transparency for light.

Impact of Piling, dredging and other construction activities due to release of sediments: The riparian area soil are loose and sticky/clayey. Release of these sediments would cause high increase in turbidity of water during and sometime after the dredging/oiling activity. Such soil has a tendency of sticking over the skin and gills and blocking the pores and is hence harmful. Suspended sediment due to dredging operations in the water column blocks available light for photosynthesis, reducing benthic primary productivity and inhibiting the ability of benthic plants to recover from dredging impacts. But the effect of suspended sediments and turbidity in open environment like river are generally short term (<1 week after activity) and near field (<1km from activity). There is only need to be concern if sensitive species are located in the vicinity of the maintained channel.

Some pollutants such as insecticides, pesticides, fertilizers may be unlocked from sediments when dredged. But soon it will be washed away along the flow. The test results show very low concentration of pesticide. Even then there are chances that it may enter the food chain.

Construction activities to be undertaken involves storage of raw material, debris, fuel, paints etc. There are likely chances that, the run-off from the site may get contaminated with these materials and when it will enter the water body may also degrade the water quality of the river.

Mitigation Measures:

- To avoid the construction debris wash or blown into the water the area shall be surrounded by silt screens, which must be placed in the water before the work starts. Geo-Textile synthetic sheet curtain can act silt screen which should be placed around pilling and construction area to prevent movement of sediments and construction waste The screens should also be placed around storage areas, to prevent waste from blowing away and to prevent sediment run-off into

the river. The storm water drain shall be connected to temporary sedimentation pit and collected water shall be used for dust suppression. Run-off from site should also pass through oil/grease traps and flow down to the same sedimentation tank before its reuse

- In addition to silt screens, building guidelines of the Bonaire National Marine Park require that storage areas for sand and soil, and all work areas, must be at least 20 meters away from the high water mark and construction equipment must not be cleaned or washed within 50 meters of the high water mark.
- Piling and dredging activities should be carried out rapidly. Piling should not be carried out during breeding and spawning season means during rainy season. It should be carried out in low water season, i.e. pre-monsoon
- Piling/Dredging should be stopped for some time, if any dolphin/RET species is sighted in activity area
- Equipment shall be maintained in good condition to prevent leaks or spills of potentially hazardous materials like hydraulic fluid, diesel, gasoline and other petroleum products
- Excavation activities onshore should not be undertaken during monsoon season so as to minimize sediment load of run-off
- Soil stabilization works in the bank must consider implications on changes in hydrological flow, current and behaviour of the river. Such changes may create new problems such as change of river course, erosion of river embankment, change in erosion and inundation pattern of the bank etc. which will in turn impact the habitat of aquatic life
- Workers should be trained to handle the equipment and material at site so as to minimize the spillage of materials and contamination of water
- All workers should be made aware of not throwing any waste in the river or any drain
- No construction debris/ already accumulated solid waste at site or waste generated from labour camp should be thrown in river or any drain
- Sewage generated from labour camp should not be directed into river but should be disposed through septic tank/soak pit
- Run-off from site should pass through oil/grease traps and sedimentation tank prior discharging into the river
- All construction and operation equipment shall be maintained in good condition shall be checked for oil & grease leakage
- Dredged soil should not be disposed in river or its banks especially during breeding spawning seasons of aquatic organisms
- Aquatic ecology monitoring should be carried out prior start of construction and after completion of construction so as to assess the impact of construction activities on aquatic life.
- All construction and operation equipment shall be maintained in good condition shall be checked for oil & grease leakage

- Nesting grounds, breeding & spawning grounds shall be identified and project activities shall be minimized in those areas

5.7.8.3 Impacts During Operation Phase: Terrestrial Ecology

Positive impact on ecology is anticipated during the operation stage of planned interventions majorly. Thick peripheral green belt will be developed and avenue plantation will be carried out at all the proposed intervention sites. Green belt will provide excellent habitat to avifauna, insects, small animals like squirrels, lizards, chameleons etc. Tree survival rate will be monitored and will be maintained to minimum 70%. Proper after care will be done for the planned green belt and this has separate budgetary provision under the EMP. But as the interventions like terminals and jetties involve movement of vehicles at and around the site, dust level may increase in the area. This dust when settles on the leaves of the trees will hamper the photosynthesis activity.

Mitigation Measures:

- Proper aftercare and monitoring of the green belt & avenue plantation
- Maintaining survival rate of plantation to minimum 70%
- Regular watering and cleaning of the leaves to remove the accumulated dust on the leaves

5.7.8.4 Impacts During Operation Phase: Aquatic Ecology

Impact due to operation of any project is of main concern as it always persists. Construction of berths, jetties and other off-shore structure will consume physical space in water reducing the available space for the aquatic organism. Planktonic population at berth area and nearby area will reduce or will decrease drastically which will impact the primary productivity of the water body. Planktons is feed for various big fishes, thus reduce in plankton population will affect the aquatic food chain. However, area to be covered by berth is very less as compared to width of the river. Thus reduction of this much space will not have significant impact. Also it is possible that aquatic organisms may collide with these newly constructed structures. But as behavioural response, instinctively aquatic animals at the first encounter avoid approaching the site of unknown object. This is done using echolocation, olfaction or chemo-reception, if the object is not making any sound. Thus the space occupied by unknown structures will be avoided by aquatic organisms thereby reducing the chances of collisions and injury to aquatic organisms.

During rains, run-off from the stockyards at jetty/terminal sites may enter the river and may contain the contaminants. This contaminated run-off may pollute river water quality, if discharged in river. Thus proper storm water collection and management system is required so as water from stockyards do not enter the river directly. Sewage & waste will be generated at intervention sites (terminal/jetties/locks) and in vessel. If this waste is disposed on the land or in river, then this waste can pollute the soil impacting the terrestrial ecology and can pollute the water impacting aquatic ecology. Release of coal

dust during coal transhipment and may settle on surface of the river and will have a negative impact aquatic life.

Other activities at the sites of civil interventions which may have impact on aquatic ecology are berthing & mooring of vessel, oil/material spillage, dust generation from material transportation, barge movement and maintenance dredging for keeping the berth area navigable. Berthing & mooring of the vessel at terminal/jetties reduces the circulation of water in the area thereby reducing the air flow in the water and self-assimilative capacity of river in that stretch. If vessel is berthed for longer duration at terminal/jetty sites, then there are increased chances of release of toxins from anti-fouling coating of vessel or leakage of some oil from bilge tank into the river. All these may pollute the river water quality near the terminal/jetty sites. Movement of barges in the civil intervention area will increase after development of the proposed interventions and thus the transportation of commodities will also increase. Some of the commodities to be transported include building & construction material, and coal which may generate the dust and this dust can settle over the surface of the river. This dust will increase turbidity of water and may reduce the visibility of the water there by impacting the SAV, planktonic communities and other aquatic fauna. This dust if consumed by aquatic organisms may cause respiratory and other related problems in organisms. Thus it is required for transportation of dust generating material under covered conditions. Also coal should be kept moist so as to reduce the dust generation potential during transportation. It is proposed to transport edible oil/POL at Haldia terminal site so there are likely chances of accidental oil spillage near the terminal site or in the waterway. Oil spillages are threat to aquatic organisms and can lead to mass mortality also. Oil spills can affect all planktons, benthos and Fishes.

Maintenance dredging and disposal of dredged material will also be required to be undertaken at the proposed intervention sites so as make them navigable throughout the year. As per the planning, insignificant quantity of dredging will require to be carried out at Sahibganj & Varanasi terminal site. Dolphins are found in the river stretch along Sahibganj terminal. Terminal site is located in the secondary channel so impact of dredging near terminal site on the dolphins is nil.

Dredging of 30-60 lakh cum will be required at Haldia Terminal site but no dolphins are observed in that stretch of river. Quantity of dredging will depend on the duration for which terminal will be kept navigable and nos. of berths to be kept navigable. Dredging operations generate high noise levels, increased turbidity of the water, and removal of benthic community thus impacting aquatic ecology, reduce DO level in water thus reducing available oxygen for aquatic organisms, may unlock toxins trapped in the sediments etc. All these impact the aquatic environment and organisms. Impacts of dredging operation and disposal of dredged material on aquatic ecology are discussed in detail in section 5.4 of this chapter. Mitigation measures are proposed to prevent the impact of project on aquatic ecology and are given below

Mitigation Measures:

- Dust generation during loading & unloading of barges shall be minimized by adopting mechanical conveying system and provision of water sprinklers for dust suppression. This will reduce the chances of disposal of dust on river surface. Materials like coal should be kept moist to suppress the dust generation.
- The solid wastes, sewage, oily ballast, bilge water and bunker fuel bottoms generated from barge should not be discharged directly and it should be discharged as per the norms. Cargo Operators needs to exercise all caution to avoid any kind of accidental discharge of such wastes. Maintenance and repairing and fuel refilling of barge and vessels should be carried out at approved locations only and measures for separation and removal of oil/grease from wastewater should be kept at that site.
- The opposite bank of river shall remain untouched to balance the impacts of active site.
- To the extent possible river training works (RTW) must be avoided as it destroys the natural aquatic ecosystem
- Location of river training works must avoid key habitat areas such as breeding and feeding grounds etc. of key biodiversity species found in the project area such as dolphins, migratory birds, reptiles, benthic organism and others. If it is necessary to do river training in key biodiversity areas, appropriate compensation with similar area and habitat type must be included in the plan
- Nesting grounds, breeding & spawning grounds shall be identified and project activities shall be minimized in those areas
- Dolphin Conservation: The Gangetic dolphin belongs to Order Cetacea of Class Mammalia and has been categorized as 'Endangered' by the International Union for Conservation of Nature (IUCN) in 1996. It is included in Appendix I of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES), and in Appendix II of Convention on Migratory Species (CMS). Government of India provided legal protection to this species by including it in Schedule I of the Wildlife (Protection) Act 1972. It was declared as the National Aquatic Animal of India by Honourable Prime Minister, Dr. Man Mohan Singh, on 5 October, 2009. Considering this it is proposed to support Dolphin conservation activity. It is proposed to allocate a separate budget for this activity. This task may be undertaken through “The Vikramshila Biodiversity Research and Education Centre (VBREC)” together with the Whale and Dolphin Conservation Society (WDCS), the Environmental Biology Laboratory of Patna University, and T.M. Bhagalpur University, who has jointly initiated a project to improve the conservation value of Vikramshila Gangetic Dolphin Sanctuary.
- No wastewater or waste should be disposed in river from terminal site or from vessel into the water. Penalty should be imposed on the vessels reported of disposing waste/wastewater in the river

- Surface run-off from site should be collected separately in dump pond, retained and then clear water should be re-used at site for dust suppression. Run-off from building roof-top should be collected separately and should be used for plantation and cleaning purpose or should be recharged into the ground.
- STP should be provided at site for treatment of sewage generated. Treated water from STP should be reused completely at site and should not be discharged into river
- Dredged sand should not be disposed at river banks especially during breeding spawning seasons of aquatic organisms. Dredging should be avoided during the breeding and spawning seasons
- Instruction should be given to all vessels and all employee and staff that no dolphin or any other endangered species should be harmed due to any reason
- Instruction should be given to vessel operator that in case any accident with dolphin occurs that should be reported immediately to terminal authority
- Waiting time of vessel should be reduced at the terminal by providing the adequate loading and unloading equipment and vehicles.
- Vessel should be instructed for not using sharp lights and sounds as they may disturb aquatic organisms
- Ship speed should be controlled especially in dolphin habituated stretch to minimize dolphin kill and the design of vessel and acoustic treatment should be done for vessel so as to minimize the sound exposure of dolphins.
- Propeller guards should be provided for all the vessels to minimize the propeller inflicted injuries and scars.
- No developments should be brought up on other bank of river opposite to terminal site so as to provide the ground to aquatic organisms for their activities
- Dust suppressors should be used at site and at barge while loading & unloading of material to suppress the dust level.
- Quick clean-up operations should be carried out in case of accidents. Vessel owner should be responsible for paying the clean-up expenses in case of the accidents and pollution of river water quality
- Time schedule and the quantity of material allowed shall be strictly checked and monitored for each ship. This will prevent overcrowding of the vessels at terminal site and thus no obstruction will be there on movement of the aquatic organisms due to vessel.
- Vessel shall be instructed for not using sharp lights and sounds as they may disturb aquatic organisms
- Ship design (of capacity > 5000 DWT) should be as per MARPOL and should be provide with double hulls/double bottoms. Speed of oil carrying vessels should be maintained to prevent accidents due to high speed. Sensors and hooters should be fitted with vessel which can notify the closeness of another ship or any other potential matter which can cause accident.
- Survival rate of planted tree species should be monitored after every six months.

- Crew of the vessel carrying the oil should be competent and experienced so as they can prevent the accidents to happen as much as possible
- IWAI should carry out the inspections of the vessels which are transporting the material to and fro from the terminal.
- Aquatic ecology monitoring should be carried out yearly so as to assess the impact of terminal activities on aquatic life.

5.7.9. *Impact on Socio-Economic Environment*

5.7.9.1 Impact during Design & Construction Phase

Land is one of the major requirements for project development. At some of the proposed site it is also required to acquire private land or common public land. For the planned civil interventions under Jal Marg Vikas Project, it is required to acquire the land. At present acquisition of private land is required for Sahibganj & Varanasi terminal. However, in case of Haldia terminal and Farakka lock land belongs to Haldia Dock Complex and no acquisition of land will be required. Private land area of 5.685 ha and area of 61.38 ha/151.71 acres (44.92 ha/111 acres in phase I) will be acquired for Varanasi terminal and Sahibganj terminal respectively. Apart from private land area, 19 acres of Government land will also be required for development of the Sahibganj terminal. Land at Varanasi is agricultural land but is not being used for agricultural purpose by people. However, land at Sahibganj site is being used by farmers for carrying out agricultural activities for earning livelihood. Also there are few household and community temple located at terminal site. Acquisition of land will disturb their livelihood & living and will make them landless. However, it is proposed to provide them adequate compensation as per R & R Act, 2013 and resettlement & rehabilitation of the displaced population should be as per R & R Plan. Further land may be required for setting up labour camps, batching plant etc. But the land will be required temporarily for construction phase. Adequate compensation should be given for the land to be used for these activities and then the land should be rehabilitated in its original condition before handing back to the owner. Any utility or CPR like community temple, school, hospital, hand pump, well etc. if required to be shifted should be shifted immediately after the dismantling so as to minimize disturbance to people. Shifting should preferably be carried out on private land.

Construction activities at sites of civil intervention involves excavation, filling, parking of machinery/equipment etc. which may be threat to the population and can lead to any accident. Thus it is required that site should be barricaded and entry to the site should be strictly restricted to authorized personnel only. Construction of the terminal will require transportation of raw material to the site and debris from the site. Transportation of material may increase pressure on the roads which are used by villagers. Thus the haul roads should be well maintained and in case any diversion of traffic is required on these land alternate arrangements should be made. Traffic management is utmost required so as to prevent the congestion &accidents on these roads during peak hours.

Construction activities will generate high dust and noise levels which can be uncomfortable for nearby residing population. However, no habitation is within 100 m of all planned site but to mitigate this impact measures for controlling air and noise pollution are proposed to be taken during construction phase. These measures will significantly reduce the emissions and noise level.

Development of the project will generate employment options for local people as construction worker, supervisors etc. thereby improving the quality of life of people.

Mitigation Measures

- Separate SIA, LA and RAP are being prepared for the sites which involves land acquisition. Adequate compensation should be given to the people losing the land
- People have sentiments associated with River Ganga so relocation of people should also be given near to River only as desired by them
- Shifting of utilities/CPRs if any shall be done immediately so as to minimize disturbance to the people or owner of the utility. Shifting should preferably be carried out at private land. The location proposed for shifting should also be acceptable by people.
- Skill training and assistance should be given to people so as they can get other jobs or get into other business. NGOs should be hired for this purpose
- Small loans should be given to the farmers losing the land and wishing to start new business
- Infrastructure development in form of small school, hospital, library etc. can be undertaken in the village as compensation to the disturbance caused
- Rest area should be provided at site in which workers can rest after the lunch hours and should not lie at site in open. This will help in preventing the accidents at site
- Adequate illumination should be provided at site during evening and night time till the work is being carried out
- Site should be barricaded and should have entry guarded by security guard. Register should be maintained for entry of outsiders. No unauthorized person should be allowed to enter the site especially village children
- A board should be displayed at entrance of site displaying name of project, area and hazards associated with the site on entrance and activities prohibited within and near site area in local language
- Workers should wear the personal protective equipment like helmet, gum boots, safety shoes, safety jackets, ear plugs, gloves etc. while working
- Noise level in the work zone should be maintained and followed as per OSHAS norms.
- Non-productive lands, barren lands, raised lands; wastelands should be used for setting up labour camps, plant sites and debris disposal site. Agricultural land should be avoided. Land should be used for establishment of construction camps, debris disposal site and plant site only after obtaining consent from land owner.

- Fishermen should be consulted prior restricting fishing activity in the activity area
- Necessary permits should be obtained by contractor from concerned authorities for setting up any batching plant or hot mix plant.
- Labour camps, plant sites and debris disposal site should not be located close to habitations, schools, hospitals, religious places and other community places. A minimum distance of 500 m should be maintained for setting up such facilities.
- Management, rehabilitation and closure of these sites should be as per the Management plans proposed for these sites. Records for starting, maintaining and closure should be maintained and should be approved by site engineers
- Contractors should adopt and maintain safe working practices. SOPs should be prepared for each and every activity and all activities should be undertaken as per SOPs under supervision of site engineer
- Training should be given to workers to handle the heavy equipment so as to prevent accidents
- Training should be given to workers to handle emergency situation like fire, earth quake and flood
- Complete medical check-up should be done for workers prior to joining and after six months of joining
- First aid facilities, first aid room, first aid trained personnel and ambulance should be provided at the site 24 X 7. Also tie-ups with local hospital should be done to handle emergency case, if any
- List of emergency nos., hospital contacts, ambulance contacts and doctors contacts should be displayed in first aid room, rest area and at all required location
- Working hours of labour should not exceed than standard norms as per state factory law
- Labour camps should be located at neat and clean location with no water logging issues and should be well ventilated with adequate illumination, kitchen and safe drinking water facility
- Construction labour camps and site should be properly cleaned and hygiene should be maintained
- Proper sanitation facility like toilet and bathing facility should be provided at site and labour camps. Wastewater generated from these facilities should be disposed through septic tanks and soak pit
- LPG should be provided as fuel for cooking to workers and open burning of fuel should not be allowed
- Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of mosquitoes. Septic tanks/soak pits should be provided for its disposal
- Sprinkling of water should be carried out at site and haul roads, so as to minimize dust generation due to movement of construction vehicles and its impact on nearby residing population

- Temporary storm water drainage system should also be provided at camp site and construction site so as to drain the storm water and prevent accumulation of storm water at site and thus breeding of mosquitoes/flies
- Safety officers should be appointed at site so as to ensure all safety measures are taken at the site
- All construction workers should be provided with personal protective equipment like helmet, gloves, gumboots, safety jackets etc. and fines should be imposed if found not wearing
- Job rotation should be carried out for workers exposed to high noise and dust areas
- Activity like smoking and consuming liquor should be prohibited at the site
- Awareness on AIDS should be spread among the workers
- Traffic manager should be present at the site all the time to manage incoming and outgoing traffic to prevent accidents
- Crèche facility should be provided for kids if female workers are employed
- Regular inspection for hygiene and safety in labour camps should be done
- Provision of cautionary and guiding signage in local and English language indicating the hazard associated with the site & activities. Usage of fluorescent signage, in local language at the construction sites
- Speed limit of vehicles should be restricted at site to prevent any accidents and fines should be imposed on vehicles if same is not maintained. All construction vehicles should follow the designated routes & timings only.
- Construction vehicle movement should be restricted to non-peak hours, i.e. late evening (7-12:00 pm) only. Villagers should also be given intimation of these timings.
- Noise level in the work zone should be maintained and followed as per OSHA norm
- Employment should be provided preferable to local & affected people
- Dustbins should be provided at labour camps for collection of waste and waste should be regularly disposed through the concerned agency
- Arrangement of fire-fighting should be made at site and workers should be trained to use the system in case of fire
- All construction vehicles should be regularly serviced and maintained and carry pollution under control certificate
- All proposed environmental pollution measures should be taken during construction of phase of terminal to minimize the harm to existing environmental quality of the area, which is being enjoyed by the residents of that area

5.7.9.2 Impact during Operational Phase

Civil intervention works will involve development of terminals, jetties, locks, river training work, bank and bed erosion/scour protection works etc. These developments will lead to further development of infrastructure like roads to connect these sites to the existing roads, water supply system, power supply system etc. All these facilities will also be

beneficial for nearby residing population. River bank protection works, construction of bunds/levees etc. will help in controlling the floods in area thus will be beneficial for people. Development of NW-1 project does not involve extraction of water from the river, thus no impact is anticipated on existing irrigational schemes set up on the NW-1.

All the civil intervention works are components of Jal Marg Vikas project which aims at enhancing the IWT mode of freight transportation. IWT is most environment friendly, cost efficient and safest mode of transportation. Transportation of material through waterway will reduce the risk of accidents, cost of transportation and GHG emissions associated with transportation. Reduced cost of transportation will reduce the ultimate cost of the goods to be manufactured thereby benefiting the consumers. Increased freight movement and low transportation cost will boost the economy of the country. Shift of freight from road or railway to waterway will also reduce the GHG emissions & other associated pollutants with the project. Also this will reduce the pressure on existing roads and railways there by reducing the need of further land acquisition for expansion or development of new roads.

Project will also generate large scale direct and indirect employment for unskilled, semiskilled and skilled workers. Employment opportunity will improve the quality of life of people in the area. Project may also induce development of various other facilities like warehouses, industries, roads, power supply etc. in the area. Thus project will lead to overall development of the whole area.

However, there are some negative impacts of the project at sites of proposed interventions. Traffic movement near these sites will increase due to increased nos. of vehicles carrying goods to & fro from these sites. Increased traffic involves generation of increased air emissions, increased pollution, increased noise level and increased risks of accidents in the area. Increased traffic will exert the pressure on the existing roads near the site. All these may increase the pollution level in the area and quality of life of people in nearby area may get affected. Thus it is required to upgrade the infrastructure like roads which will be used for project during operation phase and adoption of proposed pollution control measures to minimize the negative impact of project on society. Development of these civil interventions also may impact the quality of River Ganga. People are spiritually attached with the river thus impact on the quality of water of River Ganga will impact the sentiment and spiritual value of people. Increased cargo movement may also hamper fishing movement or damage the fishing gear of fishermen. Also there may be chances of reduction of fish yield in the river due to increased barge movement and increased pollution thereby impacting livelihood of farmers. Mitigation measures are required to be taken to prevent the impact on socio-economic environment

Mitigation Measures

- Traffic management should be carried out at site so as to reduce the congestion and accident risk. Roads to be used for material transportation should be

maintained. Routes and time for material transportation should be fixed. All vehicles carrying the material should be green tagged and should carry PUC certificate. All vehicles carrying transportation material should be properly serviced and maintained. All vehicles carrying material should have some restricted speed limits and should not be overloaded. Monitoring of these vehicles should be done through GPS.

- Regular maintenance of plantation along the roadside should be done. No invasive plantation near the road. Plantation along the road side should be maintained and trimmed timely to prevent accidents. Proper street lighting should be given at site and at approach road to prevent accidents
- Traffic managers should be deputed at haul roads, approach roads and within the site
- All the workers at site involved in material handling, traffic management and other such operations should wear the safety equipment like helmets, gum boots, safety shoes etc.
- Honking within the site should be prohibited
- Existence of spill prevention and control and emergency responsive system at the site
- Emergency plan for vehicles carrying hazardous material should be in place
- Implementation of the environment management plan as proposed to prevent the environmental pollution during operation phase
- Vessel should comply with safety norms and should maintain the speed so as to prevent the accidents. In case of accidents, ship owner should be responsible for clean-up operations
- Employment should preferably be given to local people. Women should be given equal opportunity for work.
- Emergency preparedness and response plan should be available at the site for all the natural and occupational hazards associated with the site. The plan should be approved by health & safety officer. The plan should be implemented by EHS cell at the site.
- Safety training should be given to the terminal staff for managing the floods, earthquake, fire, ship accidents like situation. Emergency collection area should be designated at the site which is safe. All workers should be directed to collect at this area in case of emergency.
- Fire-fighting facility should be provided at site and trained personnel should be available at site who can operate the fire extinguishers and other fire-fighting equipment.
- Development activities as CSR should be carried out in the village and nearby areas for development of area
- Meetings should be conducted with nearby people six monthly to address the problems they are facing. A grievance redressal cell shall be set up at each intervention site. People should be communicated about the facility & system of grievance redressal so as they can launch their complaints, if any easily

- Fishing activity should not be restricted in the river. Alternate provision for fishermen should be given in case fishing activity is restricted.

E: Impact Assessment Concerning Indo-Bangladesh Water Treaty

5.8. Impact on Indo-Bangladesh Water Sharing Treaty and Downstream water users in Bangladesh

River Ganga flows to Bangladesh after Farakka. A feeder canal is constructed to divert water from Ganga to Hooghly river as per agreement between India and Bangladesh. This treaty is known as “The Indo Bangladesh Ganga Water Sharing Treaty’ and was signed on 12 December 1996 between Indian and Bangladesh. The Treaty is essentially regarding the sharing of lean-season flow. The sharing formula agreed in the Treaty is related to actual flows at various levels and not to 75% dependable flows as in past agreements. The basic formula is that of equal sharing of the lean-season flows by the two countries. This applies to a range of flows. India diverts water through feeder canal which has full diversion capacity of 1132.66 cumec at a flow level of 2,123.74 cumec (75,000 cusec). Any water above this flow goes to Bangladesh without sharing with India.

The Jal Marg Vikas Project is aimed to waterways (NW-1) between Allahabad to Haldia. As per planning NW-1 navigational channel width will be of 64 m and maximum LAD of 3m. NW-1 route moves as per River Ganga alignment upto Farakka and diverts its route to Farakka Feeder Canal through Farakka Navigation Lock prior to Farakka Barrage. The route diversion view of NW-1 at Farakka is shown at **Figure 5.8**.

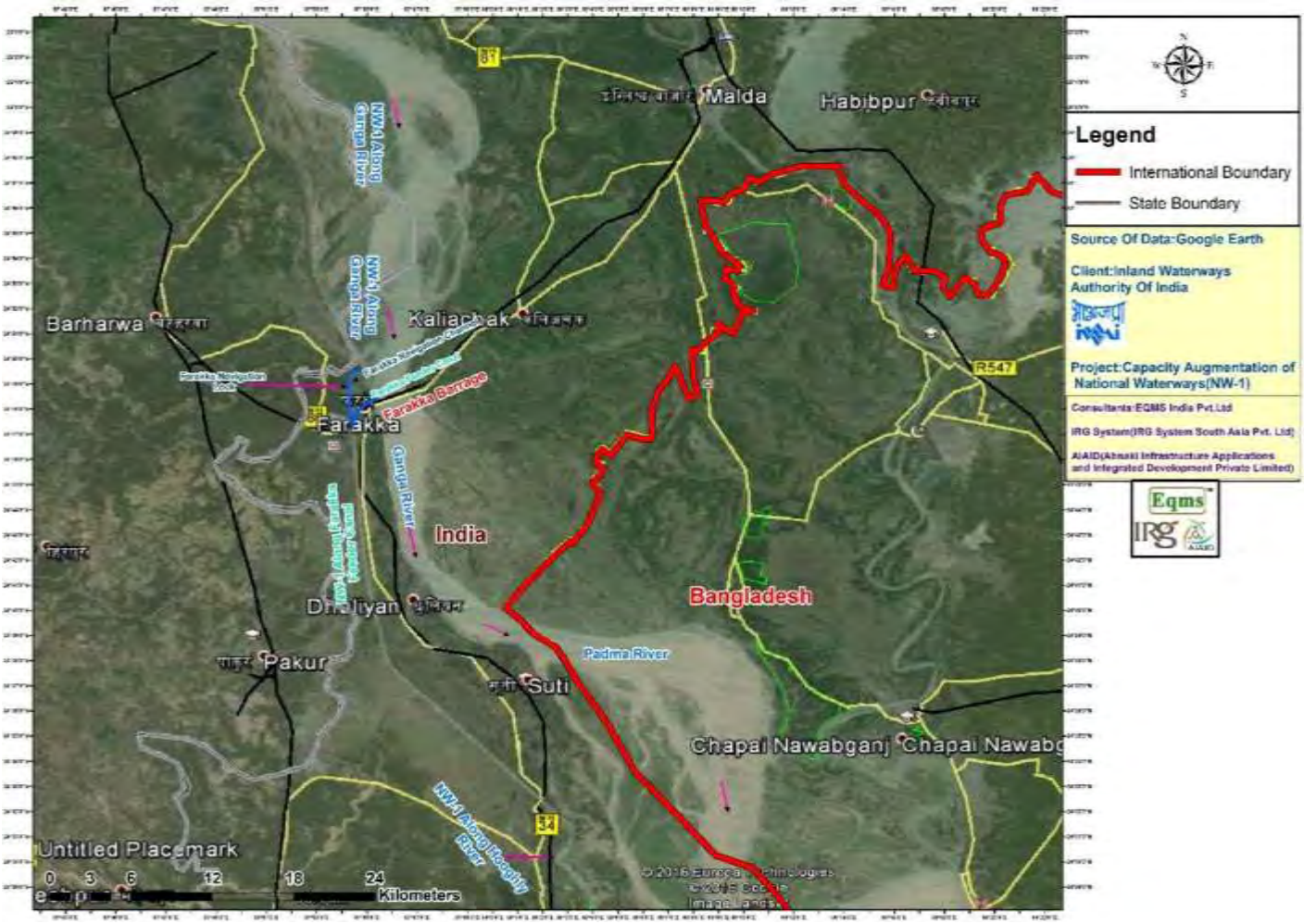

Figure 5.8 View of NW-1 route at Farakka and Control location for River Ganga Water flow to Bangladesh

An assessment of impact of Jam Marg Vikas Project over this treaty and downstream users in Bangladesh was made against water flow, Aquatic Biodiversity and sedimentation load was made qualitatively and presented at Table 5.16.

Table 5.16 : Analysis of Impact on Indo Bangladesh Water Sharing treaty and Down Stream River Water Users

Component	Before NW-1	After NW-1	Remarks
Water Flow Level	As per Treaty	No Change remains as per treaty	India diverts maximum of 1132.66 cumec, the peak capacity of Farakka feeder

			canal. This water flow will remain the same since no water diversion or storage structure is proposed under Jal Marg Vikas Project.
Aquatic Bio Diversity	Already fragmented	No Change.	Since NW-1 diverts its route through Farakka Feeder Canal prior to Farakka Barrage, this project will not interfere with ecological aspects of Farakka barrage even during construction of additional Farakka navigation lock which is proposed to be constructed along existing lock at the same navigational channel. The aquatic life is already fragmented and aquatic and avi fauna are accustomed to existing situation.
Increase in silt load due to disposal of Dredge Material	Silt load reduce in river downstream of Farakka barrage due to water storage at Farakka barrage	All dredge material is disposed in water channel itself and no change in sedimentation load dynamics.	No change on this aspect is expected as under NW-1 dredged river bed sediments will be disposed in flowing water stream only.

Conclusion: Jal Marg Vikas project will not change river dynamics in terms of water flow, or aquatic biodiversity or sedimentation load. Therefore, this project will not have any impact on this treaty and downstream users of water in Bangladesh.

5.9. Cumulative Impact Assessment

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to in this document as “developments”) when added to other existing, planned, and/or reasonably anticipated future ones. Planned Jal Marg Vikas Project is augmentation of navigation capacity of NW-1 through construction of new navigation infrastructure, maintaining LAD

through dredging & bandalling, river training works, bank protection works and improvement of existing and development of new navigational aids. NW-1 traverses through major cities which are highly populated. Various festivals and religious rituals are associated with the River Ganga. Developments like TPPs & industrial areas also exist along the NW-1. Total 5 bird areas and 3 eco-sensitive zones, i.e. Kashi turtle sanctuary, dolphin sanctuary & Udhawa sanctuary exists within 10 km of the NW-1. Planned developments, existing developments and existing sensitive zones will interact with each other to produce the cumulative impacts.

Cumulative Impact Assessment (CIA) of NW-1 from Allahabad to Haldia has been carried out for (a) analyzing the potential impacts and risks of proposed, indirect & induced developments in the context of water flow, water availability and water quality, considering human activities and natural environmental and social external drivers on the chosen Critical Environmental Resources (CERs) over time, and (b) proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible in the influence area (10 km delineated boundary on both sides of the NW-1). At first Cumulative opinions of various stakeholders which are directly & indirectly impacted due to proposed development, and extensive review of the consolidated EIA report & basin critical resources study of the proposed project has been carried out to identify the CERs. Further, overlay mapping and GIS have been extensive used for identifying the spatial distribution of CERs. Also indicators have been identified which can determine status/conditions of CERs. Baseline study has been conducted to assess the existing condition or status of the identified CERs based on these indicators in the study area. Further CERs under stress have been identified and are termed as hotspots. These hotspots have also been verified through stakeholder consultation. Total 14 zones are identified as hotspots. These include Haldia, Daimond Harbor to Nischintpura, Kolkata, Mahesthala, Katwa to Hoogly Ghat, Lalbagh in Farakka to Murshidabad, Mangalghat, Rajmahal, Sahibganj, Pirpanti, Kahalgaon, Bhagalpur, Munger, Semaria, Begusarai, Barh, Patna, Buxar, Ghazipur, Varanasi & Allahabad.

Also nature of the impacts due to proposed/planned & anticipated development on these hotspots has been assessed. Type and nature of the cumulative impact has been evaluated on all CERs in each hotspot. It has been identified that nature of impact varied from low to moderate. For example Varanasi, Patna and Howrah, air quality of the area is already impacted due to high PM10 concentration. Varanasi turtle sanctuary and Dolphin sanctuary are the eco-sensitive zones in NW-1 which are being impacted due to existing development and will be impacted due to development of NW-1 and other upcoming and planned development in the area. Other areas like Barh, Danapur, Bhagalpur etc are sensitive due to presence of important bird area. Varanasi will be the common station of upcoming EDFC and NW-1 and exchange of material will be taking place between these two points. Rating is provided to assess impact of each identified activity on CERs and it is found that impact on these hotspots due to existing, planned and upcoming development varies from low to moderate. As per the impact assessment, it is also found that the identified impacts are mitigable and mitigation plan for the impacts has been described. Further, impacts triggered due to induced & indirect

development can be mitigated & monitored due to construction & operation stage of the project.

Chapter 6. PUBLIC CONSULTATIONS AND DISCLOSURE

6.1. Introduction

Public consultation is one of the key components of the environmental assessment. The environmental and social impact assessment team conducted public consultations in project site and study areas. The approach involved a mix of conventional as well as participatory/ rapid rural appraisal (PRA/ RRA), focus group discussions (FGD) and one-to-one discussion. Two stage consultations have been carried out in line with World Bank Guidelines for conducting public consultations. First level consultations was carried out prior and during impact assessment studies and second level consultations was carried out after completion of impact assessment studies.

This chapter provides details of the public consultations and participation activities undertaken during the environmental and social impact assessment studies for the project “Jal Marg Vikas” extending from Allahabad to Haldia. During public consultation, emphasis was placed on a fully-inclusive, open and transparent public participation process in the transfer of information regarding the project and likely impacts from the project on each component of environment. A number of stakeholders are involved in this project ranging from the locals, local bodies, state & central level Government agencies and Non-Government Organizations.

6.2. Methods of Public Consultation

6.2.1. First Stage Consultations

Both the informal and formal consultations were conducted during the EIA study to obtain the views of people about the project and to ensure their involvement. Issues pertaining to both environment and social were discussed in depth during the consultations.

6.2.1.1 Informal Consultation:

Informal consultations were carried out between June, 2015 to February, 2016, prior and during the EIA studies of different components of the Jal Marg Vikas project. Informal consultations is undertaken in reference to proposed interventions and activities of NW-1 at respective locations. One to one and focused consultations were conducted following informal interview approach. No questionnaires/ brochures were supplied to the participants.

The discussions were primarily focused on receiving maximum inputs from the participants regarding their acceptability and environmental concerns arising out of the project. Consultation was started with the short description of the upcoming project components under Jal Marg Vikas Project. The objectives, proposed developments and the possible impacts of the project components and connectivity aspects the project

were also explained. The study team recorded their perceptions, demands and recommendations, about the project. Informal consultation was carried out for different planned components at different time periods. The detail of the same are given in **Table 6.1.**

Table 6.1 : Detail of Developmental Activity and Period of Public Consultation

S. No.	Details of Developmental Activity	Period
1.	Haldia Terminal	Sep, 2015
2.	Farakka Lock	June, 2015
3.	Sahibganj Terminal	July-Nov, 2015
4.	Varanasi Terminal	Oct-Nov, 2015
5.	Movement of Barges in Buxar & Patna Area	Feb, 2016

Visit was made to the villages and offices of the local bodies, Government officials, Universities and NGOs to interact with different stakeholders and obtain their views. Local people interacted includes farmers, fishermen, boatmen, land owners, cultivators and students. Interaction with females was also done during the informal focused group discussions. During the consultation, it was found that people are aware about the IWAI planning for development of terminals, navigation lock, and navigation channel. Following briefing about the project and its likely impacts on environment, people were asked about their views, issues and expectation from the project. Focus on both environmental and social issues was given during the consultation.

6.2.1.2 **Formal Consultation**

Formal consultations were carried out for the interventions sites where large land acquisition is involved. Two large scale consultations have been carried out, one for Farakka Lock development on 9th October, 2015 at Bewa Panchayat, Farakka and second for Sahibganj Terminal on 16th October, 2015 at Ashram, Samda Nala village, Sahibganj. Invitation letter were sent through e-mail and also given in person to local bodies, Government officials & NGOs for attending the public consultation, minimum a day before the formal public consultation meeting. Locals were given invitation by personally visiting the village. List of the stakeholders invited for the consultation meeting at Farakka Lock and Sahibganj Terminal are attached as **Annexure 6.1.** Copy of one invitation letter sent to stakeholder is attached as **Annexure 6.2** for reference.

6.2.2. Second Stage Consultations

Second stage public consultation was carried out after the completion of impact assessment studies on 22nd February, 2016 at Morya Hotel, Patna. Second stage public consultation was carried out with the experts, NGOs, Government Officials, prominent

personalities, and other interested parties for interaction on EIA findings (identified impacts and proposed mitigation measures) to get their opinions and suggestion for enhancing the acceptability of the project by the public and improvement in mitigation and management plan.

6.3. Objective of Public Consultation

The public consultations were conducted with the following objectives:

- To create awareness and generate understanding about the project among stakeholders, and to collect their opinion, suggestions for planning and designing of the project
- To assess positive as well as adverse socio economic and environmental impacts in the area through participatory methods such as walk through and focus group discussions.
- To identify the need and concern of the public
- To assess cultural patterns and behaviour of local communities towards the project
- To understand the environmental and social issues associated with the project through discussions
- To understand suggestions and opinions of the community, Government officials and NGOs on mitigation measures to counter and check the adverse and negative impact that threaten the socio economic environment in the area.
- To understand the satisfaction level of people with proposed mitigation and management measures proposed for the project

6.4. Outcome of Informal Stakeholder Consultation

People and are supportive of the project in general. Extract of the informal public consultation meetings held are attached as **Annexure 6.3.** Main concerns raised during the consultation with redressal measures is given at **Table 6.2.** Photographs of informal public consultation are given in **Figure 6.1**

Table 6.2 : Main Outcome of Informal Consultation and Redressal of Concerns

S. No.	Outcomes/Concerns	Redressal
1	Development of project may affect fish productivity and in turn will affect the fishing businesses. They expect some support from the Government to protect their income.	Such impacts are unlikely from this project. However, mitigation measures and management plan includes the measures for reduction of impacts if any due to construction & operation of NW-1 and its components. Some of

		measures includes: Regulated/slow speed of vessel at select locations Management of pollution by ships/vessels Intimation of dredging/piling plan to fishermen community prior to carrying out any activity Technical Support for enhancing fish productivity by setting up demonstration nurseries and training centre through institute of repute like CIFRI Provision of sirens and strong search lights in vessels/barges to prewarn the fishermen
2	Nearby roads to the terminal facilities should be strengthened and widened, as there may be substantial increase in traffic movement in the roads connecting the terminal site after construction of the terminal.	Being taken care and approach road will be constructed at Sahibganj terminal and Varanasi terminal.
3	Turtle will get impacted due to regular movement of vessels in river.	Maxium of 1-2 vessels per hour are expected to move in the sanctuary area. Speed of vessels will be maintained to 5 kmph/2.7 knots in turtle sanctuary area. Such speed barges generate noise in order of 110-140 dB. Threshold noise level of turtles for change in behavioural response is 150 dB which is above the noise expected to be generated by moving barges and the impact on turtles behaviour responses is insignificant. Other measures are also being proposed in the EMP to minimize impact of barge movement on turtle.
4	Oil spillage from ships during accident may impact the aquatic flora, fauna	Such situations are remote. Safety measures are proposed in the EMP for vessels as well. No vessels are proposed

	and water quality	to discharge any of its liquid or oily waste in the river. Emergency response for oil spillage is also proposed under EMP.
5	People raised concerns regarding the water quality which may be further effected due to construction of terminal facility and operation of cargos.	Environment management plan has incorporated the measures for prevention of water pollution from terminals, and barge operations.
6	Provision shall be made for adequate compensation for land acquisition wherever involved.	SIA and RAP has been prepared for Sahibganj and consolidate SIA/RAP for NW-1. Provision of due compensation has been made as per these plans which are prepared as per applicable R&R policies.
8	People likely to be displaced, desires to have relocation site near river Ganga.	Relocation site shall be selected in consultation with people concerned.
9	People raised concern about cutting of large no. of tree at Sahibganj site.	Compensatory plantation and additional plantation is proposed to be undertaken. At all the terminal/jetty site green belt will be developed to the extent possible. This will help in minimizing the impact and will lead to reduced impact of CO2.
10	Impact of barge movement on dolphins	Regulated vessel speed in dolphin sanctuary area. Provision of propeller guards to prevent entangling of dolphins. Other measures are also proposed in management plan to reduce the impact on dolphins
11	Due to inadequate or varying LAD vessels has the risk of grounding.	LAD is proposed to be maintained in stretch between Haldia to Varanasi during entire lean period
12	Dredging may have significant impact on breeding and spawning season	Dredging is proposed to be regulated during this season
	Erosion occurs along the bank of feeder canal and that is creating problem. Ship movement has further enhanced erosion	River training works of 39 km are proposed to be undertaken on banks of feeder canal

13	As part of social development the local immersion Ghat at Durgachak (near to the project site) should be expanded by the project sponsors to overcome the current congestion especially during the local festival.	Proposal is made to undertake expansion of ghat and budgetary provisions are also kept.
14	The access road of Haldia terminal needs to be carpeted as present road is not in good condition.	Shall be carried out as part of project development
15	Provision for appropriate parking facilities inside the proposed terminal for better management of container carrying vehicles.	Provision of parking area is made at each terminal site
16	Sanjana Chemicals near Haldia terminal site suggested that no water logging should take place at terminal site and nearby areas after development of terminal and firefighting measures should be provided at the site	Adequate storm water drainage is provided at the site to drain the storm water. Fire-fighting facility is also proposed at the site.

Session 1: Consultation with Boatmen and Fishing community	**Session 2: Consultation with Boatmen, Sqatters and Fishing community**

Session 3: Consultation with Boatmen and Fishing community	**Photograph of Baluva Ghat**
FGD at Gharaipara Village with local villagers.	**FGD at Bewa Villages with non-title holder farmers.**
Socio-economic survey carried out by AIAID representative	**Photo of some non-title holder farmers nearby proposed project location at Farakka**

Consultation with villagers in Ashram, Rampur and Samdhanala	**Consultation with villagers in Ashram, Samdhanala**
Consultation with villagers in Samdha nala, Naya Tola Asram	**Consultation with fishermen in Sahibganj**
Consultation at Samda Nalla Ghat	**Consultation in Village Rampur**

Consultation with fishery Department

Consultation with Villagers in Rampur

Consultation with Villagers in Village Area & Ashram in Rampur Village

Stakeholder Consultation with Mr. Purnendu S. Naskar at HDA office Haldia	**SC with Haldia Municipality Chairman Office at Haldia.**
Interview with Encroachers during the socio-economic survey.	**SC with Haldia Block Development Officials at Haldia**
Structure of one of the Encroachers at Haldia.	**FGD with local residential at Durgachak,Haldia**

KII with local fishermen at Durgachak,Haldia	**Photo from project location at Durgachak,Haldia**
BisarjaniGhat at Durgachak which located in nearby proposed project site.	**Consultation with fisherman**
Consultation with Fisher man	**Consultation with boat man near Pathakali ghat**

Consultation with locals at Ram Rekha Ghat, Buxar	**Consultation with locals at Adi Nath Ghat, Buxar**
Consultation with locals at Gai Ghat, Patna	**Consultation with WII, IWAI Officials and DFO, Kashi**

Figure 6.1 : Photographs of Informal Consultations

6.4.2. *Formal Public Consultation Meetings*

Formal public consultation was conducted for Terminal at Sahibganj & Lock at Farakka. Formal consultation at Sahibganj was conducted on 16th October, 2015 in Ashram, Samda Nala village, Sahibganj. Formal consultation at Haldia was conducted on 9th October, 2015 at Bewa Panchayat, Farakka. Request for support and participation in public consultation meeting was sent to stakeholder, Grampanchayat, Project Affected Families(PAF) and Local Administrations. Some of the stakeholders were invited by giving invitations personally. Villagers were invited through Gram Sarpanch and also by giving door to door invitations.

Formal Consultation in Sahibganj

Meeting was started with brief introduction about the project by Mr. Ravi Kant, Director IWAI, Patna. At the community meetings information on the socio-economic studies, environmental impact studies and other engineering related to the proposed terminal of IWAI were discussed. He requested stakeholders to cooperate and provide information to these teams for facilitating their studies. The stakeholders and community members were then given an opportunity to raise their concerns regarding the proposed project. About 700 people participated in the PCM. Meeting was attended by Government

officials, PAF's, World Bank Officials, IWAI Official, Environment and Social Impact Assessment team and General public. The summary of the key concerns/views and observations of the different stakeholders are presented in **Table 6.3**. Photographs of the formal public consultation meeting are given in **Figure 6.2.** Attendance sheet for the PCM is attached as **Annexure 6.4.**

Table 6.3 : Summary of Formal Public Consultation Meeting at Sahibganj

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
1	**Person/ Organization:** Shri K.K. Tiwari **Designation:** Divisional Forest Officer, Sahibganj **E mail:** sbgforest@gmail.com **Phone**: 09431306331 **Address:** Divisional Forest Office, Sahibganj, Jharkhand	Shri K.K. Tiwari told that the area behind the terminal site is protected forest. He told that forest department has plans to carry out afforestation and grasses/shrubs in 5 km area of the Ganga River and along the Railway lines in Udhwa Region for benefit of livelihoods of local communities. Also forest department has plan to develop wetland. His concerns about the project development are 1. Dolphins will be impacted due to the movement of cargo so mitigation measures should be taken to minimize the accidents 2. Water pollution may result due to disposal of sewage from terminal and from vessels and disposal of solid and other waste in River Water. Thus mitigation measures and management plan should be prepared to prevent water pollution. 3. Surveys should be carried out to identify the breeding and spawning grounds of fishes and project activities should not be undertaken in those regions 4. Construction activities should not be carried out during spawning and breeding seasons 5. Piling and construction within water should be carried out during low flow period 6. Measures should be taken to minimize the impact of the project on aquatic organism
21	**Person/ Organization Consulted:** Shri Jayant Ranjan **Designation:** District Fisheries officer **Phone**: 09835031630 **Email**:jayant.ranjan21@gmail.com **Address:** Department of Fisheries, Sahibganj	Shri Jayant Ranjan raised the following concerns: 1. About 5000 fishermen depend on River for their livelihood 2. Major fish species in the area are Indian Major carps, singhi, shrimps, Mystus sp. catfishes, tengra etc. These are commercially important species. Project development may affect the production of

		fishes in the River and will affect the livelihood of people 3. Breeding and spawning grounds of the fishes should be identified and care should be taken that no development should be carried out in these regions 4. Dolphins are very sensitive and care should be taken that minimum disturbance should be caused to dolphins 5. Mechanism should be developed for river clean up during accidents, oil spills, spillage etc. 6. Dredged material should be disposed in safe places and dumping should not be carried out on banks as these are habitat to various important species. 7. Fish catch may reduce due to increase in water pollution due to project development 8. Project may increase the export of frozen fishes and also there is potential for growth of commercial fisheries
4.	**Person/ Organization:** Mrs Munni Gaud **Phone**: 07808789116, 7070603324	Mrs. Munni Gaud raised the following concerns: 1. Appropriate compensation should be given to the land owners 2. Alternate employment options should be provided to people who are losing their complete land 3. Developments should be carried out in the nearby areas also for development of villages 4. Fishing activity should not be restricted after development of terminals 5. Farmers practising river terrace agriculture should not be stopped
5.	**Person/ Organization:** Mrs Usha Khalkoo **Phone**: 9801018326,9801352024 **Address:** Gram Panchyat Head, Hathigarhi	Mrs. Usha Khalkoo raised the following concerns: 1. Villagers are opposing the project as they are losing their land and they do not have any alternate employment option and are completely dependent on agriculture for their livelihood 2. Compensation should be given to villagers as per prevailing market rate, then they may get interested in selling their land 3. Alternate livelihood options should be provided to affected people 4. Pollution should not increase at the site and nearby areas due to project development

6.	**Person/ Organization:** Mr Niranjan Kumar **Designation:** Additional Deputy Collector + Land Acquisition officer, Sahibganj **Phone**: 09431306331 **Location/ Address: District Collectorate Office** Sahibganj, Jharkhand	Mr. Niranjan Kumar informed the survey of land is under process and some more time is required to finalize the award list and land details.
7.	**Person/ Organisation:** Mr Vishal Chandra **Address:** Jharkhand Rajya Vidut Vitran Nigam Ltd Sahibganj Jharkhand	Mr Vishal Chandra raised the following points: 1. He was in favour of project and said that the project is good for betterment of the area 2. This project will increase the development opportunities in the area 3. Shifting of LT line may be required from village which will be a challenging task 4. IWAI should be responsible to compensate for shift of the utilities
8.	**Person/ Organization:** Mr Sushil Kumar Executive Engineer PWD **Address:** Public works Department Sahibganj, Jharkhand	Mr Sushil Kumar said that project is good for development of the area and raised the following points: 1. Land acquisition will be the major hurdle for project development as one of the PWD project of road is also on hold due to difficulties in land acquisition 2. No paved public road connects the site to the highway or other road. Also it is expected that traffic will increase in the area, thus to prevent dust generation and traffic congestion, it is required to construct minimum 4 lane road to connect site to NH-80. 3. ROB should also be constructed above the railway line to allow smooth flow of traffic 4. Green belt should be maintained along the approach road to suppress the dust generation 5. Assessment of increase in traffic should also be carried out on existing roads so as expansion can be planned when required
9.	**Person/ Organization :** Dr. Bhagwant Marandi **Designation:** Chief Medical Officer **Address:** CMO,Health Department, Sahinganj, Sahibganj, Jharkhand	Dr. Bhagwant said that in his point of view, project will lead to overall development of the area. Healthcare facilities will also increase in the area after development of project.
10	**Person/ Organization :** Mr Safaij Reiz,	He supported the project and said that project is beneficial for overall development of area

	Address: Ganga pump Canal Nahar Pariyojna (Irrigation Department, Sahibganj, Jharkhand	and improvement of living standards of people.
11.	**Person/ Organization :** Mr Faiku Ram **Address:** District Mining Officer , Sahibganj, Jharkhand	He supported the project and said that project is beneficial for overall development of area and improvement of living standards of people. He is ready to extend his support to IWAI, if required
12	**Person/ Organization :** Mr Vinay Kumar Mishra and (5 staff members) **Address:** District Land Acquisition Officer Sahibganj, Sahibganj, Jharkhand	He said that land acquisition is under process and they are trying to identify land near the village for relocation and resettlement of displaced families and facilities
13.	**Person/ Organization :** Mr Prasant Kumar Additional Director, IWAI and (6staff members) **Address:** IWAI, Bhagalpur, Jharkhand	He gave confirmation to villagers that no additional land will be acquired for terminal construction. Land will be acquired as per law of land. He explained about the project to villagers and clarified the queries of people during meeting.
14.	**Person/ Organization:** Villagers of Samda Nala and Rampur village (Direct and Indirect Affected Persons)	Villagers were highly concerned and raised following points 1. They said that land should be acquired as per prevailing market rates 2. Alternate employment options should be provided to people who are losing their land 3. Land should be provided to affected people within or near village for relocation and resettlement 4. Fishing should not be restricted in the River due to project development 5. Employment opportunity should be provided preferably to local people
15.	**Other Participant** Mrs. Abha Singal Joshi, Consultant World Bank Mrs. Mridula Singh, World Bank Mr Pranaykumar +2 persons from social team of IWAI Consultant Mr Krishna + 2 persons from Environment team of IWAI Consultant Media: Dainik Jagaran, Hindustan	

Figure 6.2 : Photographs of Formal Consultation at Samda Nala Village, Sahibganj

Formal Consultation in Farakka

Meeting was started with a brief about the project, objective of the Environmental and social impact assessment studies, associated likely environmental and social issues requiring attention for sustainable development. The stakeholders and community members were then given an opportunity to raise their concerns and suggestions regarding the proposed project. The summary of the key concerns/views and observations of the different stakeholders are presented in **Table 6.4**. Photographs of the formal public consultation meeting are given in **Figure 6.3.**

Table 6.4 : Summary of formal Stakeholder Consultation

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
1.	Kesang Dhendup Bhutia BDO & Block Executive	• BDO,Farakka, welcomed the project development and assured his and local administration cooperation for the project

	Officer Farakka Block Development Office,Farakka,Murshidabad	implementation. • Also mentioned that without addressing environmental and social concern/impact in a structured manner no project can be completed on time successfully. • Any kind of toxic pollution by the vessel like oil spillage and chemicals in the river water, transport emissions, needs to be considered. • The project implementing agency should be careful about river erosion during the vessels movement. River bank erosion has a permanent effect upon the socio-economic conditions and demographic dislocation. • As Farakka BDO, he appealed to the authority that they should provide jobs to the local unemployed youth based on their skill and should give business opportunities to the local people especially non-title holders, who are cultivating the Farakka Barrage land since last 35 years at the proposed location. • The access road needs to be widened and upgraded to ensure smooth traffic movement because it has an important link with NH-34. A traffic management plan needs to be in place. • The non - title holder farmers would not create any problem to the project implementation, but an appropriate and implementable action plan should be prepared. • He suggested that the project should employ local people in the proposed location on a priority basis provided they have the required skills. • The health safety and protection of labour and other community members should be considered on project site as well as nearest locality of the villages during the operation phase. • Also suggested for adequate mitigation measures in EIA/SIA to address to erosion if and where identified. • The public consultation meeting should be held at different places for awareness of the people and Grievance Redressal Committees should be active with timely

		conflict resolution. • The interviewee was optimistic that implementation of this project would change the current socio-economic scenario of the local communities.
2.	Mr. Arnab Chakraborty Journalist (Malda & Murshidabad Division) Uttarbanga Samgbad Farakka, Murshidabad	• The non - title holder farmers would not create any problem to the project implementation, but an appropriate and implementable action plan should be prepared. • He suggested that the project should employ local people in the proposed location on a priority basis provided they have the required skills. • The health safety and protection of labour and other community members should be considered on project site as well as nearest locality of the villages during the operation phase. • The interviewee was optimistic that implementation of this project would change the current socio-economic scenario of the local communities.
3.	Mr.Jahid Hussain Arun Director, Mahadevnagar Rural Welfare Society, Farakka,Murshidabad	• The non – titleholder farmer's compensation should be provided and the demand of locals should be met for any other compensation. • The authority can support them through livelihood restoration programmes. • Also suggested for safety and protection from the construction site near the locality of the villages and • The consensus described as during the construction period authority should consider the vulnerable health issues like HIV/AIDS because Murshidabad is one of the vulnerable health related district in West Bengal.
4.	Mr. Rana Dutta,IFS DFO Divisional Forest Office, Nadia & Murshidabad Range Institutional Stakeholders consultation through KII	• There is no forest conservation around the Farakka area. • The continuous turbulence and waves from plying vessel movement can cause river bank erosion. This is problem that is difficult to resolve in entire downstream • As a DFO gave the assurances that DFO range will give all help for smooth operation of the project activities.

	(key informant interview)	
5.	Community members of local Villages at PCM	• The villagers also informed that there is no forest area. Further, they did not anticipate any adverse impacts on their livelihood due to construction works. • They further opined that there would be positive impacts on the sources of livelihood due to increased economic opportunities which will provide good earning sources to the local families due to the project implementation. It was also informed that there is no Schedule Tribe (ST) population in the project area. • Representatives from Beoa panchayat extended their support during the construction and operational phase of the proposed project. -They also suggested that public consultation meetings should be held at different places for awareness of the people and Grievance Redressal Committee should be active with timely conflict resolution.

Figure 6.3 : Photographs of Formal Consultation Meeting at Farakka

6.5. Second Stage Consultation

Second stage consultation for the project was held at Patna on 22.02.2016 at Patna with IWAI team, environmental and design consultants and experts of various fields. Identified impacts were discussed during the consultation and discussion was held on adequacy of the mitigation and management measures proposed. Suggestions were given and concerns were raised by the experts during the consultations. Suggestions and concerns are given in the **Table 6.5.** Photographs of the consultation are attached as **Figure 6.4.**

Table 6.5 : Summary of the Second Stage Consultation

S. No.	Person Consulted	Concerns Raised
1	Mohd. Najeeb Ahsan, Sr. Social Management. Specialist, National Mission for Clean Ganga	Alignment of Jal Marg Vikas Project's Environmental Management Plans and afforestation plans with the DPR's of Namami Gange would be appropriate. Facilities of Ferry and Ro-Ro crossings should be examined in detail under the JMV Project. Provision of Water Ambulance for transportation of patients in congested cities. Disaster Management and Emergency Response System should be developed under the project. Plan for treatment of waste water and re-use should be developed. As traffic on NW-1 would increase in future; proper planning for deployment of river patrolling and security is required. Last mile connectivity should be examined properly.
2	Dr. S. Samanta, Principal Scientist, CIFRI	Documenting the impacts along the river and understanding the various relationships with the river is important. IWAI is also a stakeholder in river. As other stakeholders need water in river for different uses as irrigation, drinking etc., IWAI also require water for navigation. The role of the project on overall water management in the river must be clarified.
3	Shri Vishva Ranjan,	Environment friendly waste disposal mechanism is required

	Urban Planning & Urban Development Specialist, Patna	for vessels. Need of a Charter for ensuring waste is not directly discharged in the river and third party monitoring to ensure the same. Waste management has been included in the draft revised Indian Vessels Act.
4	Shri K. Praveen Rao, Chief Conservator of Forests-Kanpur, Department of Forest, U.P	Reconstitution of Project Oversight Committees with representation of appropriate Forest Officers. Afforestation along the banks of Ganga should be done under the project.
5	Professor R.K Sinha, Head, Zoology Dept., Patna University	Vessel traffic management system should be developed under the Project. Dolphins are National aquatic animals and are blind. Noise generated due to vessel movement should be controlled to avoid adverse impact on dolphins. Propellers on the vessels should be caged for safety of the dolphins
6	Shri Rakesh Tiwary, Astt. Professor, A.N. Sinha Institute of Social Studies	Proper planning should be done to maintain sufficient depth by conserving wet lands and constructing reservoirs (rain water harvesting) and releasing them in the river during lean season in the system. Long term modelling of rivers should be ensured to meet the water depth requirement Cumulative impact on the society due to the project should be studied in details and proper mitigation measures should be adopted

(पोत परिवहन मंत्रालय, भारत सरकार)
AND WATERWAYS AUTHORITY
(Ministry of Shipping, Govt. of India)

Figure 6.4 : Photographs of Formal Second Stage Consultation Meeting at Patna

6.6. Conclusion and Disclosures :

Stakeholder's view and perception was assessed through informal and formal public consultation meetings. Two stage consultation has been carried out for the project. This ensures involvement of public, NGO, experts in the project's pre-planning stage itself and adressal of their problems and expectation from the projects.

The community members, Government officials and NGO members voiced that the proposed project will contribute in social and economic development of the region. The proposed project shall contribute to increase employment opportunities for the local people during and after project implementation. The communities welcomed the project and all were in favour of the project. However, some of the fishermen and land holders have raised some concerns about the fishing activities/yield and the compensation to be given. Major issues highlighted during consultation were adequate compensation against the land, loss of livelihood, provision of alternate employment, river water pollution, fish yield and disruption of fishing activities. Each of the issues raised by stakeholders were analysed for practical and scientific basis, and for evolving appropriate mitigation measures, EMP, depending on its importance and practicality.

An executive summary of consolidated EA report is available for public view in local language (Hindi and Bengali) versions at IWAI website. EIA report for entire Jal Marg Vikas Project and its executive summary is also disclosed at IWAI website and as per provisions of World Bank disclosure policies.

Chapter 7. ENVIRONMENTAL MANAGEMENT PLAN

7.1. Introduction

The Environmental Management Plan (EMP) is the synthesis of all proposed mitigation and monitoring actions, set to a time frame with specific responsibility assigned and follow-up actions defined. EMP is a plan of actions for avoidance, mitigation and management of the negative impacts of the project. Environmental enhancement is also an important component of EMP. A detailed set of mitigation measures have been compiled in view of the likely impacts associated with the proposed “Jal Marg Vikas” Project.

7.2. Objective of Environmental Management Plan

The EMP consists of a set of mitigation, monitoring and institutional measures to be taken during the design, construction and operation (post-construction) stages of the project. The EMP has been designed keeping in view the regulatory and other requirements to ensure the following:

- Minimum disturbance to the environment and social components
- Compliance with the environmental acts, rules and guidelines of GoI & maintaining the quality of air, water, soil and noise as per the prescribed norms by regulatory bodies.
- Conservation of natural resources to the extent possible
- Enhancement of Project benefits for Society & Environment
- Sustainable development and operation of project

7.3. Environmental Management Plan

Major activities associated with the project are construction and operation of the civil interventions, barge movement and maintenance dredging. Barge movement and maintenance dredging will be carried out during the operation phase of the project only whereas development of civil interventions will have components distributed during design, construction and operation phases. Civil interventions include construction of jetty, terminals, river training works, bend corrections, barge maintenance facility, and RO-RO jetties. A detailed environmental management plan for each associated development for all the three phases of the project, i.e. design/pre-construction, construction and operation phase is prepared as applicable. EMP lists the activities involved, associated impact with each activity on environment, suggestive mitigation measures, allocated environment budget for impact mitigation, implementation plan covering monitoring, reporting and implementation and supervisory responsibility.

7.3.1. *Environmental Management Plan for Maintenance Dredging*

Maintenance dredging will be carried out during operation phase of the project to maintain LAD for navigation. Maintenance dredging will be carried out as per the

availability of the depth naturally and depth required for movement of the cargo depending on the size of the cargo planned to ply in the stretch. Estimation of the required amount of maintenance dredging in different stretch of the waterway is estimated by the design consultant. Dredge disposal shall be first decided based on dredging and dredge disposal management plan given at **Table 7.1**. Environmental Management Plan for dredging is given at **Table 7.2**.

7.3.2. *Environmental Management Plan for Barge Movement*

The project Jal Marg Vikas aims ensuring the movement of barges in NW-1 during the entire year. Barge movement as discussed in Chapter 5 have certain associated impacts on environment which is required to be mitigated and managed to prevent environmental damage. Environmental management plan for barge movement is given **Table 7.3**.

7.3.3. *Environmental Management Plan for Civil Interventions*

Civil interventions proposed to be undertaken for the project are Terminals, navigational lock, Ro-Ro jetties, Bank protection measures, barge maintenance slipway and river training works. Terminal construction involves construction of berths, jetties, loading and unloading areas, material storage areas, internal roads, and administration building. Ro-Ro jetties are the extension inside the river from land facilitating movement of vehicles carrying cargo onto the vessel directly on wheels. Ro-Ro jetty involve development of the walkway and area for berthing of the vessels. No material loading/unloading operations are undertaken at Ro-Ro jetties. Bank protection works includes stone pitching, and construction of retaining walls. River training works will include bend corrections, closure of secondary channel, and construction of guide walls. All these activities will interface with various environmental, biological and socio-economic components of the study area and will impact them. Assessment of those impacts is carried out in detail in Chapter 5 and mitigation measures are suggested to minimize the impacts. Management plan has been prepared for implementation of suggestive mitigation measures along with the budget and responsibility of the agencies involved. Environmental management plan for terminal, locks & River Training Structures/Bank Protection Measures for construction and operation phase is given in **Table 7.4** &**Table 7.5.** EMP for Ro-Ro jetties is given in **Table 7.6**.

7.4. Institutional Framework of IWAI for Environmental Management

For effective implementation of the proposed environmental management plan, it is necessary to have permanent organizational set up charged with the task of ensuring effective implementation of EMP and to monitor the implementation efficiency. IWAI has set up a project management unit which is staffed with environmental and social specialists. These specialists would work as an environment and social cell (ESC) within PMU. It is proposed that each field unit will have one designated officer responsible for environment and social aspects who will also coordinate with ESC. The major responsibilities of IWAI and of ESC would be:

- To implement the environmental management plan

- To assure regulatory compliance with all relevant rules and regulations
- To ensure regular operation and maintenance of pollution control devices
- To minimize environmental impacts of operations as by strict adherence to the EMP
- To initiate environmental monitoring as per approved schedule
- Review and interpretation of monitoring as per approved schedule
- Review and interpretation of monitoring results and corrective measures in case monitored results are above the specified limit
- Maintain documentation of good environmental practices and applicable environmental laws as ready reference
- Maintain environmental related records
- Coordination with regulatory agencies, external consultant, monitoring laboratories
- Maintain log of public complain and the action taken
- Efforts shall be made for setting up of common conservation cell consisting of one marine biologist, and ecologist, a sociologist and a fishery expert

The ESC should have all basic record keeping facilities such as hard ware/software facilities, adequate space, vehicle (transport) and basic furniture and all simple instruments such as GPS, Digital camera, Hand held noise metre etc. The cell should have all basic environmental management data of the project that includes but not limited to the following:

- Environmental Impact Assessment Report (both well preserved soft and hard copy) and Environmental Management Plan
- All valid and up to date regulatory permits and consent papers
- All latest Environmental legislations, policies, codes and manuals for ready references
- A list of consultants on environmental management need to be kept with yearly revision of the list. This will help to receive proper advice in case of an emergency or are requirement and also to implement day to day environmental management activities.

Over a period of time a system to understand and absorb the new revisions and changes in the environmental requirements and practices are to be established. This can only be achieved by regular training and genuine capacity building initiatives. IWAI shall also ensure availability of adequate resources. Institutional framework for the project is given in **Figure 7.1.**

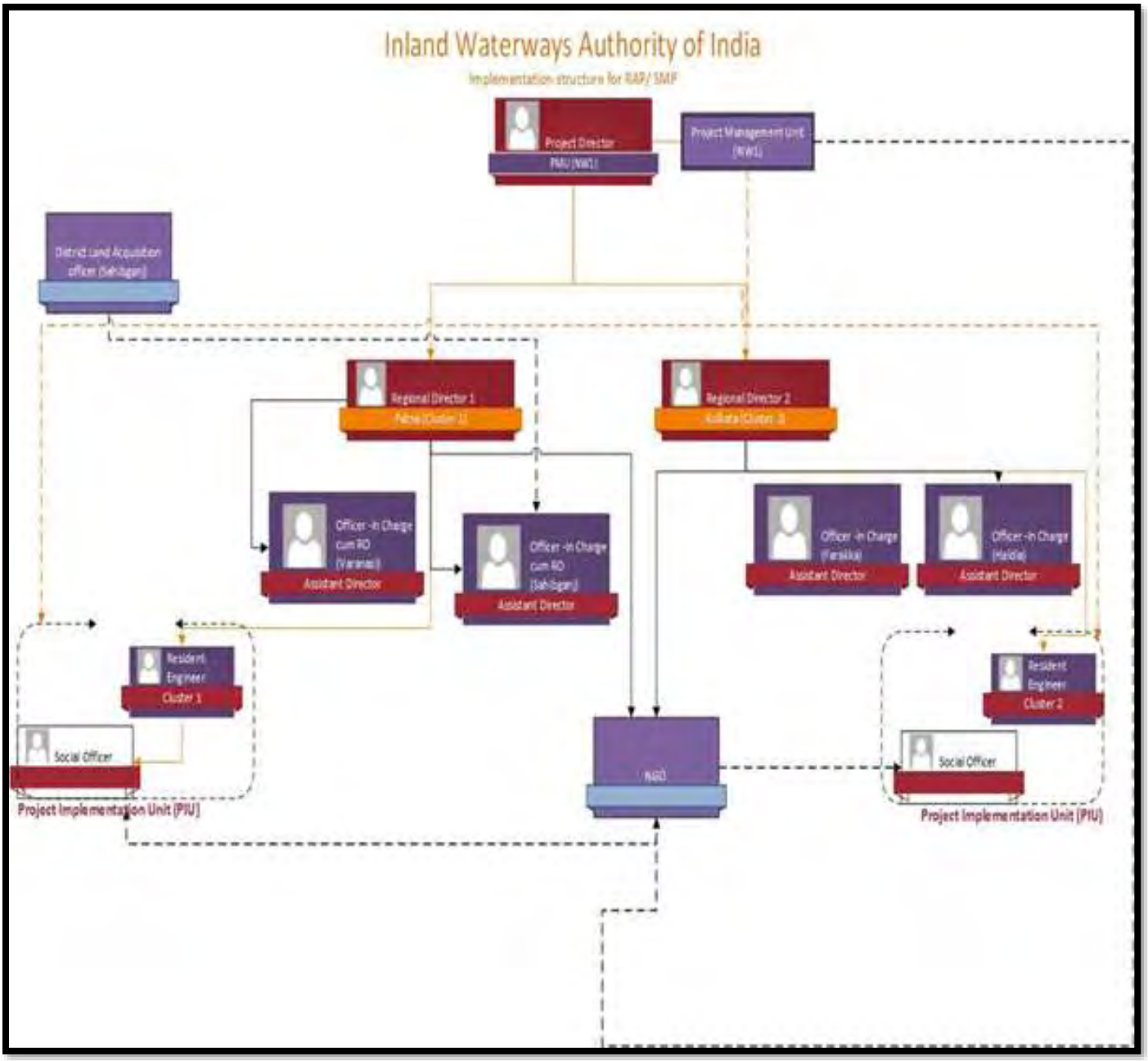

Figure 7.1 : Institutional Framework of IWAI

7.4.2. *Effective Implementation of Environmental Management Plan during Construction Phase*

Pre-construction and construction activities are taken by the contractor to whom work will be awarded. For implementation of Environmental Management Plan during pre-construction and construction phase, it is necessary that EMP for construction phase should be shared with the contractor so as he is aware of the environmental provision he

has to keep during construction phase and he can do budgeting accordingly. This will ensure effective implementation of the EMP. Thus IWAI should include the EMP as environmental and social safeguard measures in the bid document. EMP implementation by contractor can be achieved by following ways:

- Incorporation of contractor's EMP in bid document and instructing him to keep environmental provisions in planning while budgeting
- Contractor should have full-fledged environment management cell to ensure the implementation of the EMP and the SHE policy aiming at achieving the goals of safety, health and environmental management.
- Mandatory Deputation of environmental and social expert (by contractor) at site
- Environmental & social experts to be deputed should have broad experience of working in similar field
- Linking payments of the contractor to environmental performance
- Assigning penalties in case the environmental safeguard measures are not taken up adequately
- Appointing PMU/PMC to monitor the performance of contractor and compliance of the EMP by contractor. PMU/PMC is responsible to communicate the status of compliance/non-compliance of EMP by contractor to project proponent and suggest the measures to be taken to contractor to meet the gaps/non-compliances. PMU/PMC can be appointed by IWAI through tendering process again and the company's having experience of managing similar kind of projects should only be appointed for the PMU/PMC work only.

7.5. Environmental Health & Safety Policy and EHS Management System

An effective environmental health and safety policy is essentially required to be prepared for the project and it should be communicated to the workforce through displaying posters/bill boards/posters/glow boards and campaigning around the work site. Posters should be in Hindi, English & Regional language so as it can be understood by the workforce. Verbal communication through campaigning also should be carried out. Some of the important days such as Environment Day (June 5), Red Cross Month (March), Emergency Preparedness Week (May 1-7), National safety day (4th April), National Health Day (7th April), Fire safety day (14th April), 20th April (Earth day) can be planned for spreading the awareness for Environment Protection, Cleanliness and safety among work force through campaigning.

For effective and systematic implementation of the project, it is desirable that IWAI (The EA) develops its Environmental and Social management systems which is auditable and effectively enforceable. Parallel can be drawn from the experience of National Highway Authority of India or Delhi Metro Rail Corporation and adopt EHS system on the similar lines. Each contractor should be contractually bound to follow such system and must have EHS management system in line with EA's management system. IWAI should also

develop its standard technical guidelines for Environmental Assessment, Management and Reporting

7.6. Environmental Standards for operation and maintenance of Various Civil Interventions, Barge Movement and Dredging Operations

Mentioned activities have potential to pose threat on the environmental quality. Regulatory Authorities of India and other countries have specified certain limits of pollutants which, if maintained, environmental pollution can be maintained. The Environmental standards applicable for the operation and maintenance stage of the project and that should be adhered to are listed below. Details of each of the standards are given in **Annexure 2.2** of this report.

- Standards for discharged of effluent in inland surface water bodies and Marine Coastal Areas (Source: G.S.R 422 (E) dated 19.05.1993 and G.S.R 801 (E) dated 31.12.1993 issued under the provisions of E (P) Act 1986)
- Classification of Surface water Bodies on basis of Quality (Source: Guidelines for Water Quality Management-CPCB, 2008)
- Water Quality Standards for Coastal Waters, SW-IV & V-Harbour and Navigation & controlled waste disposal (EIA Guidance Manual for Ports & Harbours, MoEF&CC, GoI)
- Standards for permissible level of water quality indicators (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Permissible limit for off-shore dumping of dredged material (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Criteria for harmful bottom sediments (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Approximate Quantity of Suspended Sediments Generated by Dredging or Dumping Operations (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- MARPOL 73/78 for prevention of pollution from ships
- SOLAS (Safety of Life at Sea) as per latest amendments (Chapter I-XII)
- CPWD Norms for construction of off-shore works, river bank protection structure, carrying out dredging works, river raining works

7.7. Environment Monitoring Plan (EMoP)

The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. The following are the main objectives of the environmental monitoring program:

- Provides information for documentation of monitoring of mitigation measures and impacts

- Tool for the statutory authority of unanticipated adverse impacts or sudden changes in the environmental condition due to the proposed project
- Provides information that could be used for evaluating the effectiveness of implemented mitigation measures
- Provides information that could be used to verify predicted impacts and thus validate impact prediction techniques
- The effectiveness of the mitigation measures being followed during construction and operational phases can be assessed and the measures can be revised, made more stringent and reinforced based on the monitoring results
- Environmental Monitoring can also serve a basic component of a periodic environmental regulatory auditing program for the proposed project

A monitoring schedule has been developed based on the environmental components that may be affected during the construction & operation phase of the project and is given at Table **7.8**. Environment monitoring indicators identified are listed below

Monitoring Indicators

- Air quality- ambient air quality levels & stack emissions
- Surface Water quality
- Drinking water quality- for construction labours
- Noise levels- ambient noise level and work zone noise levels
- Soil quality- dredged sand quality and soil quality
- Solid & Hazardous Waste Management
- Wastewater disposal
- Re-plantation success / survival rate
- Soil Erosion at river banks and bed scours
- Aquatic ecology– plankton, benthic communities, dolphins, turtles and other aquatic species

These indicators should be evaluated periodically based on the monitoring results, baseline conditions, predicted impacts and mitigation measures.

Water Quality: No significant change in water quality is perceived due to the project in the operation phase. Hence, it is suggested that if the monitored value for any water quality parameter exceeds by more than 20% of its last monitored status the monitoring frequency shall be increased and suitable measures taken if increase in value is due to project activity reasons

Tree Plantation: The 70% survival rate of re-plantation shall be monitored on the first year of the operation phase in consultation agency assigned for tree plantation. If the survival rate is found below 70%, additional tree shall be planted and survival rate monitoring shall be again taken up after 3 years. This cycle should continue until the 70% survival rate is achieved

Aquatic Ecology: Details about ecological aspect shall be periodically collected in terms of effect on breeding and spawning ground, accidental damage to dolphin if any or other aquatic fauna, fish productivity. Corrective action shall be initiated if IWAI activities or Barge operation are resulting in any damage to Aquatic fauna or fishermen activities.

Soil Erosion: No significant soil erosion is anticipated during construction and operation phase. In the construction phase some localised bank erosion may be noticed. Erosion may be noticed in the narrow areas of Farakka Canal. However, if bank soil erosion is noticed during construction and operation phase, the corrective action shall be initiated and frequency of check be increased to assessed the tendency of recurrence.

Safety and Emergency Preparedness: Safety measures like signage board, navigation GPS system, and other accident prevention measures for barge movement are proposed. Periodic physical and preparedness check shall be carried out. If any aspects of safety and emergency preparedness is found ineffective than appropriate corrective action shall be taken.

7.8. Reporting Requirement for EMP and EMoP

7.8.1. *Reporting Requirement during Pre-Construction & Construction Phase*

Contractor is responsible for implementation of Environmental Management Plan and ensuring health and safety of the construction workers at site during pre-construction & construction phase of the project. Thus it is required by contractor to submit the monthly and six monthly reports containing the status of environment, health & safety at site to PMC (Project Management Consultant) & PMU of IWAI. PMC will be responsible for construction supervision and ensuring effective implementation of EMP by the contractor. PMC shall report to PMU monthly about the performance and effectiveness of the EMP implemented by contractor on site and coordinate with filed units and PMU for necessary corrective actions as may be required. PMC will be hired by IWAI who will be responsible to identify gaps between the proposed environmental, safety and health management plan and actually implemented status of the system by contractor. PMU on basis of site inspections and PMC reporting, will issue orders to contractor for corrective actions with time in which gap is to be met and penalty clause in case of non-compliance. Submissions to be made by contractor to PMC/PMU are given below:

- Monthly SHE Report- Details of daily & monthly man hours of workers; fresh incident analysis; detail of SHE inspection, internal audits & SHE communication activities; data on air, noise, soil and water quality; housekeeping details and health & welfare details
- Monthly Environment Reports- Details of environmental monitoring parameters and monitoring data as per proposed EMoP; nos. of work fronts open & associated issues; compliance to management Systems , ILO and National legislative requirements as applicable; compliance to world bank requirement; green belt management status, tree cutting & afforestation and PUC & green tag status of vehicles at construction site
- Monthly Progress Report: Detailing tasks undertaken till date, tasks under progress and the planned tasks for next months

- Monthly Accidental Reporting and Investigation Report
- Six monthly compliance reports for compliance of regulatory permits and EMP requirements.

7.8.2. *Reporting Requirement during Operation Phase*

IWAI should ensure the implementation of Environmental Management Plan for the operation phase as suggested. IWAI should maintain the following records/reports

- Six monthly compliance report of suggested EMP
- Audit Report for compensatory plantation
- Energy audit reports of the terminal buildings
- Accident and Investigation Report
- Report containing details of dredging quantities and LAD maintained in different stretches

7.9. Audits & Inspection

Audits and inspections are integral part of the Environmental Management Plan. Audits and inspection helps to evaluate the performance of the implemented system and provides the rating and identify the non-compliances and gaps between the proposed and implemented system. Audits should be regularly held so as non-compliances can be identified at each stage and can be complied with by taking corrective actions. Some of the audits to be taken up by contractors include

- SHE management system
- LEED or GRIHA certification of green building compliance for terminal buildings.
- Regulatory Compliance

IWAI will also organise an independent Environment Audit which will be submitted to Bank within 3 months of completion of the second and fourth year of implementation period

7.10. Mechanism for Feedback and Adjustments

As part of the feedback mechanism, the ESC of PMU shall monitor project compliance based on monitoring reports, audit and inspection reports with respect EMP, EMoP and applicable laws, rules and regulations. ESC will report to PD quarterly. In case, any deviation from the contract requirements with respect to proposed EMP is observed, the same shall be corrected within a fortnight through contractor and PMC and records maintained for the same. ESC will also verify the facts reports through periodic site visits.

Public involvement shall be encouraged and ensured throughout the lifecycle of the project. The ESC shall gather and maintain information on any damage or public concern that may be raised by the local people, NGOs and local authorities. While immediate solutions are to be worked out with the help of contractor, a detailed report will be submitted to the PMU and PD for information or detailed consideration, as the case may be. The PMC and ESC will be responsible to bring it to the notice of the PMU and PD.

Resulting decisions shall be communicated back to PMC and contractor for correction and future implementation.

7.11. Trainings & Capacity Building

Trainings are essential for skill building and making people competent in carrying out the operations/tasks and handling emergency situation in planned manner. IWAI has already taken actions to augment the capacity of project management unit (PMU). A capacity building and training programme has been prepared which includes training of staff of Environmental and Social cell of PMU, contractor's staff (labours & engineers), PMC staff and IWAI staff on environmental management, regulatory compliance and safety aspects. Some of the trainings which are required to be conducted are given in **Table 7.9.**

7.12. Emergency Response and Preparedness Plan and Contingency Response Plan

Risks and hazards are associated with every construction site as it involves usage of heavy machinery and equipment. Similarly, risks are also associated with the operation phase are listed below:

- Vessel Accidents and spillage of commodities (especially oil)
- Leakage or spillage of oil from ships and barges at terminal/jetty
- Drowning in River during material handling and vessel movement
- Hazard to Fishing vessels/gears

It is proposed that IWAI must equipped itself with guidelines and equipment for handling the emergencies. PMU shall evolve its environmental, Occupational health and safety guidelines and performance protocol. Budgetary provision has been made under environmental budget. The same shall be developed with the help of reputed institutions and organisation of repute. It should also follow the system of emergency response. A suggested Emergency management and Response plan is included at **Annexure 7.2**.

7.13. Authorities and their Responsibilities for Implementation of EMoP

The authorities and responsibilities for the implementation of the environmental management plans shall be tiered based on the activity and as per institutional framework.

All the policy decisions, including incorporation of the EMP requirements in compliance to loan covenants shall be the responsibility of the IWAI (EA).

Projects shall be implemented by Project Management Units (PMU). IWAI has set up Environmental and Social Management Cell (ESC) within PMU. ESC will ensure that the environmental mitigation measures are being implemented effectively. The ESC shall, among others ensure that the EIA Reports comply with national and Bank guidelines, monitor the status of implementation, and preparation of monitoring reports. PMU will depute its officer at filed level unit with additional responsibility for Environmental and social management who will also coordinate with ESC at PMU. It is also proposed to appoint PMC who will supervise contractor and PMU to ensure effective implementation of management plan proposed. ESC will be technically

supported by independent subject experts who shall be hired on need basis (Air, Noise, Water, and Aquatic).

The most essential component of the Environment Monitoring Plan is the execution of the Plan in accordance with the monitoring schedule provided therein. The ESC and concerned field unit will be responsible for timely monitoring of various parameters and compliance with the mitigative measure proposed. A resultant data base is proposed to be maintained. A Management Information System (MIS) is also proposed to be put in place for effective flow of information between various levels and functions within PMU, ECS, PMC and contractor.

7.14. Enhancement Measures: Implementation Plan

The enhancement measures are proposed to meet stakeholders' expectation and enhance the positive impacts. Three proposal regarding dolphin conservation, fish productivity and cultural aspects.

IWAI will be having prime responsibility for the same. Budgeting provision is made in the EMP for all the three enhancement proposal. ESC will obtain quotations and finalise implementation modalities, success indicators in consultation with proposed agency. The implementation plan will also be submitted to World Bank for information.

7.15. Regulatory Clearances /Permission Required

Statutory clearances will be obtained for any project component wherever found applicable. Certain other permits are required for example consent to establish from State Pollution Control Board for setting up hot mix plant. All such permits are supposed to be obtained by the contractor who should obtain it before setting up any facility attracting these permissions. The most important and time-consuming clearances are permission for barge movement through Kashi Turtle Sanctuary and Vikramshila Dolphin Sanctuary but this permission is required for operation stage of project for movement of vessel through these sanctuaries. This process has already been initiated by IWAI.

7.16. Grievance Redress Mechanism

The concern/grievances from local/affected people may come up related to inappropriate implementation of various components of EMP. These issues can be easily addressed through acknowledgement, evaluation and corrective action and response approach. To resolve grievance from public or stakeholders concerning the project will be directed to the PMU/Director concerned. Firstly, it will be assessed if the grievances are genuine or suggestion is acceptable. Accordingly, response will be given within 15-30 days by the PMU in consultation with PMC and Director concerned. In case the PMU is unable to resolve the issue, the matter will be forwarded to Project Director at Head Quarter. The corrective action will be started as per the response or action plan indicated to the stakeholder. The outcome shall also form part of quarterly report to World Bank **(Figure 7.2)**

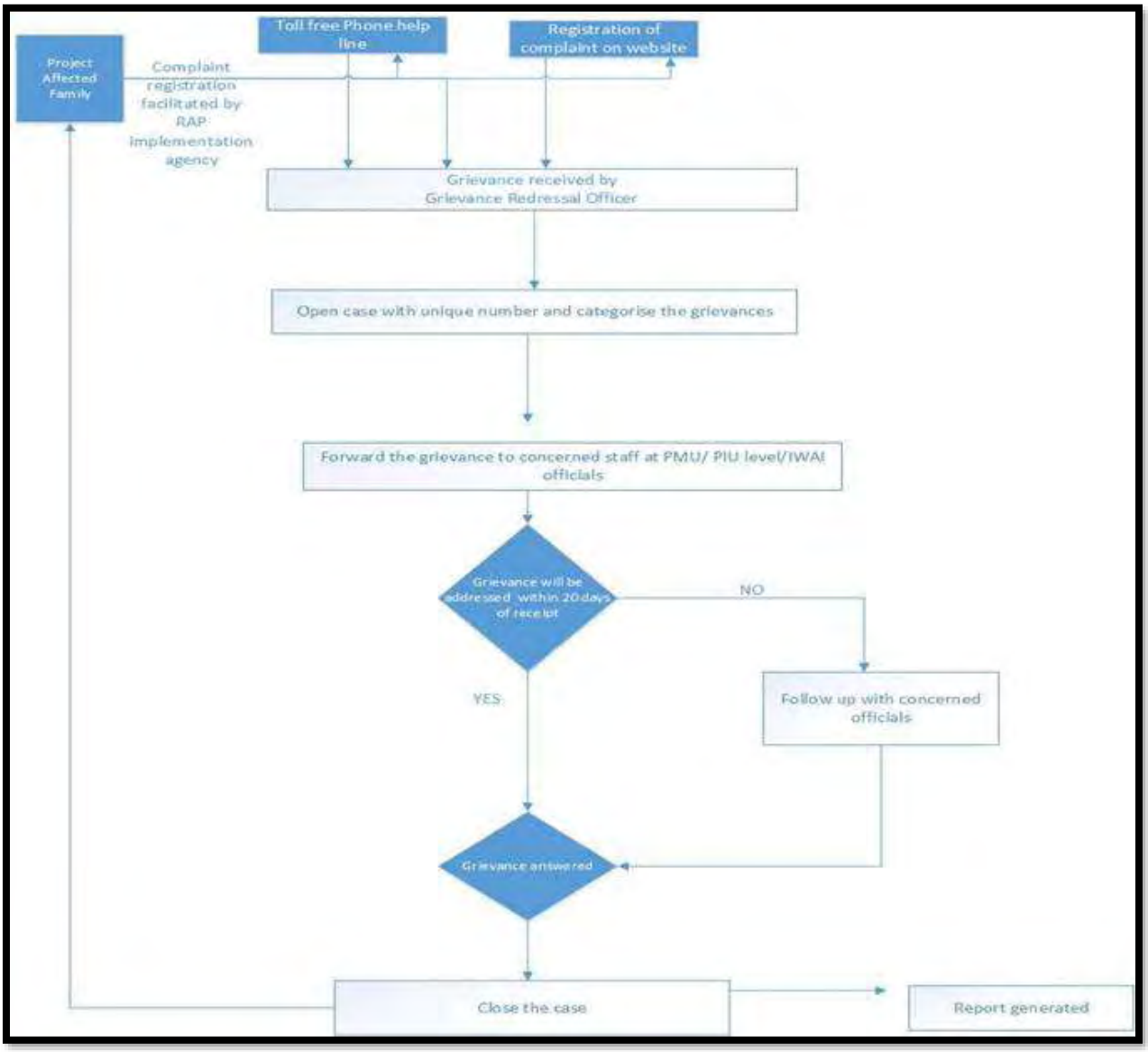

Figure 7.2 : Grievance Redressal Cell

7.17. Environment Budget

Environment budget has been prepared for design, construction and operation phase of the project. The Environmental budget includes the cost of environmental structures like Sewage Treatment Plant, Air Pollution Control System at terminals, monitoring, enhancement measures, GHG reduction, training and awareness and technical support for establishment, enhancement measures and environmental guidelines. Environmental budget is estimated as Rs 49.9 crores. The summary of environmental budget is given below. The detailed break-up of costs is given at **Table 7.10**.

Summary Environmental Budget:

S.No.	Description	Amount
1.	**DESIGN AND CONSTRUCTION STAGE**	**Rs in INR**
	Technical Support of preparation of guidelines, bio-diversity conservation plan for turtle and dolphin sanctuary and performance indicators	90,00,000
	Compensatory tree plantation (7000 trees) Additional tree plantation for GHG sink (18000)	15000000
	Measures to Reduce GHGs by Green buildings certification & additional tree plantation under plantation head	90,00,000
	Storm-water and wastewater management/ Construction of soak pits/ clean drinking &domestic water facility/ STP construction, Zero Discharge management.	44000000
	Provision of trainings and PPE to workers	1,72,00,000
	Health check-up camps for construction workers	3,20,00,000
	Enhancement Measures • Institutional Support for Vikramshila Wild Life Sanctuary through reputed institutions • Support Fish productivity enhancement through fish nursery development and training fishermen • Bath shelter for women along NW-1 for maintaining privacy from vessel movement • Support for cleanliness at Ghats and improvement of Ghats	12,60,00,000
	Environmental Monitoring in the construction phase: Terrestrial and Aquatic Fauna, Ambient Air Quality, Surface Water Quality, Drinking Water Quality, Noise & Vibration, Soil Quality, Erosion & Siltation and River Bed Sediment	58080000
	• Drainage Congestion and disposal of accumulated water/ Erosion & Sedimentation/ Reduction in dredging requirement • Land/ Soil/ Noise/ Air Quality -Dust Management during construction • Appointment of Safety Officers, Safety signage, fire-fighting measures & water ambulance etc.	Covered in project design and engineering cost
	SUB TOTAL (Design & Construction stage)	**310280000**
2.	**OPERATION STAGE**	
	Monitoring of performance indicators viz. Terrestrial and Aquatic Fauna including surveillance audit, Ambient Air Quality, Surface Water Quality, Ground Water /Drinking Water Quality, Noise & Vibration, Soil Quality, River Bed Sediments, Soil Erosion & Siltation, Integrity of embankments	59040000
	Emergency Preparedness: Accident Response: Ambulance equipped with requisite emergency medical aid facility, First Aid Facility, Fire-fighting Equipment, Safety Trainings, Mock Drills etc.	6,79,00,000

S.No.	Description	Amount
	Waste Water Management (STP Operation, rainwater harvesting management and maintenance)	2,16,00000
	Storm Water Management System & Waste Management System, Erosion Control and landscaping, Reduction in GHGs	To be part of OM cost
	SUB TOTAL (Operation stage)	**1,48,540,000 Or say 14.85 Cr**
3.	**ESTABLISHMENT & TRAINING and MANAGEMENT SYSTEM)**	**1,65,00,000**
4.	**SUB TOTAL (Construction + Operation + Establishment)**	**47,53,20,000 Or say 47.53 Cr**
5.	**CONTINGENCIES @ 5 % on total Environmental Costs**	**2,37,66,000 Or say 2.38 Cr**
6.	**GRAND TOTAL (in Rs)**	**499086000 Or say 49.91 Cr**

Table 7.1 : Dredging and Disposal Management Plan for NW-1

Stretch/Dredging Quantity & Quality/Proposed Disposal Location	Biological, cultural, social and religious Sensitivity	Aquatic sensitivity		Management Measures
		Sensitive zone	Breeding & Spawning Period and grounds	
Stretch: Haldia to Farakka Dredged Qty: Nil for navigation channel & 30-60 lakhs cum for maintaining terminal site Dredged Quality: Not contaminated70 Disposal Location: In river/shoals/scours	Imp. Bird area- Farakka Barrage and adjoining area (Surrounding NW-1) Archaeological locations- St. John's Church (300 m, E), Temple of Gour Chandra and Krishnachandra at Chatra-Gaur Chandra Ghat (0 m, W) & Hazardwari Palace (30 m, E) Fest & Festivals: Ganga Sagar Mela at Sagar (January)	Hilda Sanctuary (Within NW-1)- 4 locations	Peak spawning season for Hilsa is July-August Breeding & Spawning grounds for Hilsa: Stretch between Nischintpur (Kolkata) & Diamond Harbour, Hoogly ghat & Kalna and Lalbagh to Farakka71	Dredging should be regulated during July-August Dredge disposal should not be carried out within Sanctuary area and other defined sensitive locations Dredge disposal should be carried out at minimum distance of 100 m from bank Dredging & disposal should not be carried out during time & location of festivals
Stretch: Farakka to Barh Dredged Qty: 26,00,000 cum Dredged Quality: Not contaminated Disposal Location: In river/shoals/scours	Imp. Bird Area- Udhwa Lake Bird Sanctuary (9 km, W), Vikramshila Gangetic Dolphin Sanctuary-VGDS (within NW-1), Mokama Taal (Barah) Wetlands (Along NW-1) & Kurseala River Course and Diyara Flood Plains (Along NW-1) Archaeological locations- Sindhi Dalan (300 m, W) & Jama Masjid (140 m, W) Religious locations: Community Temple at Sahibganj Terminal site (to be shifted) Fest & Festivals: Chatt (Oct-Nov)	Vikramshila Gangetic Dolphin Sanctuary (within NW-1)	Major Birth season for Dolphin is October to March72 Breeding Ground: Very shallow waters for giving birth	Dredging should be stopped if Dolphins are sighted Dredge disposal should not be carried out within Sanctuary area and other defined sensitive locations Dredge disposal should be carried out at minimum distance of 100 m from bank Dredging & disposal should not be carried out during time & location of festivals
Stretch: Barh to Patna Dredged Qty:18,00,000	Fest & Festivals: Chat (Oct-Nov)	None	Peak spawning season for Indian Major Carps is	Dredging should be stopped if any dolphin or big aquatic species is sighted

[70] There are no standards and specification for disposal of dredged material. Thus reference is made to Canadian and Japanese standards for dredged disposal (given in Annexure 5.1 of report). Not contaminated here is referred to the quality of sediments within the permissible limits of the above mentioned standards for onshore disposal.

[71] Perspectives of reproductive biology and spawning behavior of Indian shad (*Tenualosa ilisha*)-A global review, Utpal Bhaumik, Former Divisional Head, Riverine Ecology and Fisheries, Central Inland Fisheries Research Institute, Barrackpore, India

[72] Ganges River Dolphins, WWF (http://wwf.panda.org/what_we_do/endangered_species/cetaceans/about/river_dolphins/ganges_river_dolphin/)

cum Dredged Quality: Not contaminated Disposal Location: In river/shoals/scours			May-August Breeding & Spawning grounds: Shallow waters and areas inundated during monsoon season73	Dredging should be avoided during May-August Dredge disposal should be carried out at minimum distance of 100 m from bank Dredging & disposal should not be carried out during time & location of festivals
Stretch: Patna to Buxar Dredged Qty:18,00,000 cum Dredged Quality: Not contaminated Disposal Location: In river/shoals/scours	Imp. Bird Area- Danapur cantonment area (2 km, S) Fest & Festivals: Chatt (Oct-Nov)	None	Peak spawning season for Indian Major Carps is May-August Breeding & Spawning grounds: Shallow waters and areas inundated during monsoon season	Dredging should be stopped if any dolphin or big aquatic species is sighted Dredging should be avoided during May-August Dredge disposal should be carried out at minimum distance of 100 m from bank Dredging & disposal should not be carried out during time & location of festivals
Stretch: Buxar to Varanasi Dredged Qty: 13,00,000 cum Dredged Quality: Not contaminated Disposal Location: In river/shoals/scours	Archaeological locations- Kardmeshwar Mahadeva Mandir (240 m, W), Ramnagar, fort (40 m, E), archaeological excavation site, Varanasi (130 m, E) & Manmahal and observatory (40 m, W) Cultural locations: Ghats Fest & Festivals: Ganga Mahotsav at Varanasi (Oct-Nov) & Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March)	None	Peak spawning season for Indian Major Carps is May-August Breeding & Spawning grounds: Shallow waters and areas inundated during monsoon season	Dredging should be stopped if any dolphin or big aquatic species is sighted Dredging should be avoided during May-August Dredge disposal should be carried out at minimum distance of 100 m from bank Dredging & disposal should not be carried out during time & location of festivals
Stretch: Varanasi to Allahabad Dredged Qty: Dredged Quality Disposal Location	Fest & Festivals: Ganga Mahotsav at Varanasi (Oct-Nov), Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March) & kumbh at Allahabad (Jan-Feb)	Kashi Turtle Sanctuary (within NW-1)	Spawning season for River Turtles: March-April Breeding & Spawning grounds: Wetlands/River banks	Dredging should be regulated during July-August Dredge disposal should not be carried out within Sanctuary area and other defined sensitive locations Dredge disposal should be carried out at minimum distance of 100 m from bank Dredging & disposal should not be carried out during time & location of festivals

Table 7.2 : Environmental Management Plan for Maintenance Dredging

[73] Genetic Resources of Indian Major Carps, Their Distribution and Characterization, FAO (http://www.fao.org/docrep/006/x3850e/X3850E02.htm)

Environmental Issue /Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
1. Physical Environment							
Water Quality	• Attempt shall be made to minimizing and optimizing the dredging requirements by effective assessment and study of the Thalweg profiles of the river. This can be achieved some of the following measures: o Increase use of bandalling which helps in diverting the flow of river towards the channel and reduces the quantity of dredging o Low draft vessels should be deployed which will reduce the requirement of dredging • Dredged material shall be checked for toxicity and contamination prior its disposal onshore for prevention of contamination of water and its impacts on aquatic life. Standards for judging onshore & off-shore disposal of dredged material are given in Annexure 5.1. • Dredging should not be carried out during very low flow seasons so as to minimize the dispersion of fine sediments • Usage of silt or air bubble screens/curtains should be explored to minimize the sediment release during dredging operations. Silt/air bubble screens can hang from surface floats or stands attached to the bottom and held upright by sub-surface floats (PIANC). The use of silt curtains is reported to considerably reduce the loss of suspended sediments from the dredge area, by up to 75% where current velocities are very low. However, they are	Water Act, 1974	Within River	During Dredging Operation	Part of Project Cost (IWAI & Contractor)	Contractor	IWAI/PMU/PMC[74]

[74] It is proposed to set up Project Unit (PMU) in IWAI to manager social and environmental aspect of NW1 augmentation. PMC (Project Management Consultants) anticipated to be appointed for project management and quality check.

	generally ineffective in areas with high current velocities which exceed 0.5 m/s (UK Marine SACs Projects). • To minimize the sediment dispersal during disposal of dredge sediments, it should be place as close to the bed possible preferable at a level of 1m above the bed to minimise the dispersal of sediments. • Provision shall be made of emergency response equipment like floating blooms to deal with any emergency of oil spills or leakages. Regular servicing and maintenance of dredgers should be taken up so as to prevent any leakage of the dredged material. Leakage detection of the sediment transportation pipe shall be carried out regularly to prevent any sediment loss and water pollution at leakage location. Corrective actions should be taken immediately after detection of such leaks. • Cutter head of CSD should be selected according to material to be dredged so as to maximize the dredged material transport from dredging point to suction mouth and prevention of sediment loss and re-suspension. • Ratio of cutter revolutions and pump velocity should be adjusted to ensure that cutter advancement rate is not greater than the ability of the suction pump to remove the material that is cut. This will prevent the suspension of the dredged material. • Dredge cuts and lifts should be designed so as to prevent undercutting of material and hence a collapse of material locally at the cutter head, leading to an increase in the sediment being disturbed by dredging. • If dredge material is found contaminated at any particular location that it should be disposed off-shore. Off-shore disposal of dredged material should be carried out only at approved TSDF site such as						

	approved TSDF site of Haldia Dock Complex at Sagar. • Dredge material if disposed on river banks or on land caution should be exercised as per the Dredging and Disposal Management Plan for NW-1 given at Table 7.1. • *If dredged material is disposed at land, then the care should be taken that the tail water is collected and made free from sediments prior its discharge back to surface water body. Regular monitoring of the excess water should be done in case dredged material is disposed on land. This will help in assessing the efficiency of sediment trap system provided at site and controlling contamination of water by minimizing the sediments.*						
2. Biological Environment							
Environmental Issue /Component	**Remedial Measure**	**Reference to laws and Contract Documents**	**Approximate Location**	**Time Frame**	**Indicative / Mitigation Cost**	**Institutional Responsibility**	
						Implementation	**Supervision**
Aquatic Ecology- Removal of benthic communities, increasing underwater noise levels, increasing sediments/turbidity, release of locked pollutants in sediment, disposal of dredged material, increasing depth	• Dredging plan including timeframe should be prepared for each stretch prior initiating dredging activity. No dredging should be undertaken within VGDS, Turtle sanctuary. No dredging shall be carried out in winter season (November to February) along Mokama Taal to minimize impact on aquatic species and avifauna. • Dredging operations should not be carried out during the breeding and spawning season of the valued aquatic	Wildlife Protection Act, 1972 & 1993 and Bio-diversity Act, 2002	Within River	During Dredging	Part of Project Cost (IWAI & Contractor)	Contractor	IWAI/PMU/PMC

	species which is from June to August (Monsoon season). Bends and meandering locations are the most potential breeding grounds and are indicated at Figure No. 4.41 to 4.45. • Dredging if required to be taken at critical stretches (Turtle and Dolphin Sanctuaries) as mention above then dredgers should be provided with turtle and Dolphin deflectors. This would prevent the sucking of the animals (fish or turtle) swimming nearby. But such dredgers are inefficient and costly. • Measures like provision of bubble curtains or creation of agitation in water should be carried out prior carrying out dredging operations so as to provide avoidance time and let the species move away from drudging point. and to prevent any injury/mortality. Dredging operations should be halted in case of sighting of aquatic mammal in adjoin locations. • Contractors should submit SOPs and action time chart with risk management plan prior to any dredging work. Dredging sub-contractor should follow the defined safety procedures to avoid accidents and spills, and IWAI should ensure that other vessel users are provided with adequate						

	information and instruction to avoid conflict with the dredgers.						
Avifauna (Migratory & water birds)	• Dredging operations should be restricted to day time only, i.e. 6:00 Am-10:00 Pm only to minimize noise impacts on the avifauna near Important Bird Areas listed at Table 4.32 and located close to river. • Dredgers should be equipped with the noise reduction/masking equipment to reduce the noise generation inside and outside water. Noise from dredgers can be reduced at source (dredger) by isolation of exhaust system, by keeping engine room doors shut and by shielding.	Wildlife Protection Act, 1972 & 1993 and Bio-diversity Act, 2002	Within River & bird areas along NW-1	During Dredging	Part of Project Cost (IWAI & Contractor)	Contractor	IWAI/PMU/PMC
3. Socio-Economic Environment							
Environmental Issue /Component	**Remedial Measure**	**Reference to laws and Contract Documents**	**Approximate Location**	**Time Frame**	**Indicative / Mitigation Cost**	**Institutional Responsibility**	
						Implementation	**Supervision**
Location of Socio-economic importance and socio-economic environment	• Dredging operations should be restricted to day time only, i.e. 6:00 Am-10:00 Pm only to minimize noise impacts on the residents of nearby settlements. Dredgers should be equipped with the noise reduction/masking equipment to reduce the noise generation • Dredgers should be placed in consultation with the fishermen so as to minimize	--	Area near the dredging operations and dredging locations	During dredging operation	Part of project cost (IWAI/Contractor)	Contractor	IWAI/PMU/PMC

	the impact on their equipment/gears and their fishing activities • Dredging should not be carried out in the areas close to Ghats in Varanasi and buffer of 2 km should be maintained for dredging during time of religious gatherings during Chat and Kumbh festivals. • In case contaminated dredged material is disposed on land, then it should be disposed at approved TSDF sites to prevent any harm to community residing in nearby areas. One of such approved TSDF site is located Sagar (Haldia Dock Complex site) • Material to be disposed on land may create nuisance odour due to exposure of anaerobic sediments with air. Thus if land disposal is involved than disposal site should not be in upwind direction of any settlement area or sensitive locations like hospitals, schools etc. • Log book should be maintained for recording the accidents at site/mortality of the any marine mammal should be maintained. Analysis shall be carried out to assess the reason for the accident/mortality and measures should be taken to prevent repetition of the event. • Contractors having experience of dredging and						

	well trained staff should only be allowed to carry out dredging. This will help in prevention of spillage of dredged material or any accidents during the dredging operations • Dredging plan should be prepared by contractor and submitted to IWAI for approval prior to carrying out dredging operations. Dredging plan should be reviewed considering its location w.r.t environmental sensitive locations/archaeological locations/cultural festival/pollution influx in the area/dredged material quality & texture/available depth etc. as given in this EIA report and through local sources and past experience. • Contractors should submit method statement & risk assessment plan prior to carrying out any dredging work. Dredger should follow the defined safety procedures to avoid accidents and spills, and IWAI should ensure that other vessel users are provided with adequate information and instruction to avoid conflict with the dredgers. • Post-dredging monitoring of the sediment nature, rate of sedimentation shall be made part of contractor's job as best dredging practise. This						

	will provide information which can be taken into consideration before the next maintenance dredge is carried out. • Re-use of dredged material should be explored if dredged material is not contaminated. Economically and environmentally feasible options can be adopted to minimize the dredge spoil burdens. Some of such measures include • Dredged sediment can be used for beach nourishment/development of artificial beach/deposition on shoal & thus enrichment of habitat o Dredged material can be explored for its usage for coast/bank protection purpose/flood protection o Use of dredged material can be explored for land filling, as construction material for road foundations, dikes, mounds, noise/wind barriers.						

Table 7.3 : Environmental Management Plan for Barge Movement

Environmental Issue /Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
1. Physical Environment							

Water Quality	• All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only. Standards for discharge of wastewater & garbage from barges is attached as Annexure 5.2 & 5.3. • Material having potential to generate the dust like coal, sand stone aggregates should be transported under covered conditions to minimize dust generation and its settlement on river surface. Terminals should have facility to control dust pollution during barge loading and unloading actions. • Provision of oil water interceptors with the bilge tank to separate oil prior discharge of bilge water into river. Bilge water should be discharged as per MARPOL requirements. Bilge water tank should be maintained as per MARPOL requirement. Standards for discharge of oily waste is attached as Annexure 5.4 • Usage of non-toxic and non TBT containing anti-fouling paints for painting vessel • Immediate/quick clean-up of oil/other spills shall be undertaken in case of accidental release and ship owners should be liable for the same. • Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible • IWAI should develop the stringent norms to be followed by vessel operators and shall develop the system of penalizing based on polluters pay principle in case the standards are not met or violated • Ship design (of capacity > 5000 DWT) should be as per MARPOL and should be provided with double hulls/double bottoms. Speed of oil carrying vessels should be maintained to prevent accidents due to high speed. • Vessels should not be washed or cleaned	Water Act, 1974	Within River & at terminal/jetty location	During Barge Movement	Cost to be borne by vessel owner	Barge owner	IWAI

	at terminal/jetty facility and washings should not be discharge at the terminal/jetty location. Standards for discharge of washing water as per MARPOL is given in Annexure 5.5.						
Erosion of River Banks/ Bed	• Restricting the ship speed in the stretches where river is narrow and in feeder canal to prevent impact on the river banks. • Regularizing the barge speed to 7-8 knots in bending areas so as bank erosion can be reduced • River bank protection works should be carried out at the bank locations which are prone to erosion. Opt for the bank protection measures in feeder canal to maintain the speed of the barges. • Provision of cautionary signage at the navigational hazard locations	--	At Banks	During Barge Movement	Part of Maintenance cost of project	Barge owner/IWAI	IWAI
Air Quality	• Material having potential to generate the dust like coal, sand stone aggregates should be transported under covered conditions. • Air emissions from the vessel should be under the prescribed limits as per MARPOL and the standards. (Refer Annexure 5.6 for standards). Regular maintenance of vessels engine and Propellers. IWAI should develop the stringent norms to be followed by vessel operators and shall develop the system of penalizing based on polluters pay principle in case the standards are not met or violated • Adoption of cleaner fuels such as low sulphur bunker oil as per USEPA norms, 2000 (sulphur content is 0.25% for diesel oil and 2.7% for residual oil) or switching to LNG based vessels	Air Act, 1981	Areas along the NW-1	During Barge Movement	Cost to be borne by vessel owner	Barge owner	IWAI
2. Biological Environment							
Environmental Issue /Component	**Remedial Measure**	**Reference to laws and Contract Documents**	**Approximate Location**	**Time Frame**	**Indicative / Mitigation Cost**	**Institutional Responsibility**	
						Implementation	**Supervision**

Aquatic ecology-due to collision with moving barges, ballast water discharges, spillage of material/oil & generation of underwater noise	• Vessel speed shall be restricted to 2.7 knots in VSDS and Kashi turtle sanctuary areas to reduce the noise generation from propeller. Hooting should also be prohibited in sanctuary areas. • Vessel shall be fitted with the dolphin reflectors • Usage of non-toxic and non TBT containing anti-fouling paints for painting vessel • Provision of propeller guards with vessel to minimize injury to the aquatic fauna • Barge/vessel movement will be restricted to the designate route only over the Sanctuary area to minimize noise disturbance of Aquatic life. • If any aquatic mammal spotted, then the measures should be taken to push it away through sirens/signals and creating noise signals. • If any accident of aquatic mammal occurs, then that should be reported to IWAI for rescue action through wild life or forests departments. • All vessels should follow MARPOL for managing their liquid and solid waste. No vessel should discharge the liquid and solid waste in the river. All waste shall be discharged at vessel repair facility only. IWAI should develop the stringent norms to be followed by vessel operators and shall develop the system of penalizing based on polluters pay principle in case the standards are not met or violated • Material having potential to generate the dust like coal, sand	Wildlife Protection Act, 1972 & 1993 and Bio-diversity Act, 2002	Within River	During Barge Movement	Cost to be borne by vessel owner &Part of Maintenance cost of project	Barge Owners/IWAI	IWAI

	stone aggregates should be transported under covered conditions to minimize dust generation and its settlement on river surface. • Provision of oil water interceptors with the bilge tank to separate oil prior discharge of bilge water into river. Bilge water should be discharged as per MARPOL requirements. Bilge water tank should be maintained as per MARPOL requirement. • Immediate/quick clean-up of oil/other spills to prevent damage on aquatic organisms shall be undertaken and ship owners should be liable for the same. Facilities should be made to ensure quick rescue and clean-up operations in case of accidents • Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible • Regular maintenance of vessels engine and Propellers. • River training works should be carried out at the bank locations which are prone to erosion to minimize sedimentation & impact on water quality &aquatic organisms • Adequate depth to be maintained to prevent grounding under low flow conditions. Information on available depths should be conveyed to the navigators through online systems by IWAI. River Information System being developed by IWAI will serve this purpose.						

	• Maintaining flood plains & riparian corridors wherever possible and limit potential damage to the navigation channel. Restricting the project activities in breeding and spawning ground of the fisheries which are majorly the bends in the meandering river. • Design measures like bandalling and design of groin should be considered which can reduce the dredging requirement and help in meeting depth, width and steerage needs and reduces dredging requirement • Modern design vessels having low draught say 2 m instead of 2.5 m for equal payload should be procured by IWAI for transportation. Modern vessel-better technology vessels or with retrofits with quieting techniques to reduce further the noise emissions (specifically cavitation noise). • Regular patrol and inspections should be carried out to monitor the activities in waterway. Also regular monitoring of environmental attributes as proposed in environment planning plan of this should be carried out for the waterway to keep track of the condition of the environmental attributes • Enhancement Measures: • Support for promoting fish productivity through setting up or supporting existing fish nurseries. Also providing training and awareness support through reputed institutes or experts like CIFRI for better fishing techniques. • Provision of supporting Studies for						

	conservation of Dolphin and other sensitive studies shall be made.						
3. Socio-Economic Environment							
Environmental Issue /Component	**Remedial Measure**	**Reference to laws and Contract Documents**	**Approximate Location**	**Time Frame**	**Indicative / Mitigation Cost**	**Institutional Responsibility**	
						Implementation	**Supervision**
Health & Safety	• Record of the accidents should be maintained regularly by IWAI, analysis of each accident should be carried out by IWAI to know the reason for accident and preventions should be undertaken so as not to repeat the same cause • Adoption of SOLAS for maintaining the safety in vessel. Safety equipment, safety boats, lights, signalling system etc. should be as per the requirement of SOLAS • Provision of storm shelters and other infrastructure should be provided for vessel in waterways to manage the severe weather conditions like storms, floods. • Minimum passing distance between vessel and from vessel to the banks must be ensured for safe traffic conditions • Establishment of signalling system and patrol services by IWAI • Vessels licensed by IWAI and meeting the specified norms by IWAI shall only be allowed to ply in the waterway • Regular echo-soundings to be carried out by IWAI to identify LAD in different stretches and draw Thalweg profiles of various stretches. This information should be made available to the users through online system • Proper River information system, electronic charts display system, vessel tracking system automatic information	--	In River	During Barge Movement	Cost to be borne by vessel owner &Part of Maintenance cost of project	Barge Owners/IWAI	IWAI

	system etc. should be developed by IWAI for its users. RIS system is already developed by IWAI for Haldia to Farakka stretch and RIS system implementation is under process for Farakka to Patna. Work for Patna to Varanasi is also under consideration. Installation of DGPS for maintaining positioning and communication system. This is already in place for NW-1 • Maintenance of buoys, beacons, signs, gauges & limiting the shoals through maintenance dredging. Marking of navigation channel through beacons and communicating information about the navigation channel monthly to fishermen and the expected timing or frequency of barges to fishing community so as they can be pre-informed and he damage to their boats and gears can be reduced. Barge movement schedule should be prepared in advance and should be shared with the fishermen • Carrying out river training works at critical bend locations and provision of cautionary signage at the navigational hazard locations. Provision of Radar navigation during night time and low visibility timing • Installation of navigation lights to make channel visible and painting beacons & bays with refractive paints for enhancing night time visibility • A direct investigation of accidents through an interactive system may serve the purpose of both developing an authentic and reliable accident database and updating the current faults • Sensors and hooters should be fitted with vessel which can notify the closeness of another ship or any other potential matter which can cause accident.						

	• Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the accidents to happen as much as possible • Enhancement of fishing in the area by boosting and funding fish nurseries and provision of better fishing aids • There should be 24 hourly functional dedicated disaster management cells/ control rooms established along the waterway for monitoring movement of barges and to deal with emergencies. • Provision of backup medical facility for rescue operations. This can be arranged through tie up with hospitals located along the NW-1						
Impact on resources of socio-cultural aspects	• Vessel movement shall be restricted or regularise during the identified major festival period as listed under description of Environment chapter 4. • No waste in form shall be discharged by vessel in the river. • Enhancement Measures • Support for establishment of small enclosed areas dedicated for female bathing in every village along the NW-1 to allow female maintain their privacy. • Support for improving cleanliness and at existing Ghats at Varanasi and other locations • Provision for improving select Ghats as per the demand raised during public consultation.	--	Ghats, festival locations and river	During Barge Movement	Cost to be borne by vessel owner &Part of Maintenance cost of project	Barge Owners/IWAI	IWAI
Impact on Livelihood of Fishing Communities	• Barge/vessel movement will be restricted to the designate navigation route only. Maintenance of buoys, beacons, signs, gauges to mark the navigation channel • Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the damage to fishing gears and boats. • Marking of navigation channel through	--	Fishing areas and navigation channel	During Barge Movement	Cost to be borne by vessel owner &Part of Maintenance cost of project	Barge Owners/IWAI	IWAI

	beacons and communicating information about the navigation channel monthly to fishermen and the expected timing or frequency of barges to fishing community so as they can be pre-informed and the damage to their boats and gears can be reduced. Barge movement schedule should be prepared in advance and should be shared with the fishermen • Regularizing the barge speed to 7-8 knots in bending areas so as bank erosion can be reduced due to barge movement resulting in lesser turbidity, enhanced planktonic growth and thus increased fish yield. • River training works should be carried out at the bank locations which are prone to erosion to reduce the turbidity in shallow areas and its impact on fish yield. • All measures to reduce the water quality pollution & to prevent damage to ecology due to barge movement as proposed above should be adequately addressed and implemented so as to minimise impact on fish yield due to the project. • In case of damage of fishing nets, fishing crafts and other gears of fishers, arising due to barge operation, appropriate and quick compensations may be given to the aggrieved fishers. • The barges may be fitted with powerful searchlight and may sound horn so that fishermen can realize arrival of barge at least from 500 m-1 km away to prevent damage to fishing nets • Regular consultations to be carried out with the fishing communities to get their feedback on the impact due to barge movement on fishing and problems they are facing						

	Enhancement Measures • Support shall be extended in terms of supporting setting up fish nurseries for improving fish productivity and training awareness of fishermen for better fishing techniques through institute of repute like CIFRI.						

Table 7.4 : Environmental Management Plan for Terminal & Lock Sites and River Training/Bank Protection Sites (Design & Construction Phase)

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
1. Climate							
❖ Project is unlikely to cause negative effect on climate due to civil interventions However, project can contribute positively for climate	• Planning and design of the project layout should be done so as to minimize the clearance of existing vegetation and felling of trees • Permission from DFO should be taken prior undertaking any tree cutting. Compensatory plantation should be carried out as per state forest policy. Apart from compensatory plantation additional plantation should also be carried out so to recover the C sequestration earlier. Considering average life cycle of trees as 30 years, the number of trees to be planted against loss should be 30 times to recover in one year, but, it is not feasible practically, thus ratio of compensatory plantation should be kept as much as possible. In case of Sahibganj terminal project, compensatory plantation will be carried out in ratio of 1:7 (1:2-mandatory & 1:5 additional). Thus 3500 trees (1000-mandatory & 25000-additional) will be planted in place of 500 trees cut. Plantation of additional 2500 will help in recovering 5-6 years in place of 67-7 year • In terms of Carbon value, trees of high Organic Carbon contents[75] need to be planted more for faster recovery of C loss. • Project design should incorporate usage of low embodied energy building &	Kyoto Protocol, National Water Policy, 2012, Forest Conservation Rules & National Forest Policy	Construction site	During Design, and construction stage.	Compensatory /Additional Plantation (@ Rs 500 per tree) by contractor	Contractor	IWAI/PMU/PMC[76]

[75] Mid-term and long-term rotational species like Jamun and Aam (Mango) are referred. These are species with life span ranging from 20 to 100 years approximately

[76] It is proposed to set up Project Unit (PMU) in IWAI to manager social and environmental aspect of NW1 augmentation. PMC (Project Management Consultants) anticipated to be appointed for project management and quality check.

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	construction material, energy efficient electric equipment, water conservation fixture, rain water harvesting approach etc. to make project energy efficient and sustainable and to minimize the associated emissions and discharges/pollutants • Minimizing the resource requirement and waste generation through best management practices like re-use, reduce, recycle and recover. **Sahibganj Terminal** • Compensatory plantation should be carried out in ratio of 1:7 (1:2-mandatory & 1:5-additional). 3500 trees to be planted in place of 500 trees to be cut						
2. Natural & Man-made Hazard							
❖ Earthquake-Seismic Zone – III & IV damage risk zone[77] ❖ Risk of flood& Cyclones (cyclone risk at	• Sstructure design of the building should be prepared considering the seismicity of the area and building should be designed for one higher seismic zone. • All structures should be designed above the HFL of the river for 50 years return flood period minimum • Fire-fighting facility should be provided at	NBC, 2005, local building bye laws, state factory rules, Petroleum Rules and MSIHC Rules, 1989	Construction site& Navigation Channel	During Design and construction stage.	Part of Project Costs	Contractor	IWAI/PMU/PMC

[77] *IS:1893 (Part 1): 2002 Indian Standard Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings Fifth Revision divides the Indian subcontinent*

into five seismic zones (II to V) depending on the magnitude and damage intensity of seismic activity.

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
Haldia terminal site only) ❖ Risks of Occupational hazards & fire	each site • Mock drills should be conducted for the workers to handle emergency situations like floods, earthquake, cyclones etc. • Emergency response cell should be developed for each site to take care and handle the expected emergency situation • Emergency collection area and emergency control room should be provided at the site. Display of emergency contact nos. should be made in the emergency room and at other site locations. Emergency cell should comprise of personnel well trained in health & safety management at sites • Fuel should be stored in isolated location in HDPE tanks only and fire-fighting facility should be provided at the fuel storage location also • Entry to high risk area like electrical panels, control room, HT lines, fuel storage area should be restricted only for authorized & trained personnel • Availability of the first aid facility & ambulance facility at each site • Tie-ups with the local hospitals of the area to handle the emergency situations • Regular supervision for adequacy and intactness of the flood control measures provided at the site • Nearest cyclone shelter should be notified to all the workers at the site • Regular health check-ups should be conducted for the workers at site to detect the occupational hazards						
3. Site Preparation: Levelling Terminal Site, Construction Camp, Construction Works							
❖ Levelling of project site &Removal of	• Tree cutting should be carried out only after obtaining NOC from forest department and conditions given in NOC should be complied	Municipal Solid Wastes (Management and	Construction site	During design and Construction	Part of Project Costs	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
vegetation	with • Excavation and filling operations should be carried out in parallel so as to minimize the soil erosion • Compaction of soil shall be undertaken by sprinkling the water to minimize the erosion • Water sprinkling to be carried out for dust suppression • Top soil (15 cm) should be stripped wherever excavation will be undertaken and will be preserved under covered conditions for landscaping purpose in later stage. This should be stored in the form of the heap with the slide slopes covered with grass. Remaining excavated soil should be used within the site for filling purpose to the extent possible. Excess soil should either be used for approach & internal road construction or construction of railway embankment as per the requirement at site. • Dredge soil shall also be either utilised for construction activity or disposed along with excess excavated soil to the identified debris disposal site • Compensatory plantation should be carried out as per the details given under climate section above • Green belt should be developed at the site as per the Green Belt Management Plan (**Annexure 7.1**) • Survival rate of trees should be regularly monitored. It is should be minimum 70%. • Work timings should be restricted from 6:00 AM to 10:00 PM. Adequate illumination should be provided at site during evening hours • Rest area should be provided for workers at site and sleeping/lying down at site should be strictly prohibited to prevent accidents	Handling) Rules, 2015 Hazardous Waste (Management, Handling & Transboundary) Rules, 2008 C & D Waste Management Rules, 2016 Forest (Conservation) Act Social Impact Assessment requirements		Stage			

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• Develop and obtain approval from IWAI for occupational health & safety management. The plan should follow safety guidelines as given at **Annexure 7.2** and other tools such as OSHAS 18001 • Movement of construction vehicles shall be restricted to the designated haulage roads only to prevent compaction of soil in other areas • The earth stockpiles to be provided with gentle slopes to prevent soil erosion. • Sedimentation tanks shall be provided with storm water drain to arrest the sediments and these sediments shall be removed and stored with remaining excavated soil **Solid Waste Management:** • Arrangement should be made for segregation of waste into recyclable and non-recyclable waste • Non-recyclable waste generated should be disposed regularly through authorized agency. Recyclable waste should be sold to authorized vendors. • Construction waste generated should be segregated at site into recyclable, reusable & rejected fraction. Recyclable should be sold to authorized vendor, reusable waste should be stored at site for usage and rejected fraction should be disposed at designated sites by the municipal authority • If no debris or waste disposal site exists in the area then a site should be identified for debris disposal, should be approved by IWAI and should be used & manage for the same as per the Debris Management Plan **(Annexure 7.3)** • Waste oil generated from construction machinery should be stored on concrete platform and disposed to authorized						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	recyclers. **Sahibganj Terminal Site** • (2.1 lakhs cum to be used for filling &levelling) and remaining (11.0 lakhs cum) should be used for construction of the approach road, railway track and rehabilitation of the mines located about 4-5 km from the terminal site • The soil storage location shall be identified in advance in consultation with PWD which is likely to construct the approach road. • Shore protection works like stone pitching along the bank and construction of stone apron in the river to prevent the scouring of banks shall be undertaken • Bio-turfing of embankments shall be made enhance the slop stabilization • Site preparation would require cutting of app. trees which should be undertaken only after obtaining permission from forest department for tree felling **Haldia Terminal Site** • Site is low-lying and requires filling of 3.3 lakhs cum to achieve finished level above HFL of river. Soil should preferably be taken from waste/barren land. • Monitoring of existing shore protection works carried out by Haldia Dock Complex should be done **Varanasi Terminal Site** • Stone pitching works should be carried out in upstream and downstream of the terminal site to prevent bank erosion (35 m D/s & 117 m U/s) • Excess soil from the site should be used for construction of approach road to site **Farakka Lock Site** • Excess soil of 7.63 lakhs cum from the site should be re-used for realignment of road to						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	the extent possible and remaining should be disposed within 5 km from the project site						
❖ Setting of Labour Camps: Loss of agriculture land, contamination of land and water resources from municipal waste from Camps, worker's health, Pressure on natural resources due to establishment of labour camps	**Location of Camp:** • Construction camp siting, establishment, location and management should be as per proposed Construction & Labour Camp Management Plan **(Annexure 7.4)** • Labour camps should be located close to the construction sites to the extent possible **Sanitation and Worker's Health& Safety:** • Hygiene in the camps should be maintained by providing good sanitation and cleaning facilities. Soak Pits can be provided only if labour camp is located away from river. • Camp should be well ventilated. It should have adequate provision for illumination, kitchen and safe drinking water facility. Proper drainage to be maintained around the sites to avoid water logging leading to disease • Proper sanitation facility like toilet and bathing facility should be provided at site and labour camps. Wastewater generated from these facilities should be disposed through septic tanks and soak pit • Preventive medical care to be provided to workers • Segregated, collection and disposal of solid waste on regular basis at identified municipal solid waste disposal location. If municipal solid waste site not available than waste should be land fill following the regulations. • Provision should be made essential material supply like cooking fuel (gas) • Provision should be made for day crèche for children • First aid facilities, first aid room, first aid trained personnel and ambulance should be	The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and Cess Act of 1996 and The Water (Prevention & Control of Pollution) Act, 1974 and amendments thereof. Municipal Solid Wastes (Management and Handling) Rules, 2000 and manual 2014	Labour Camp Locations	During design and Construction Stage	Approximate Rs 5,00,000/- per camp for sanitation and health facilities.	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	provided at the site 24 X 7. Also tie-ups with local hospital should be done to handle emergency case, if any • Rest area should be provided at the site where labour can rest after lunch and should not lie on site anywhere • Working hours of labour should not exceed than standard norms as per state factory law • Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of mosquitoes. Septic tanks/soak pits should be provided for its disposal • Temporary storm water drainage system should also be provided at camp site and construction site so as to drain the storm water and prevent accumulation of storm water at site and thus breeding of mosquitoes/flies • Wash-off from concrete mixing tanks and wash from washing area shall not be allowed to enter the soil. This wash shall be collected through drains into tanks and concrete shall be settled, collected, dried and re-used in the site again						
❖ Setting up Batching Plant, Hot Mix Plant, Mechanical Workshop, Fuel storages, Lubricant storages	• All these facilities shall be installed at proposed project site itself if possible. In case these are to be set up away from site than these shall be located at minimum distance of 500 m from habitation, water bodies and 1000 m from forest areas. • All maintenance facilities, hot mix plant and concrete mixing plant shall be established with prior consent to establish to be obtained from SPCB. • All such equipment/plant shall be fitted with air pollution control system and shall comply with condition of consent to establish. • Periodic monitoring shall be carried as per	Air (Prevention and Control of Water Pollution) Act, 1981 and Water (Prevention and Control of Water Pollution) Act, 1974	Site construction Camp	During design and construction Stage	Approximate Rs 5,00,000/- per camp for waste management facilities.	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	consent conditions.						
4. Site Preparation: Power supply, Water Supply, and Drainage, disposal of piling muck and debris							
❖ Power supply and Energy Conservation: Air Pollution, energy loss	• Power shall be sourced from state power grid during construction stage as well • DG sets shall be used only in case of power failure. DG sets shall be enclosed in acoustic enclosures and shall be provided with stacks as per CPCB norms to discharge exhaust gases • Back-up power shall be set up with all provisions of containment for fuel leakages, air pollution control (stack height as per regulation) and with acoustic enclosure. • Solar energy shall be used in common lighting area on 1:2 basis. • Energy Conservation Building Code shall be used as applicable to various office and other structures.	Air Act, 1981 & Water Act, 1974	Construction Sites and Labour Camp Locations	During design and construction stage	Part of Project Costs	Contractor.	IWAI/PMU/PMC
❖ Water Supply, Drainage and effluent discharge	• Source can be municipal or private water tankers or ground water depending on the availability. All the three terminal sites fall under safe category except Haldia terminal site. Thus water source at Haldia site will be supply water. • Caution signage shall be placed at site for optimal use of water • Garland storm water temporary drains shall be provided around the excavated or activity area so as to divert rainfall run-off away from these locations. These pits shall be covered during rainy season to the extent possible. Excavation shall be avoided during monsoon season. • Storm water drains shall be connected to sedimentation tank for arresting the sediments before discharging into the river • All washing and maintenance effluent from the workshop area of vehicle maintenance	Central Ground Water Board, Water (Prevention and Control of Water Pollution) Act, 1974	Construction Sites and Labour Camp Locations	During design and construction stage	Approx. Rs 300,000 for construction of grease traps and de-siltation chambers	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	area should Drain to separate collection areas fitted with oil and grease trap and de-siltation chamber. The treated water shall be used for dust separation and green belt development. This water shall not be discharged to river at all. • Vehicle washing and maintenance workshops shall be located away from river • Rain water should be collected into temporary ponds which should be used for various construction activities and dust suppression.						
❖ Disposal of piling earth, muck and debris: uncontrolled disposal may lead to increased sedimentation of the river.	• Excavated soil should be used within the soil for backfilling, road/railway construction etc. to the extent possible. Remaining excavated soil should be disposed as per Debris management plan prepared for the project **(Annexure 7.3).** Surplus soil will be generated in case of Sahibganj terminal site (12.1 cum) & Farakka lock site (7.63 lakhs cum). At Sahibganj terminal site excess soil can also be used for restoration of mine pits located within distance of 5 km from site. • Provision shall be made for collection and draining of water for the piling earth. It shall be used for embankment protection or road construction depending on its suitability. • Piling earth or dredged soil shall not be disposed on the River bank as they are critical habitats especially during the breeding and spawning season (May-August). Dredged soil quantity in case of Sahibganj terminal is 1.5 lakhs cum and in case of Haldia terminal is 7 lakhs cum. • Provision shall be made for geo Synthetic Screen for arresting silt flowing down stream.	Solid Waste (Management & Handling) Rules, 2000 and Manual 2014	River Bank along the terminal	Pre-Construction and construction Stage	Part of Project Costs	Contractor.	IWAI/PMU/PMC
5. Embankment Design and Construction, Drainage Pattern							
❖ River Bank	• Provision of bank protection structures like	Water (Prevention	River banks	During design,	Part of	Contractor.	IWAI/PMU/P

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
Erosion Protection	stone pitching along the banks to prevent the bank erosion. Stone pitching is proposed to be carried out for bank protection at Varanasi terminal site and at Sahibganj terminal site. Adequate shore protection is carried out at Haldia terminal site. Apron of 40 m width is also provided at Sahibganj terminal site for prevention of bed scouring. Guide walls and stone pitching is proposed to be provided along the lock walls to prevent erosion during operational phase. • During stone pitching, the stone shall be dropped from suitable distance and shall not by drop from height to prevent injury or killing of aquatic species. Stones shall be placed by making grid in pitching area. • Erosion monitoring shall be carried out periodically downstream as well. • River Bed material/dredged soil shall be tested for toxicity before its use or disposal for land fill site. If any level of heavy metal contamination or toxicity is found than it shall be disposed in a secure manner to TSDF.	and Control of Water Pollution) Act, 1974	and River bed near the proposed terminal locations	Pre-Construction and construction Stage	Project Costs		MC
❖ Dredging activities: Impacts on dolphins, fishes, and benthic organisms	As part of the detailed engineering design report, the Contractor shall prepare a Dredging plan that will ensure no adverse impacts shall occur on the local biodiversity. The Dredging Plan shall comply with the following: • **Roles and Responsibilities**. Define roles and responsibilities for implementing and adhering to the commitments made within this Dredge Management Plan. • **Legislative Requirements and Guidelines**. All dredging and disposal of dredge material will be undertaken in compliance with relevant national and state	Part of EMP/Wild Life Protection Act, 1972	Location of off-shore construction of berths & jetties	During design and construction stage	Part of Project Costs	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	legislation. In case no standards exist, best international practice will apply. • **Studies on the existing Environment**: Contractor shall carry out supplementary EIA study including Key Environmental Sensitivities, Physical Freshwater Environment: Riverbed morphology and geology, Bathymetry, Hydrodynamics, Sediment quality. Fresh Water Quality: Physiochemical, Chemical, Sediment plume modelling. Biological freshwater Environment: Benthic Primary Producer Habitat, Freshwater Fauna. • **Dredging Environmental Impact Assessment and Management**: The Contractor shall prepare a supplementary EIA to establish potential impacts and its effective management in terms of key performance indicators, mitigation and monitoring measures on the: freshwater quality, benthic primary producer habitat (BPPH), freshwater fauna, dredge materials disposal and spoil ground management **The Dredging Plan shall highlight the following:** • Location of dredging sites must avoid key habitat areas such as breeding and feeding grounds etc. of key biodiversity species found in the project area such as dolphins etc. • The schedule or time of dredging must avoid breeding season of dolphins, fishes etc. • Decisions on method of dredging and type of technology and equipment to be used must consider the noise and vibration levels and extent of siltation being generated. Noise and vibration levels must						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	be far below levels that can cause injury to dolphins and other wildlife. The dredging space must include measures to contain silt or suspended solids to a minimum area within the river as excess siltation can hamper wildlife activities. • Appropriate protocols and procedures must be prepared for sighting of dolphins and other endangered wildlife species (migratory birds, reptiles etc.) within the vicinity of the dredging site. The objective of the protocols and procedures must be aimed at having no or minimal impacts on the respective wildlife species. • Dredged soil shall be tested for contamination and toxicity and accordingly shall be disposed • Dredged soil shall not be pilled on the River banks						
❖ Drainage Pattern	• Natural Drainage pattern of area around shall be maintained. • Storm water management drains shall be provided at site for management of storm water management		Construction Sites, Access road, and Labour Camp Locations	During construction stage	Part of Project Costs	Contractor.	IWAI/PMU/PMC
6. Construction Material Sourcing							
❖ Borrow areas for sourcing earth for filling as required (erosion, loss of productive land, land degradation, air pollution)	Filling of the site is required only in case of Haldia terminal site at present. App. 3.3 lakhs cum of sand is required which will be sourced from borrow areas within 20 km radius of terminal site. Borrow areas should be established as per the borrow area management plans attached as **Annexure 7.5.** Following guidelines should be followed for establishment and closure of borrow areas • Non-productive lands, barren lands, raised lands; wastelands shall be used for borrowing earth with the necessary	IRC Guidelines on borrow areas and for quarries. EIA Notification 2006(under Environmental Protection Act and Rules, 1986) and amendments	All Identified Borrow sites	During design and construction stage	Part of Project Costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	permissions/consents. • Agricultural areas not to be used as borrow areas unless requested by the landowner for lowering the land for making it cultivable. • Environmental Clearance from District/State Environmental Impact Assessment Authority under EIA Notification, 2006&amendments and required permission from District Magistrate shall be obtained prior to excavation. Copy of this permission shall be submitted to IWAI before start of excavation. • Record of location, area, accessibility to the location and photograph of borrow area should be maintained prior to excavation • Site selected for borrow area should be approved by PMC/PMU & IWAI expert prior to excavation • Ridges of not less than 8m width will be left at intervals not exceeding 300m. Small drains will be cut through the ridges, if necessary, to facilitate drainage. • The slope of the edges will be maintained not steeper than 1:4 (vertical: Horizontal). • Topsoil to be stockpiled and protected for use at the rehabilitation stage. • Rehabilitation shall be satisfactorily undertaken immediately after the use has ceased and at least three weeks prior to monsoon. • Unpaved surfaces used for the haulage of borrow materials to be maintained. • Transportation of earth materials shall be through covered vehicles. • Borrowing should be carried out within 20 km area of the project site so as to minimize the emission due to earth						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	transportation. Dredged soil and debris resulting from realignment of road should be used for the site filling to the extent possible.						
❖ Quarries for sourcing stone and aggregates (loss of productive land, land degradation, air pollution. Any illegal quarrying may lead to land use change, unstable rock formation)	• Aggregates required for construction of terminal/stone pitching works shall be sourced from nearby licensed quarries • It shall be ensured that selected quarries are having requisite environment clearance, and comply with Air Pollution Control and Noise level requirements as per the law. • Material shall be transported in covered vehicles only. • Each Quarry shall be visited prior to its selection to ensure its compliance with lease conditions, EC and consent conditions • In case new quarry is established, prior environment clearance for the same shall be obtained under EIA Notification, 2006 & amendments	EIA Notification 2006 (under Environmental Protection Act and Rules, 1986) and amendments & Air Act, 1981	Quarry Site	During design and construction stage	Part of Project Costs	Contractor	IWAI/PMU/PMC
7. Protection of Flora and Fauna							
❖ Protection of terrestrial flora & fauna	• Project layout design shall be in a way to minimize tree cutting • Permission shall be obtained from forest department prior tree cutting and only the identified and permitted tree shall be cut and remaining shall be maintained properly • Thick green belt shall be developed at the periphery and along the roads on the project site which will prevent spread of dust and reduce noise propagation. • Areas reserved for future development at site shall also be made green by growing grass and shrubs and herbs • Caution sign shall be placed to prevent hunting of animals	Wild Life (Protection) Act, 1972, Bio-diversity Conservation Act, 2002	Terminal site/construction camps site/plant site/other sites to be used temporarily for construction phase of project	During design and construction stage	Part of project costs	PMU through DFO	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• Provision shall be made for strict penalty for hunting/harming any animal • Construction activities shall be restricted to 6:00 Am-10:00 Pm especially noise generating activities. • Compensatory plantation should be carried out as per state forest policy • Green belt to be developed should be mainly naturally growing native species of the area. Green belt should be developed as per the CPCB guidelines proposed above climate section. • Survival rate for compensatory plantation and green belt to be developed at the site shall be monitored regularly and measures shall be taken so as to achieve minimum rate of 70% • All efforts shall be made to minimize the cutting of tree through design changes. Layout should be designed in a way so as to minimize the tree cutting. Only trees identified for cutting should be cut • Workers should not use any timber or firewood as fuel for any purpose. LPG should be made available to workers in construction camp. • Tree cutting should be carried out only after obtaining due tree cutting permission from forest department. • No hazardous material or waste shall be disposed in the other land or nearby area as it may harm the animals, if consumed accidently • Speed limit will be regulated to prevent any accidents of animals. Regular maintenance of the dumper shall be done to prevent leakage of oil so as to prevent pollution of the soil and impact on fauna and flora dependant on soil.						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• Regular Water Sprinkling shall be carried out to minimize dust generation and settling the dust on surface of flora. • Trees retained at the site (after site clearance) should not be disturbed, cut or harmed in anyway. These trees should be maintained. • Adequate parking space should be provided within the site for construction vehicle and equipment so as they are not parked in other areas like road side, others agricultural field, open areas etc. to avoid any harm to flora of that area due to movement of heavy vehicles. • Construction camps should not be established inside or near the forest area • Construction activities and vehicle washing should not be undertaken at the river or any other water body or close to the water body • Site should be barricaded to prevent entry of the animal in the site • Hunting, poaching and harming any animal (wild or domestic) by any worker or project related person should be strictly prohibited and monitored • Illumination at the night time should be reduced during the night time (if no activity is going on) as it may disturb the nocturnal animals • Noise generating activity should not be undertaken during night time to minimize disturbance to animals. Noise levels should be maintained within the prescribed CPCBs limits to the extent possible during the day time. • Workers should not use any timber or firewood as fuel for any purpose						
❖ Protection of	• The area in which the construction of the	Wild Life	Around	During design	Part of	PMU through	IWAI/PMU/P

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
Aquatic Fauna including Dolphins from high sound generation during piling	Berth (jetty) is planned, advisable to carefully determine drop sites before anchor placement to ensure that Dolphin and fish communities that could locally still be present in the area are not unnecessarily damaged. • Before starting piling / dredging allow some time to aquatic fauna to displace from the piling area. Bubble curtains can be provided at the time of pilling so as to displace the aquatic fauna prior start of construction activities • The piling/dredging activities must be carried out in shortest possible timeframe as possible • All the debris shall dispose away from river course as per debris management plan of the project. • Decisions on method of construction and type of technology and equipment to be used must consider the noise and vibration levels and extent of siltation being generated. Noise and vibration levels must be far below levels that can cause injury to dolphins and other aquatic life. • Noise reducing devices like mufflers, enclosures shall be fitted with the equipment as much as feasible. Erecting barriers shall also be installed • Fish exclusion devises shall be installed in water column around the pile driving area to prevent fish access • Geo Textile synthetic sheet curtain & turbidity traps shall be placed around pilling and construction area to prevent movement of sediments and construction waste	(Protection) Act, 1972, Bio-diversity Conservation Act, 2002	Pilling/dredging Area	and construction stage	project costs	DFO	MC
❖ Protection of Aquatic Fauna	• To avoid the construction debris wash or blown into the water the area shall be	Wild Life (Protection) Act,	Around Pilling	During design and	Part of project costs	PMU through DFO	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
including Turtles, Dolphins & other aquatic species from increased sedimentation in water body during piling & dredging and other construction activities	surrounded by silt screens, which must be placed in the water before the work starts. Geo-Textile synthetic sheet curtain can act silt screen which should be placed around pilling and construction area to prevent movement of sediments and construction waste. The screens should also be placed around storage areas, to prevent waste from blowing away and to prevent sediment run-off into the river. The storm water drain shall be connected to temporary sedimentation pit and collected water shall be used for dust suppression. Run-off from site should also pass through oil/grease traps and flow down to the same sedimentation tank before its reuse • In addition to silt screens, building guidelines of the Bonaire National Marine Park require that storage areas for sand and soil, and all work areas, must be at least 20 meters away from the high water mark and construction equipment must not be cleaned or washed within 50 meters of the high water mark. • Piling and dredging activities should be carried out rapidly. Piling should not be carried out during breeding and spawning season means during rainy season. It should be carried out in low water season, i.e. pre-monsoon • Piling/Dredging should be stopped for some time, if any dolphin/turtle/RET species is sighted in activity area • Equipment shall be maintained in good condition to prevent leaks or spills of potentially hazardous materials like hydraulic fluid, diesel, gasoline and other petroleum products • Excavation activities onshore should not	1972& Bio-diversity Conservation Act, 2002	&dredging area	construction stage			

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	be undertaken during monsoon season so as to minimize sediment load of run-off • Workers should be trained to handle the equipment and material at site so as to minimize the spillage of materials and contamination of water • All workers should be made aware of not throwing any waste in the river or any drain • No construction debris/ already accumulated solid waste at site or waste generated from labour camp should be thrown in river or any drain • Sewage generated from labour camp should not be directed into river but should be disposed through septic tank/soak pit • Aquatic ecology monitoring should be carried out prior start of construction and after completion of construction so as to assess the impact of construction activities on aquatic life. • Run-off from site should pass through oil/grease traps and sedimentation tank prior discharging into the river • All construction and operation equipment shall be maintained in good condition shall be checked for oil & grease leakage • Dredged soil shall not be disposed in river or its banks especially during breeding spawning seasons of aquatic organisms						
❖ Conservation of Dolphins	• Appropriate protocols and procedures must be prepared for sighting of dolphins in the construction zone. The objective of the protocols and procedures must be aimed at having no or minimal impacts on the dolphins. • No construction/dredging activity to be undertaken in turtle sanctuary	Wild Life (Protection) Act, 1972& VGDS Notification	Sanctuary area	During design and construction stage	Part of project Costs	IWAI	IWAI/PMU/PMC
8. Air Quality							

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
❖ Fugitive Dust Generation due to construction activities	• Barricading the site to prevent dust dispersion to nearby areas • Excavation and filling shall be carried out in parallel. Excavation and filling shall be carried out in phases • Excavated soil shall be stored under covered conditions • Transport of loose and fine materials through covered vehicles. • Loading and unloading of construction materials in covered area. • Approach roads shall be paved and widened. • Water spraying on earthworks, unpaved haulage roads, other dust prone areas and construction yard. Flow of water sprinklers shall be maintained to avoid water ponding • Make Provision of PPEs like face masks to workers. • Raw materials like cement, sand and construction debris should be stored under covered conditions • Wheel wash facility shall be provided at exit points of the site • Monitoring of air quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP • Development of green belt at the terminal & lock sites efficient for arresting the particulate matter • Thick green belt shall be developed as per the provision already made in the design and maintained all along the periphery and	Environmental Protection Act, 1986 and amendments thereof; The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereof	Construction sites, Loading areas, storage areas,	During the Construction phase	Part of project Costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	along the roads. The green belt shall be developed in canopy[78] shape with local species of broad leaf variety. • Species selected for development of green belt shall also be tolerant to expected pollutants and shall have the ability to adsorb the pollutants. Suggested species are suitable for different areas are also listed under CPCB guidelines for green Belt development[79]. • LPG should be used as fuel source in construction camps instead of wood. Tree cutting shall not be allowed for fuel wood. • Mixing Plant, crushers and batching plant shall be located on downwind direction of the site fitted with adequate stack height to ensure enough dispersion of exit gases. with appropriate pollution control measures • Loading and unloading of construction materials shall be made at designated locations in project area with provisions of water fogging around these locations • Low sulphur diesel should be used for operating DG sets, dredgers and construction equipment.						
❖ Exhaust gas emissions from machinery and vehicular traffic.	• Regular maintenance shall be carried out of machinery and equipment. • Periodic Ambient air quality monitoring shall be carried out. • DG sets to be fitted with stacks of adequate height and low sulphur diesel to be used in DG sets as well as in machineries. • Monitoring of air quality for PM_{10}, $PM_{2.5}$,	Environmental Protection Act, 1986 and amendments thereof; The Air (Prevention and Control of Pollution) Act, 1981	Construction camps and sites, batching plants, DG sets locations	During the Construction phase	Part of project Costs	Contractor	IWAI/PMU/PMC

[78]Canopy shape green belt design includes three row of trees with middle tree species gore more in height compared to inside and outside tree species. Each of tree will have wider leaf which forms like a curtain and acts as beerier to dust spread. Dust accumulated over leaf falls down within the site boundary. Similarly external dust gets prevented from entering the terminal site. http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

[79] CPCB guidelines for green Belt development http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	SO_x, NO_x, and CO shall be carried out quarterly at construction sire	and amendments thereof					
❖ Emissions at access road: avoidance of traffic Jams	• Efforts shall be made to transport construction material early morning and late evening period. • Traffic regulators (Guard) shall be posted in habitat area and at key junction areas to avoid congestion • No construction, material, equipment or vehicle shall be stored or parked at any road or the non-project area • Transportation vehicle shall strictly adhere to the designated routes and timings and shall avoid the peak traffic hours • Parking space for dumpers shall be provided within the site so as to prevent parking of vehicles on road and other area and thus preventing traffic jams	Environmental Protection Act, 1986 and amendments thereof; The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereof	Existing roads	During the Construction phase	Part of project Costs	Contractor	IWAI/PMU/PMC
9. Noise and Vibration							
❖ Noise from construction vehicle, equipment and machinery.	• All equipment to be timely serviced and properly maintained to minimize its operational noise. • Construction equipment and machinery to be fitted with silencers and maintained properly. • Barricading the construction site to minimize the noise level outside the site boundary • Protection devices (ear plugs or ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines. • Speed control shall be enforced in habitat areas. The ambient noise level as per standard is 55 dB(A) and 45 dB(A). Current level at habitat area meets the standard • Honking shall be prohibited at the project site • Hearing test for the workers shall be	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof	Construction & Plant site	During the Construction stage	Part of project Costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	undertaken before employing them and thereafter shall be done after every six months • Job rotations should be practiced for workers, working in high noise level areas • No noise generating activity shall be carried out between 6:00 AM to 10:00 PM. • Monitoring of Noise levels shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP						
10. Land-use and Landscape							
❖ Loss of agricultural land and productive top soil	• Agricultural land shall not be selected for setting up project, construction camps, borrow area (if any), plant site or any other construction purpose • 15 cm of top soil layer shall be stripped off prior to excavation and shall be stored separately in covered condition and used for landscaping purpose or shall be given to farmers in nearby areas, if required by them	Design requirement	Project site and area used temporarily during construction phase	During construction Stage	Part of project cost	Contractor	IWAI/PMU/PMC
❖ Soil erosion due to construction activities, earthwork	• The earth stockpiles to be provided with gentle slopes to prevent soil erosion. • Sedimentation tanks shall be provided with storm water drain to arrest the sediments and these sediments shall be removed and stored with remaining excavated soil • Provision of cross drainage structure like culverts shall be made in the access road if required to maintain the natural drainage pattern and prevent soil erosion. • Provision of side drain shall be made in access road if required to prevent water logging. • Shore protection works like stone pitching, andgeo-textile matting along the bank and construction of stone apron in the river to	Municipal Waste Rules, 2000 & Manual 2014, Hazardous Waste Rules, 2008	Construction site and river banks	During construction Stage	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	prevent the scouring of banks shall be undertaken as required to prevent erosions and scour (bank protection required in case of Sahibganj & Varanasi terminal in u/s & d/s of the terminal site and scour protection is required in case of Sahibganj site) • Bio-turfing of embankments shall be made enhance the slop stabilization						
• Compaction and contamination of soil due to movement of vehicles and equipment	• Excavation and filling operation should be carried out in parallel so as to minimize the soil erosion. Unusable debris material should be suitably disposed at pre designated disposal locations, with approval of the concerned authority. • Compaction of soil shall be undertaken by sprinkling the water to minimize the surface runoff and erosion. • Remaining excavated soil should be reused at site for filling/levelling/ road construction/railway construction/construction activities in nearby areas/restoration of mine pits (Sahibganj) as possible. • Remaining excavated soil should be send for the disposal at designated location or to debris disposal site as approved by IWAI • Fuel shall be stored in HDPE containers on paved surfaces with provision of catchment pit to prevent soil contamination from oil spillages. • Municipal waste likely to be generated at site shall be collected in segregated manner with the use of two bin system at site. It shall be segregated into biodegradable and non-biodegradable waste. Provision of bio composter shall be made at site. The biodegradable material shall be decomposed for production of compost for use at site. The non-biodegradable waste	Municipal Waste Rules, 2000 & Manual 2014, Hazardous Waste Rules, 2008	Construction site	During Design & Construction stage.	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	shall be disposed to predefined land fill site nearby. The land fill site shall have provision of liners to prevent leachate to ground. • Septic tank or mobile toilets fitted with anaerobic treatment facility shall be provided at construction camp • Aggregates will be sourced from existing licensed quarries. Copies of consent/ approval / rehabilitation plan for a new quarry or use of existing source will be obtained by DBOT contractor and submitted to IWAI. • Geometric adjustment shall be made if required and technically safe to minimize cutting of the tree. Provision shall be made for additional tree plantation as feasible along the road while finalizing the road alignment and rail alignment as proposed (Access road to be constructed at Sahibganj terminal & Varanasi terminal, realignment of road required at Farakka lock site and at Haldia terminal and Railway link to be provided at Sahibganj terminal site). • Hazardous waste like used oil from DG sets shall be stored in HDPE containers and shall be stored on paved surfaces in isolated location to prevent its spillage and contamination of soil. Used oil shall be disposed through authorized vendors only. • Movement of construction vehicles shall be restricted to the designated haulage roads only • Wash-off from concrete mixing tanks and wash from washing area shall not be allowed to enter the soil. This wash shall be collected through drains into tanks and concrete shall be settled, collected, dried and re-used in the site again.						
11. Water Resources							

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
❖ Depletion of Groundwater resources due to unregulated abstraction for construction purpose	• Preference shall be given to surface water from rivers wherever feasible with due permission from authorities. • Temporary rain water storage structures should be provided at the site to store rain water and this water should be used for sprinkling and construction activities • No dumping of waste/wastewater in the ground. Hazardous waste or wastewater shall not be stored in unlined ponds • Permission shall be obtained from irrigation department in case river water is used and from CGWA/CGWB in case ground water is used.	Water Act, 1972		During Construction stage	Part of project costs	Contractor,	IWAI/PMU/PMC
❖ Increase in water Siltation levels due to construction of terminal/river training works and contamination due to disposal of domestic waste/sewage	• Washing of vehicle and equipment shall not be carried out at river or any water body. Washing area should be provided with the storm water drains fitted with oil & grease trap. • Piling of the raw materials & debris shall be avoided at the site. Storage of debris and raw material shall be carried out in paved and covered areas. This will minimize interface of run-off with raw material and debris. • Site should be cleaned regularly • Septic tank/soak pit shall be provided at site for disposal of sewage from the toilets at site and from the labour camps. Adequate toilets & bathrooms shall be provided to prevent open defecation. Wherever septic tanks are not provided mobile toilets with anaerobic digestion facility shall be provided and no domestic waste shall be discharged to river. • Water use shall be minimized by using RMC, practicing curing by water sprinkling, maintaining flow of sprinklers, covering the water storage tanks to minimize water evaporation, creating awareness for water	Water Act, 1972	Construction Site	During Construction stage	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	conservation and regular inspections at site to monitor the leakages in water storage area • In case RMC is not used then concrete transit mixer should be washed and cleaned daily. Wash from these mixers shall be collected in block work tanks which will allow settling of concrete, removal of aggregates and allowing the waste to wastewater drain. This collected waste concrete can be dried and used for various purpose at site like construction of temporary roads at site and labour colony • Wastewater generated from the washing/cleaning area after passing through oil & grease trap & curing area shall be re-used for water sprinkling and wheel washing • Fuel shall be stored in leak proof containers and containers shall be placed on paved surface Substructure construction should be limited to the dry season and cofferdams may be constructed and utilized to lift the spoil directly out of it and carried to the riverbank for land disposal. • Restoration of changes in the stream, if any, made during construction to its original level • The piling work in river shall be undertaken during low flow period. • Provision shall be made for collection and draining of water for the piling earth. It shall be used for embankment protection or road construction depending on its suitability. • Turbidity traps/curtains should be provided or Geo-Textile synthetic sheet curtain shall be placed around pilling and construction area to prevent movement of sediments and construction waste. • Sedimentation tanks shall be provided at the site so as run-off from site shall enter the						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	sedimentation tanks before discharging into the river. Sedimentation tanks will trap the sediments in the run-off • Provision shall be made for geo Synthetic Screen for arresting silt flowing down stream. • Proper collection, management and disposal of construction and municipal waste from site shall be made to prevent mixing of the waste in run-off and entering the water bodies • Natural Drainage pattern of area around shall be maintained • Dredged soil shall be tested for toxicity & contamination, if toxic/contaminated shall not be disposed back in water and should be send for disposal to TSDF • Monitoring of surface water quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP						
12. Accident and Safety Risks							
❖ Impact on Social life	• Separate SIA is being carried out and RAP and other social measures should be proposed under SIA and same should be followed. • R & R issues to be settled prior start of construction at site. People have sentiments associated with River Ganga so relocation as required in case of Sahibganj terminal site should also be given to people near River only • Skill training and assistance should be given to people so as they can get other jobs or get into other business. NGOs should be hired for this purpose. Employment should be given to both women & men and preferably to local people						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• Small loans should be given to the farmers losing the land and wishing to start new business (Sahibganj terminal site) • Infrastructure development in form of small school, hospital, and library can be undertaken in the village as compensation to the disturbance caused • Any common property resources, if removed should be relocated to the other location (should be a private land) as soon as it is removed and location should be acceptable to the local people • Site should be barricaded and should have entry guarded by security guard. Register should be maintained for entry of outsiders. No unauthorized person should be allowed to enter the site especially village children • A board should be displayed at entrance of site displaying name of project, area and hazards associated with the site on entrance and activities prohibited within and near site area in local language • Non-productive lands, barren lands, raised lands; wastelands should be used for setting up labour camps, plant sites and debris disposal site. Agricultural land should be avoided. Land should be used for establishment of construction camps, debris disposal site and plant site only after obtaining consent from land owner. • Consultations to be done with fishermen prior start of any activity at bank/ in river to avoid any conflicts. Fishermen should be consulted prior restricting fishing activity in the activity area • Care should be taken that fishing gears and the equipment should not be impacted due to construction activities at site • Necessary permits should be obtained from						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	concerned authorities in case any batching plant, and hot mix plant. is set up at site. • All these facilities shall be installed at proposed project site itself if possible. In case these are to be set up away from site than these shall be located at minimum distance of 500 m from habitation, water bodies and 1000 m from forest areas. • Management, rehabilitation and closure of these sites should be as per the Management plans proposed for these sites. Records for starting, maintaining and closure should be maintained and should be approved by site engineers • Implementation of EMP adequately so as to prevent environmental pollution and its impact on socio-economy due to project development						
❖ Accident risk from construction activities and health & safety of workers	• Adequate illumination should be provided at site during evening and night time till the work is being carried out • Rest area should be provided at site in which workers can rest after the lunch hours • Workers should wear the personal protective equipment like helmet, gum boots, safety shoes, safety jackets, ear plugs, gloves etc. while working • Noise level in the work zone should be maintained and followed as per OSHAS norms • Contractors should adopt and maintain safe working practices. SOPs should be prepared for each and every activity and all activities should be undertaken as per SOPs under supervision of site engineer • Training should be given to workers to handle the heavy equipment so as to prevent accidents • Training should be given to workers to	Central Motor and Vehicle Act 1988 EP Act 1986 Noise Rules 2002	Construction sites	Construction period	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	handle emergency situation like fire, earth quake and flood • Emergency preparedness plan should be available at the site all the time and mock drills for workers should be conducted from time to time • Complete medical check-up should be done for workers prior to joining and after six months of joining • First aid facilities, first aid room, first aid trained personnel and ambulance should be provided at the site 24 X 7. Also tie-ups with local hospital should be done to handle emergency case, if any • List of emergency nos., hospital contacts, ambulance contacts and doctors contacts should be displayed in first aid room, rest area and at all required location • Working hours of labour should not exceed than standard norms as per state factory law • Labour camps should be located at neat and clean location with no water logging issues and should be well ventilated with adequate illumination, kitchen and safe drinking water facility • Construction labour camps and site should be properly cleaned and hygiene should be maintained • Proper sanitation facility like toilet and bathing facility should be provided at site and labour camps. Wastewater generated from these facilities should be disposed through septic tanks and soak pit • LPG should be provided as fuel for cooking to workers and open burning of fuel should not be allowed • Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	mosquitoes. Septic tanks/soak pits should be provided for its disposal • Temporary storm water drainage system should also be provided at camp site and construction site so as to drain the storm water and prevent accumulation of storm water at site and thus breeding of mosquitoes/flies • Safety officers should be appointed at site so as to ensure all safety measures are taken at the site • All construction workers should be provided with personal protective equipment like helmet, gloves, gumboots, safety jackets etc. and fines should be imposed if found not wearing • Job rotation should be carried out for workers exposed to high noise and dust areas • Activity like smoking and consuming liquor should be prohibited at the site • Awareness on AIDS should be spread among the workers • Traffic manager should be present at the site all the time to manage incoming and outgoing traffic to prevent accidents • Crèche facility should be provided for kids if female workers are employed • Regular inspection for hygiene and safety in labour camps should be done • Provision of cautionary and guiding signage in local and English language indicating the hazard associated with the site & activities. Usage of fluorescent signage, in local language at the construction sites • Speed limit of vehicles should be restricted at site and on haulage roads to prevent any accidents and fines should be imposed on vehicles if same is not maintained. All						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	construction vehicles should follow the designated routes & timings only. • Construction vehicle movement should be restricted to non-peak hours, i.e. late evening (7-12:00 pm) only. Villagers should also be given intimation of these timings. • Noise level in the work zone should be maintained and followed as per OSHA norm • Employment should be provided preferable to local & affected people • Dustbins should be provided at labour camps for collection of waste and waste should be regularly disposed through the concerned agency • Arrangement of fire-fighting should be made at site and workers should be trained to use the system in case of fire • Site should be barricaded and should have entry guarded by security guard. Register should be maintained for entry of outsiders. No unauthorized person should be allowed to enter the site especially village children • A board should be displayed at entrance of site displaying name of project, area and hazards associated with the site on entrance and activities prohibited within and near site area in local language • All construction vehicles should be regularly serviced and maintained and carry pollution under control certificate • All proposed environmental pollution measures should be taken during construction of phase of terminal to minimize the harm to existing environmental quality of the area, which is being enjoyed by the residents of that area • Maintenance and repair of the village road should be carried out both before and end of construction by contractor.						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• Sprinkling of water should be carried out in village road also, so as to minimize dust generation due to movement of construction vehicles.						
❖ Shifting of community properties and utilities	• Any CPR, if removed shall be relocated at the earliest with consent of the villagers and the Gram Panchayat to suitable location in consent with the villagers (preferably private land). A community temple would be required to be relocated in case of Sahibganj terminal site		Project Area	Pre-Construction	Part of Project Costs	Contractor	IWAI/PMU/PMC

Table 7.5 : Environmental Management Plan for Terminal & Lock Sites-Operation & Maintenance Phase

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
1. Climate								
1.1 Impact on Climate	• Management of the traffic carrying cargo to be received at the terminal/jetty site by fixing the hours and route of transportation • Development of adequate road/rail infrastructure for transportation of material to & fro from terminal/jetty site to minimize the emission generation due to traffic congestion • Usage of low sulphur diesel/CNG based vehicles to transport the material • Adoption of energy efficient machinery for material handling & barge loading to minimize energy consumption • Adoption of 4Rs, i.e. Reduce, Re-use, Recycle and Re-use • Ensuring survivability of the plantation within site and at other locations under Jal Marg Vikas project to minimum 70%. • Adoption of clean energy options like solar energy, designing building to obtain green building rating of Platinum level etc.	Kyoto Protocol, National Water Policy, 2012, Forest Conservation Rules & National Forest Policy	Terminal/ Lock site	Survival rate of trees and monitoring performance of energy conservation equipment	• Observations and inspection	Aftercare & Monitoring of Compensatory Plantation and green belt (@ Rs 100 per tree)	IWAI	IWAI
2. Bio-Diversity								

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
2.1 Dolphin Conservation	• Considering sensitivity of Dolphins, it is proposed to support Dolphin conservation activity. It is proposed to allocate a separate budget for this activity. This task may be undertaken through "The Vikramshila Biodiversity Research and Education Centre (VBREC)" together with the Whale and Dolphin Conservation Society (WDCS), the Environmental Biology Laboratory of Patna University, and T.M. Bhagalpur University, who has jointly initiated a project to improve the conservation value of Vikramshila Gangetic Dolphin Sanctuary.	Project Requirement/ Wild life Protection Act, 1972	Dolphin Existence Areas	Operation stage of project	• Site Observation • Discussion with local People • Collection information from Forestry Department	Included in Operation / Maintenancecost (@ INR10,00,000)	IWAI	IWAI
2.2 Turtle Conservation	• No construction/dredging activity to be undertaken in turtle sanctuary • It is proposed to allocate a separate budget for conservation of turtles. Fund can be given to Kashi turtle sanctuary for improving the facilities at turtle breeding centre. Purchasing the cages for turtle to be used for acclimatization in flowing river water,	Wild Life (Protection) Act, 1972 & Kashi turtle sanctuary Notification	Sanctuary area	Operation stage of project	• Site Observation • Discussion with local People • Collection information from Forestry Department	Included in Operation / Maintenancecost (@ INR10,00,000)	IWAI	IWAI/PMU/ PMC
3. Air Quality								
3.1 Air pollution due to due to vehicular	• Material shall be transported in covered vehicles	Environmental Protection	Terminal sites	MI: Ambient	• As per CPCB	Included in	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
movement& loading and unloading areas	• Transportation vehicle shall be properly serviced and maintain and shall carry PUC certificate • Thick green belt shall be developed as per the provision already made in the design and maintained all along the periphery and along the roads. The green belt shall be developed in canopy[80] shape with local species of broad leaf variety. • Species selected for development of green belt shall also be tolerant to expected pollutants and shall have the ability to adsorb the pollutants. Suggested species are suitable for different areas are also listed under CPCB guidelines for green Belt development[81]. • Water sprinkling should be carried out during all loading and unloading activities and storage period. • More frequent water sprinkling shall be carried out at coal yard during summer season to prevent	Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981	involving loading/unloading of material	air quality (PM_{10}, CO, SO_2 NO_x) PT: Levels are equal to or below baseline levels given in the EIA report	requirements • Site inspection	Operation / Maintenancecost		

[80] Canopy shape green belt design includes three row of trees with middle tree species gore more in height compared to inside and outside tree species. Each of tree will have wider leaf which forms like a curtain and acts as beerier to dust spread. Dust accumulated over leaf falls down within the site boundary. Similarly external dust gets prevented from entering the terminal site. http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

[81] CPCB guidelines for green Belt development http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	spontaneous fire. • It is recommended to provide mechanical conveying system with provision of dust collection system for loading/unloading material from barges • Monitoring of air quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP							
3. Land and Soil								
3.1 Soil erosion at embankment during heavy rainfall.	• Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching, river training structures etc. • Necessary measures to be followed wherever there are failures	Project requirement	Along river bank and embankment	MI: Existence of soil erosion sites Number of soil erosion sites PT: Zero or minimal occurrences of soil erosion	On site observation	Included in Operation / Maintenancecost	IWAI	IWAI
3.2 Soil contamination	• Fuel shall be stored in HDPE containers on paved surfaces only to prevent spillage of fuels on the soil and thus soil contamination • Dustbins shall be provided at all the required locations at the site for collection of	Project requirement	Terminal /lock site	MI: Existence of soil erosion sites Number of soil erosion	On site observation	Included in Operation / Maintenancecost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	recyclable and non-recyclable waste. Recyclable waste shall be sold to authorized vendors and non-recyclable waste shall be disposed through authorized agencies and shall not be dumped in open. • Used oil from DG sets and other equipment shall be stored in HDPE containers in isolated location on paved surfaces and shall be disposed through authorized vendors only and shall not be dumped in open. • Room shall be provided for storage of E-waste at site and this waste shall be sold to authorized vendors periodically and shall not be dumped in open. • Bio- medical waste likely to be generated at first aid centre shall be disposed of following the bio medical waste disposal rules • Dredged soil shall be tested for toxicity prior disposal, if toxic it shall not be disposed back in water and should be send for disposal to TSDF. Dredged soil shall not be dumped onto the terminal site or in open.			sites PT: Zero or minimal occurrences of soil erosion				
4. Water resources/Flooding and Inundation								

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
4.1 Siltation	• Regular checks shall be made for soil erosion along the banks and conditions of bank protection structures effective control.	Project requirement	Near surface Water bodies	MI: Water quality PT: No turbidity of surface water bodies due to the terminal activity	Site observation	Included in Operation/ Maintenance cost	IWAI	IWAI
4.2 Water logging due to blockage of drains, culverts or streams	• Regular visual checks and cleaning of drains shall be done along the alignment to ensure that flow of water is maintained through cross drains and other channels/streams. • Drains shall be regularly cleaned and de-silted • Monitoring of water borne diseases due to stagnant water bodies • Storm water drains provided in parking & road areas of the terminal & lock sites, shall be provided with oil & grease traps • Regular checks shall be made for soil erosion along the banks and conditions of bank protection structures effective control.	Project requirement	Near surface Water bodies	MI: Presence/ absence of water logging along the approach road/terminal PT: No record of overtopping/ Water logging	Site observation	Included in Operation/Maintenance cost	IWAI	IWAI
4.3 Waste Water treatment and	• Toilets to be provided with running water facility to prevent open defecation.	Project requirement	Project area	MI: proper treatment	Treatment parameter, ph, BOD,	Included in Operati	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
conservation	• Sewage generated at site should be treated in STP if sewage generation is more than 10 KLD as in case of Varanasi, Sahibganj & Haldia terminal sites and if sewage is less than 10 KLD, sewage can be disposed through septic tanks/soak pits as in case of Farakka lock site • Storm water drainage system should be provided at the site. Arrangement shall be made to collect the roof water from the building separately into a tank so as this water can be used for horticulture activity. Storm water from other areas like storage yards, stock piles and roads shall be directed into a dump pond. Storm water shall be retained in pond so as to allow the settling of dust and suspended particles in the water, this water should be used for cleaning and dust suppression. Sludge from the dump pond shall be sent for disposal along with other municipal waste • Water conservation fixtures shall be installed in toilets and kitchen area. Some of the water conservation			PT: treated water quality check	TDS etc.	on/Maintenance cost		

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	fixtures which can be installed are dual flushing cisterns, sensor taps, low water urinals etc. • No wastewater shall be received from vessels and vessels should not be allowed to discharge their wastewater and solid waste in river • No waste/wastewater shall be discharged in river or dumped into the ground • Fuel shall be stored in leak proof containers and containers shall be placed on paved surfaces • Dredged soil shall be tested for toxicity, if toxic shall not be disposed back in water and should be send for disposal to TSDF. • Monitoring of treated water every month							
4.4 Water Quality	• Oil should be stored in leak proof containers and storage area should be provided with facility of collecting the oil in case of spillage. The storage facility should be so designed that spilled oil shall not enter the storm water and sewage drains or storm water storage pits • Ship design (of capacity > 5000 DWT at Haldia site for coal transhipment) should	Project requirement	River stretch along the terminal/lock site	MI: Prevention of spills from ships and leakage of oil PT: surface water quality	Treatment parameter ,ph ,BOD ,TDS etc.	Included in Operation/Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	be as per MARPOL and should be provide with double hulls/double bottoms. Speed of oil carrying vessels should be maintained to prevent accidents due to high speed. Sensors and hooters should be fitted with ships which can notify the closeness of another ship or any other potential matter which can cause accident. • Immediate/quick clean-up of such spills shall be undertaken and ship owners should be liable for the same. • Crew of the ships carrying the oil should be competent and experienced so as they can prevent the accidents to happen as much as possible • IWAI should carry out the inspections of the vessels which are transporting the material to and fro from the terminal. • Monitoring of surface water quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP							
5. Flora& Fauna								
5.1 Vegetation 5.2 Dolphin, Turtles and other aquatic species	• Planted trees, shrubs, and grasses to be properly maintained.	Forest Conservation Act 1980,	Project tree plantation	MI: Tree/plants survival rate	Records and field observations.	Operation/ Maintena	IWAI/Forest Department	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
protection	• The tree survival audit to be conducted at least once in a year to assess the effectiveness • Regular watering and cleaning of the leaves to remove the accumulated dust on the leaves • Propeller shall have net system to avoid any accident with dolphins, international practices shall be adopted. • No wastewater or waste shall be disposed in river from terminal site or from vessel into the water. Penalty shall be imposed on the vessels reported of disposing waste/wastewater in the river • Run-off from stockpile area, storage yards, parking areas & roads shall enter a dump pond first. Run-off should be allowed to retain for some time in the pond to allow the settlement of dust contained in it. The clear run-off shall be used for dust suppression and other activities • Run-off from building should be collected separately and should be used for plantation and dust suppression	Wild Life Protection Act, 1972	sites. Dolphin & Turtle sanctuary area and the remaining river stretch	PT: Minimum rate of 70% tree survival and accidents of aquatic mammals if any	Information from Forestry Department	nce Cost		

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	• STP should be provided at site for treatment of sewage generated. Treated water from STP should be reused completely at site and should not be discharged into river • Dredged sand shall not be disposed in river especially during breeding spawning seasons of aquatic organisms • Dredging shall be avoided during the breeding and spawning seasons • Nesting grounds, breeding & spawning grounds shall be identified and project activities shall be minimized in those areas • Instruction should be given to all vessels and all employee and staff that no dolphin or any other endangered species shall be harmed due to any reason • Instruction shall be given to vessel operator that in case any accident with dolphin occurs that should be reported immediately to terminal authority • Time schedule and the quantity of material allowed shall be strictly checked and monitored for each ship. This will prevent							

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	overcrowding of the vessels at terminal site and thus no obstruction will be there on movement of the aquatic organisms due to ships. • Waiting time of vessels shall be reduced at the terminal/lock sites by providing the adequate loading and unloading equipment and vehicles. • Vessels shall be instructed for not using sharp lights and sounds all the time as they may disturb aquatic organisms • Vessel speed should be controlled especially in dolphin/turtle habituated stretch (5 kmph) to minimize dolphin kill and the design of vessel and acoustic treatment should be done for vessel so as to minimize the sound exposure of dolphins. • No developments shall be brought up on other bank of river opposite to terminal site so as to provide the ground to aquatic organisms for their activities • Dust suppressors shall be used at site and at barge while loading & unloading of material to suppress the dust level. • Quick clean-up operations							

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	shall be carried out in case of accidents. Vessel owner shall be responsible for paying the clean-up expenses in case of the accidents and pollution of river water quality							
6. **Noise & Vibration**								
6.1 Increased noise due to material handling and vehicular movement	• Site boundary should be provided which can act as noise barrier • Earplugs should be provided to workers involved in unloading operations • Provision of thick green belt along the boundary and roads which will act as noise buffer • Timely maintenance and servicing of transportation vehicles and the machinery/pumps to be used during operation phase to reduce the noise generation due to friction and abrasion • Honking shall be prohibited at the project site • Hearing test for the workers shall be undertaken before employing them and thereafter shall be done after every six months • Job rotations should be practised for people, working in high noise level areas • No noise generating activity	Noise Pollution (Regulation and Control) Rules, 2000	Access Road & Terminal Site	MI: Noise levels at the site and access road PT: No accidents due to vegetation growth	Visual inspection Check accident records	Included in operation/Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	shall be carried out between 6:00 AM to 10:00 PM • DG sets shall be provided with acoustic enclosure • Monitoring of Noise levels shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP							
7. Safety								
7.1 Accident Risk due to uncontrolled growth of vegetation	• Efforts shall be made to make shoulder of approach road to terminal/lock sites completely clear of vegetation. • Regular maintenance of plantation along the roadside • No invasive plantation near the road.	Project requirement	Access Road& Internal roads	MI: Presence and extent of vegetation growth on either side of road. Number of accidents. PT: No accidents due to vegetation growth	Visual inspection Check accident records	Included in operation/Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
72 Accident risks associated with traffic movement.	• Traffic control measures, including speed limits should be forced strictly. • Further encroachment of squatters within the ROW will be prevented. • Monitor/ensure that all safety provisions included in design and construction phase are properly maintained • Movement of traffic shall be restricted to designate hours and routes • Adequate illumination should be provided at the site during evening	IRC:SP:55	At terminal/lock sites	MI: Number of accidents Conditions and existence of safety signs, rumble strips etc. on the road PT: Fatal and non-fatal accident rate is reduced after improvement	Review accident records Site observations	Included in operation /Maintenance cost	IWAI	IWAI
7.3. Transport of Dangerous Goods	• Existence of spill prevention and control and emergency responsive system with the vessel operators & jetty authority • Emergency plan for vehicles carrying hazardous material	-	At terminal/lock sites	MI: Status of emergency system – whether operational or not PT: Fully functional emergency system	Review of spill prevention and emergency response plan Spill accident records	Included in operation/Maintenance cost.	IWAI	IWAI
7.4 Accidents Risks Due to Movement of Vessels and other hazards associated with site	• Implementation of the environment management plan as proposed to prevent the environmental pollution during operation phase • Vessels should comply with	-	Throughout the project stretch	MI: Status of emergency system – whether operational or	Review of spill prevention and emergency	Included in operation/Maintenance	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	safety norms (SOLAS) and should maintain the speed so as to prevent the accidents. In case of accidents, vessel owner should be responsible for clean-up operations • Safety norms should be followed for all operational phase activities at terminal • Development activities should be carried out in the village and nearby areas of proposed terminal/lock sites for development of area • Fishing activity should not be restricted in the river. Alternate provision for fishermen should be given in case fishing activity is restricted. • Safety training should be given to the terminal staff for managing the floods, earthquake, fire, ship accidents like situation. Emergency collection area should be designated at the site which is safe. All workers should be directed to collect at this area in case of emergency. • Firefighting facility should be provided at site and trained personnel should be available at site who can operate the fire			not PT: Fully functional emergency system	response plan Spill accident records	cost.		

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	extinguishers and other fire-fighting equipment. • All the vessels/ships should have the safety equipment like safety jackets, rescue boats, fire extinguishers, oxygen cylinders, first aids, buoys etc.							

Table 7.6 : Environmental Management Plan for Ro-Ro Jetties (Design & Construction Phase)

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
1. Natural & Man-made Hazard							
❖ Earthquake-Seismic Zone – III & IV damage risk zone[82] ❖ Risk of flood& Cyclones (cyclone risk in Haldia stretch) ❖ Risks of Occupational hazards & fire	• Adoption of Relevant IS codes while designing the civil onshore & off-shore structures to sustain the earthquake of moderate to very high magnitude (Seismic Zone III& IV). • Designing of structures above the HFL of the River • Emergency preparedness plan should be prepared for situations of cyclone, flood, earthquake and fire and should be available at the site all the time. This plan should be in line with and integrated with the off-site emergency plan prepared for the area. • Employee shall be given training to handle the emergency situation • Site should be vacated in case of cyclone alerts • Location of nearest cyclone shelters shall be located in the map and shall be displayed at the site. Coordination should be done with IMD to receive the cyclone threat and in	NBC, 2005, local building bye laws, state factory rules, Petroleum Rules and MSIHC Rules, 1989	Construction site	During Design and construction stage.	Part of Project Costs	Contractor	IWAI/PMU/PMC

[82] *IS:1893 (Part 1): 2002 Indian Standard Criteria for Earthquake Resistant Design of Structures Part 1 General Provisions and Buildings Fifth Revision divides the Indian subcontinent*

into five seismic zones (II to V) depending on the magnitude and damage intensity of seismic activity.

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	case of cyclone threats the site should be vacated. • Mock drills to handle the emergency situation shall be conducted for workers • Emergency collection area should be provided at the site near the exit gate of the site and all workers should be aware about this collection point and shortest route to reach this place • Availability of the first aid boxes and necessary medicine as per State Factory Rules • Compulsion for workers to wear PPE while working to prevent injury due to accidents while working • Only skilled/trained person should be allowed to do the tasks involving the risk of accidents with due permission of site supervisor/safety officers • Separate work procedures and safety procedures should be prepared, if any night time working is involved						
2. Site Preparation: Levelling Terminal Site, Construction Camp, Construction Works							
❖ Setting of Labour Camps:Temporary loss of agriculture land, contamination of land and water resources from municipal waste from Camps, worker's health, Pressure on natural resources due	**Location of Camp if Required :** • Construction camp siting, establishment, location and management should be as per proposed Construction & Labour Camp Management Plan **(Annexure 7.4)** • Labour camps should be located close to the construction sites to the extent possible **Sanitation and Worker's Health& Safety:** • Hygiene in the camps should be maintained by providing good sanitation and cleaning facilities. Soak Pits can be provided only if labour camp is located away from river. • Camp should be well ventilated. It should have adequate provision for illumination, kitchen and safe drinking water facility.	The Building and Other Construction workers (Regulation of Employment and Conditions of Service) Act 1996 and Cess Act of 1996 and The Water (Prevention & Control of Pollution) Act, 1974 and amendments thereof. Municipal Solid	Labour Camp Locations	During design and Construction Stage	Approximate Rs 5,00,000/- per camp for sanitation and health facilities.	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
to establishment of labour camps	Proper drainage to be maintained around the sites to avoid water logging leading to disease • Proper sanitation facility like toilet and bathing facility should be provided at site and labour camps. Wastewater generated from these facilities should be disposed through septic tanks and soak pit • Preventive medical care to be provided to workers • Segregated, collection and disposal of solid waste on regular basis at identified municipal solid waste disposal location. If municipal solid waste site not available than waste should be land fill following the regulations. • Provision should be made essential material supply like cooking fuel (gas) • Provision should be made for day crèche for children • First aid facilities, first aid room, first aid trained personnel and ambulance should be provided at the site 24 X 7. Also tie-ups with local hospital should be done to handle emergency case, if any • Rest area should be provided at the site where labour can rest after lunch and should not lie on site anywhere • Working hours of labour should not exceed than standard norms as per state factory law • Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of mosquitoes. Septic tanks/soak pits should be provided for its disposal • Temporary storm water drainage system should also be provided at camp site and construction site so as to drain the storm water and prevent accumulation of storm	Wastes (Management and Handling) Rules, 2000 and manual 2014					

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	water at site and thus breeding of mosquitoes/flies • Wash-off from concrete mixing tanks and wash from washing area shall not be allowed to enter the soil. This wash shall be collected through drains into tanks and concrete shall be settled, collected, dried and re-used in the site again						
3. Site Preparation: Power supply, Water Supply, and Drainage, disposal of piling muck and debris							
❖ Power supply and Energy Conservation: Air Pollution, energy loss	• Power shall be sourced from state power grid during construction stage as well • DG sets shall be used only in case of power failure. DG sets shall be enclosed in acoustic enclosures and shall be provided with stacks as per CPCB norms to discharge exhaust gases • Back-up power shall be set up with all provisions of containment for fuel leakages, air pollution control (stack height as per regulation) and with acoustic enclosure.	Air Act, 1981 & Water Act, 1974	Construction Sites and Labour Camp Locations	During design and construction stage	Part of Project Costs	Contractor.	IWAI/PMU/PMC
❖ Water Supply, Drainage and effluent discharge	• Raw material should be stored under covered sheds so as storm water run-off should not get contaminated with the construction material • Toilets should be provided for labour at site and septic tanks/soak pit should be provided for disposal of sewage • Washing effluent, if any generated should be directed to the septic tank/soak pit for removal of contaminants • Permission from competent authority shall be obtained prior extracting ground water/ surface water	Central Ground Water Board, Water (Prevention and Control of Water Pollution) Act, 1974	Construction Sites and Labour Camp Locations	During design and construction stage	Approx. Rs 3 lakhs for construction of toilet and septic tank/soak pit at site	Contractor.	IWAI/PMU/PMC
4. Embankment Design and Construction, Drainage Pattern							
❖ River Bank Erosion Protection	• Provision of bank protection structures like stone pitching along the banks of river to prevent the bank erosion in u/s or d/s of the proposed jetty.	Water (Prevention and Control of Water Pollution) Act, 1974	River banks and River bed near the proposed RO-	During design, Pre-Construction	Part of Project Costs	Contractor.	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• Bed scour protection shall also be carried out if required. • During stone pitching, the stone shall be dropped from suitable distance and shall not by drop from height to prevent injury or killing of aquatic species. Stones shall be placed by making grid in pitching area. • Erosion monitoring shall be carried out periodically downstream as well.		RO jetty locations	and construction Stage			
❖ Drainage Pattern	• Natural Drainage pattern of area around shall be maintained. • Storm water management drains shall be provided at site for management of storm water management		Construction Sites, Access road, and Labour Camp Locations	During construction stage	Part of Project Costs	Contractor.	IWAI/PMU/PMC
5. Construction Material Sourcing							
❖ Quarries for sourcing stone and aggregates (loss of productive land, land degradation, air pollution. Any illegal quarrying may lead to land use change, unstable rock formation)	• Aggregates required for carrying out stone pitching works shall be sourced from nearby licensed quarries • It shall be ensuring that selected quarries are having requisite environment clearance, and comply with Air Pollution Control and Noise level requirements as per the law. • Material shall be transported in covered vehicles only. • Each Quarry shall be visited prior to its selection to ensure its compliance with lease conditions, EC and consent conditions	EIA Notification 2006 (under Environmental Protection Act and Rules, 1986) and amendments, Air Act, 1981	Quarry Site	During design and construction stage	Part of Project Costs	Contractor	IWAI/PMU/PMC
6. Protection of Flora and Fauna							
❖ Protection of terrestrial flora & fauna	• Tree cutting shall not be carried out for any purposed by construction labour. If any tree cutting is required for project purpose, then prior permission from Forest Department shall be obtained for the same and compliance to the conditions mentioned in NOC should be complied with strictly.	Wild Life (Protection) Act, 1972, Bio-diversity Conservation Act, 2002	Jetty location & nearby areas	During design and construction stage	Part of project costs	PMU through DFO	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• LPG should be used as fuel source in construction camps instead of wood. Tree cutting shall not be allowed for fuel wood. • River banks near the proposed jetty location should be provided with turfing • Access roads to jetty should be planted with the small medium sized trees						
❖ Protection of Aquatic Fauna including Turtles, Dolphins & other aquatic species from increased sedimentation in water body during piling & dredging and other construction activities	• To avoid the construction debris wash or blown into the water the area shall be surrounded by silt screens, which must be placed in the water before the work starts. Geo-Textile synthetic sheet curtain can act silt screen which should be placed around pilling and construction area to prevent movement of sediments and construction waste. The screens should also be placed around storage areas, to prevent waste from blowing away and to prevent sediment run-off into the river. The storm water drain shall be connected to temporary sedimentation pit and collected water shall be used for dust suppression. Run-off from site should also pass through oil/grease traps and flow down to the same sedimentation tank before its reuse • Equipment shall be maintained in good condition to prevent leaks or spills of potentially hazardous materials like hydraulic fluid, diesel, gasoline and other petroleum products • Workers should be trained to handle the equipment and material at site so as to minimize the spillage of materials and contamination of water • All workers should be made aware of not throwing any waste in the river or any drain • No construction debris/ already accumulated solid waste at site or waste generated from labour camp should be	Wild Life (Protection) Act, 1972& Bio-diversity Conservation Act, 2002	Around Pilling & dredging area	During design and construction stage	Part of project costs	PMU through DFO	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	thrown in river or any drain • Sewage generated from labour camp should not be directed into river but should be disposed through septic tank/soak pit • Aquatic ecology monitoring should be carried out prior start of construction and after completion of construction so as to assess the impact of construction activities on aquatic life. • Run-off from site should pass through oil/grease traps and sedimentation tank prior discharging into the river • All construction and operation equipment shall be maintained in good condition shall be checked for oil & grease leakage						
❖ Conservation of Dolphins	• Appropriate protocols and procedures must be prepared for sighting of dolphins in the construction zone. The objective of the protocols and procedures must be aimed at having no or minimal impacts on the dolphins. • No construction/dredging activity to be undertaken in turtle sanctuary	Wild Life (Protection) Act, 1972& VGDS Notification	Sanctuary area	During design and construction stage	Part of project Costs	IWAI	IWAI/PMU/PMC
7. Air Quality							
❖ Fugitive Dust Generation due to construction activities	• Transport of raw materials to site in covered vehicles. • Loading and unloading of construction materials in covered area. • Approach roads shall be paved and widened. • Water spraying on earthworks, unpaved haulage roads, other dust prone areas and construction yard. Flow of water sprinklers shall be maintained to avoid water ponding • Make Provision of PPEs like face masks to workers. • Raw materials like cement, sand and construction debris should be stored under	Environmental Protection Act, 1986 and amendments thereof; The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereof	Construction sites, Loading areas, storage areas,	During the Construction phase	Part of project Costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	covered conditions • Wheel wash facility shall be provided at exit points of the site • Monitoring of air quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP • Tree plantation shall be carried out in area near the proposed jetty location as per availability of land. Avenue plantation should be carried out along the access road • Species selected for development of green belt shall also be tolerant to expected pollutants and shall have the ability to adsorb the pollutants. Suggested species are suitable for different areas are also listed under CPCB guidelines for green Belt development[83]. • LPG should be used as fuel source in construction camps instead of wood. Tree cutting shall not be allowed for fuel wood. • Mixing Plant and batching plant shall be located on downwind direction of the site fitted with adequate stack height to ensure enough dispersion of exit gases. with appropriate pollution control measures • Loading and unloading of construction materials shall be made at designated locations in project area with provisions of water fogging around these locations • Low sulphur diesel should be used for operating DG sets, dredgers and construction equipment.						
❖ Exhaust gas emissions from machinery and	• Regular maintenance shall be carried out of machinery and equipment. • Periodic Ambient air quality monitoring shall	Environmental Protection Act, 1986 and	Construction camps and sites, batching	During the Construction phase	Part of project Costs	Contractor	IWAI/PMU/PMC

[83] CPCB guidelines for green Belt development http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
vehicular traffic.	be carried out. • DG sets to be fitted with stacks of adequate height and low sulphur diesel to be used in DG sets as well as in machineries. • Monitoring of air quality for PM_{10}, $PM_{2.5}$, SO_x, NO_x, and CO shall be carried out quarterly at construction sire	amendments thereof; The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereof	plants, DG sets locations				
❖ Emissions at access road : avoidance of traffic Jams	• Efforts shall be made to transport construction material early morning and late evening period. • Traffic regulators (Guard) shall be posted in habitat area and at key junction areas to avoid congestion • No construction, material, equipment or vehicle shall be stored or parked at any road or the non-project area • Transportation vehicle shall strictly adhere to the designated routes and timings and shall avoid the peak traffic hours	Environmental Protection Act, 1986 and amendments thereof; The Air (Prevention and Control of Pollution) Act, 1981 and amendments thereof	Existing roads	During the Construction phase	Part of project Costs	Contractor	IWAI/PMU/PMC
8. Noise and Vibration							
❖ Noise from construction vehicle, equipment and machinery.	• All equipment to be timely serviced and properly maintained to minimize its operational noise. • Construction equipment and machinery to be fitted with silencers and maintained properly. • Protection devices (ear plugs or ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines. • Speed control shall be enforced in habitat areas. The ambient noise level as per standard is 55 dB(A) and 45 dB(A). Current level at habitat area meets the standard • Honking shall be prohibited at the project site • Hearing test for the workers shall be undertaken before employing them and	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof	Construction & Plant site	During the Construction stage	Part of project Costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	thereafter shall be done after every six months • Job rotations should be practiced for workers, working in high noise level areas • No noise generating activity shall be carried out between 6:00 AM to 10:00 PM. • Monitoring of Noise levels shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP						
9. Land-use and Landscape							
❖ Loss of agricultural land and productive top soil	• Agricultural land shall not be selected for setting up construction camps, borrow area (if any), plant site or any other construction purpose • 15 cm of top soil layer shall be stripped off prior to excavation and shall be stored separately in covered condition and used for landscaping purpose or shall be given to farmers in nearby areas, if required by them	Design requirement	Project site and area used temporarily during construction phase	During construction Stage	Part of project cost	Contractor	IWAI/PMU/PMC
❖ Soil erosion due to construction activities, earthwork	• Shore protection works like stone pitching, and geo-textile matting along the bank and construction of stone apron in the river to prevent the scouring of banks as required to prevent erosion of banks/scouring of bed • Bio-turfing of embankments shall be made enhance the slop stabilization	Municipal Waste Rules, 2000 & Manual 2014, Hazardous Waste Rules, 2008	Construction site and river banks	During construction Stage	Part of project costs	Contractor	IWAI/PMU/PMC
• Compaction and contamination of soil due to movement of vehicles and equipment	• Fuel shall be stored in HDPE containers on paved surfaces with provision of catchment pit to prevent soil contamination from oil spillages. • Municipal waste likely to be generated at site shall be collected in segregated manner with the use of two bin system at site. It shall be segregated into biodegradable and non-biodegradable waste. Provision of bio composter shall be made at site. The	Municipal Waste Rules, 2000 & Manual 2014, Hazardous Waste Rules, 2008	Construction site	During Design & Construction stage.	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	biodegradable material shall be decomposed for production of compost for use at site. The non-biodegradable waste shall be disposed to predefined land fill site nearby. The land fill site shall have provision of liners to prevent leachate to ground. • Septic tank or mobile toilets fitted with anaerobic treatment facility shall be provided at construction camp • Stones required for pitching/aggregates will be sourced from existing licensed quarries. Copies of consent/ approval / rehabilitation plan for a new quarry or use of existing source will be obtained by DBOT contractor and submitted to IWAI. • Movement of construction vehicles shall be restricted to the designated haulage roads only and parking should be done in defined areas only so as to prevent compaction of soil of nearby sites • Hazardous waste like used oil from DG sets shall be stored in HDPE containers and shall be stored on paved surfaces in isolated location to prevent its spillage and contamination of soil. Used oil shall be disposed through authorized vendors only.						
10. Water Resources							
❖ Depletion of Groundwater resources due to unregulated abstraction for construction purpose	• Preference shall be given to surface water from rivers wherever feasible in the project area with due permission from authorities.. • Temporary rain water storage structures should be provided at the site to store rain water and this water should be used for sprinkling and construction activities • No dumping of waste/wastewater in the ground. Hazardous waste or wastewater shall not be stored in unlined ponds • Permission shall be obtained from irrigation department in case river water is used and	Water Act, 1972		During Construction stage	Part of project costs	Contractor,	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	from CGWA/CGWB in case ground water is used.						
❖ Increase in water Siltation levels due to construction of jetties and contamination due to disposal of domestic waste/sewage	• Washing of vehicle and equipment shall not be carried out at river or any water body. Washing area should be provided with the storm water drains fitted with oil & grease trap. • Site should be cleaned regularly • Septic tank/soak pit shall be provided at site for disposal of sewage from the toilets at site and from the labour camps. Adequate toilets & bathrooms shall be provided to prevent open defecation. Wherever septic tanks are not provided mobile toilets with anaerobic digestion facility shall be provided and no domestic waste shall be discharged to river. • Water use shall be minimized by using RMC, practicing curing by water sprinkling, maintaining flow of sprinklers, covering the water storage tanks to minimize water evaporation, creating awareness for water conservation and regular inspections at site to monitor the leakages in water storage area • In case RMC is not used then concrete transit mixer should be washed and cleaned daily. Wash from these mixers shall be collected in block work tanks which will allow settling of concrete, removal of aggregates and allowing the waste to wastewater drain. This collected waste concrete can be dried and used for various purpose at site like construction of temporary roads at site and labour colony • Wastewater generated from the washing/cleaning area after passing through oil & grease trap & curing area shall be re-used for water sprinkling and wheel washing • Fuel shall be stored in leak proof containers	Water Act, 1972	Construction Site	During Construction stage	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	and containers shall be placed on paved surface Substructure construction should be limited to the dry season and cofferdams may be constructed and utilized to lift the spoil directly out of it and carried to the riverbank for land disposal. • Restoration of changes in the stream, if any, made during construction to its original level • The piling work in river shall be undertaken during low flow period. • Turbidity traps/curtains should be provided or Geo-Textile synthetic sheet curtain shall be placed around pilling and construction area to prevent movement of sediments and construction waste. • Sedimentation tanks shall be provided at the site so as run-off from site shall enter the sedimentation tanks before discharging into the river. Sedimentation tanks will trap the sediments in the run-off • Provision shall be made for geo Synthetic Screen for arresting silt flowing down stream. • Proper collection, management and disposal of construction and municipal waste from site shall be made to prevent mixing of the waste in run-off and entering the water bodies • Natural Drainage pattern of area around shall be maintained • Dredged soil shall be tested for toxicity & contamination, if toxic/contaminated shall not be disposed of back in water and should be send for disposal to TSDF • Monitoring of surface water quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP						
11. Accident and Safety Risks							

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
❖ Impact on Social life	• Site should be guarded by security guard. Register should be maintained for entry of outsiders. No unauthorized person should be allowed to enter the site especially village children • A board should be displayed at entrance of site displaying name of project, area and hazards associated with the site on entrance and activities prohibited within and near site area in local language • Non-productive lands, barren lands, raised lands; wastelands should be used for setting up labour camps, plant sites and debris disposal site. Agricultural land should be avoided. Land should be used for establishment of construction camps, debris disposal site and plant site only after obtaining consent from land owner. • Consultations to be done with fishermen prior start of any activity at bank/ in river to avoid any conflicts. Fishermen should be consulted prior restricting fishing activity in the activity area • Care should be taken that fishing gears and the equipment should not be impacted due to construction activities at site • Necessary permits should be obtained from concerned authorities in case any batching plant, and hot mix plant is set up. • All these facilities shall be installed at proposed project site itself if possible. In case these are to be set up away from site than these shall be located at minimum distance of 500 m from habitation, water bodies and 1000 m from forest areas. • Management, rehabilitation and closure of these sites should be as per the Management plans proposed for these sites. Records for starting, maintaining and						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	closure should be maintained and should be approved by site engineers • Implementation of EMP adequately so as to prevent environmental pollution and its impact on socio-economy due to project development						
❖ Accident risk from construction activities and health & safety of workers	• Adequate illumination should be provided at site during evening and night time till the work is being carried out • Rest area should be provided at site in which workers can rest after the lunch hours • Workers should wear the personal protective equipment like helmet, gum boots, safety shoes, safety jackets, ear plugs, and gloves while working • Noise level in the work zone should be maintained and followed as per OSHAS norms • Contractors should adopt and maintain safe working practices. SOPs should be prepared for each and every activity and all activities should be undertaken as per SOPs under supervision of site engineer • Training should be given to workers to handle the heavy equipment so as to prevent accidents • Training should be given to workers to handle emergency situation like fire, earth quake and flood • Emergency preparedness plan should be available at the site all the time and mock drills for workers should be conducted from time to time • Complete medical check-up should be done for workers prior to joining and after six months of joining • First aid facilities, first aid room, first aid trained personnel and ambulance should be provided at the site 24 X 7. Also tie-ups with	Central Motor and Vehicle Act 1988 EP Act 1986 Noise Rules 2002	Construction sites	Construction period	Part of project costs	Contractor	IWAI/PMU/PMC

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	local hospital should be done to handle emergency case, if any • List of emergency nos., hospital contacts, ambulance contacts and doctors contacts should be displayed in first aid room, rest area and at all required location • Working hours of labour should not exceed than standard norms as per state factory law • Labour camps if set up should be located at neat and clean location with no water logging issues and should be well ventilated with adequate illumination, kitchen and safe drinking water facility • Construction labour camps and site should be properly cleaned and hygiene should be maintained • Proper sanitation facility like toilet and bathing facility should be provided at site and labour camps. Wastewater generated from these facilities should be disposed through septic tanks and soak pit • LPG should be provided as fuel for cooking to workers and open burning of fuel should not be allowed • Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of mosquitoes. Septic tanks/soak pits should be provided for its disposal • Temporary storm water drainage system should also be provided at camp site and construction site so as to drain the storm water and prevent accumulation of storm water at site and thus breeding of mosquitoes/flies. Sediment traps can be given with these drains to trap sediments • Safety officers should be appointed at site so as to ensure all safety measures are taken at the site						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	• All construction workers should be provided with personal protective equipment like helmet, gloves, gumboots, and safety jackets and fines should be imposed if found not wearing • Job rotation should be carried out for workers exposed to high noise and dust areas • Activity like smoking and consuming liquor should be prohibited at the site • Awareness on AIDS should be spread among the workers • Traffic manager should be present at the site all the time to manage incoming and outgoing traffic to prevent accidents • Crèche facility should be provided for kids if female workers are employed • Regular inspection for hygiene and safety in labour camps should be done • Provision of cautionary and guiding signage in local and English language indicating the hazard associated with the site & activities. Usage of fluorescent signage, in local language at the construction sites • Speed limit of vehicles should be restricted at site and on haulage roads to prevent any accidents and fines should be imposed on vehicles if same is not maintained. All construction vehicles should follow the designated routes & timings only. • Construction vehicle movement should be restricted to non-peak hours, i.e. late evening (7-12:00 pm) only. Villagers should also be given intimation of these timings. • Noise level in the work zone should be maintained and followed as per OSHA norm • Employment should be provided preferable to local & affected people • Dustbins should be provided at labour						

Environmental Issue/ Component	Remedial Measure	Reference to laws and Contract Documents	Approximate Location	Time Frame	Indicative / Mitigation Cost	Institutional Responsibility	
						Implementation	Supervision
	camps for collection of waste and waste should be regularly disposed through the concerned agency • Arrangement of fire-fighting should be made at site and workers should be trained to use the system in case of fire • Site should be guarded by security guard. Register should be maintained for entry of outsiders. No unauthorized person should be allowed to enter the site especially village children • A board should be displayed at entrance of site displaying name of project, area and hazards associated with the site on entrance and activities prohibited within and near site area in local language • All construction vehicles should be regularly serviced and maintained and carry pollution under control certificate • All proposed environmental pollution measures should be taken during construction of phase of terminal to minimize the harm to existing environmental quality of the area, which is being enjoyed by the residents of that area • Maintenance and repair of the village road should be carried out both before and end of construction by contractor. • Sprinkling of water should be carried out in village road also, so as to minimize dust generation due to movement of construction vehicles.						

Table 7.7 : Environmental Management Plan for Ro-Ro Jetty Sites (Operation & Maintenance Phase)

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
1. Climate								
1.1 Impact on Climate	• Tree plantation should be carried out near the jetty area (if land is available) and along the access road • Ensuring survivability of already planted trees, minimum 70% survival rate and create additional GHG sink by planting additional trees • Solar lighting provision should be given at the site in ratio of 1:3.	Kyoto Protocol, National Water Policy, 2012, Forest Conservation Rules & National Forest Policy	Ro-Ro jetty site	Survival rate of trees and monitoring performance of energy conservation equipment	• Observations and inspection	Aftercare & Monitoring of tree plantation (@ Rs 100 per tree)	IWAI	IWAI
2. Bio-Diversity								
2.1 Dolphin Conservation	• Considering sensitivity of Dolphins, it is proposed to support Dolphin conservation activity. It is proposed to allocate a separate budget for this activity under NW-1 project. This task may be undertaken through "The Vikramshila Biodiversity Research and Education Centre (VBREC)" together with the Whale and Dolphin Conservation Society (WDCS), the Environmental Biology Laboratory of Patna University, and T.M. Bhagalpur University, who has jointly initiated a project to improve the conservation value of Vikramshila	Project Requirement/ Wild life Protection Act, 1972	Dolphin Existence Areas	Operation stage of project	• Site Observation • Discussion with local People • Collection information from Forestry Department	Included in Operation / Maintenancecost (@ INR10,00,000)	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	Gangetic Dolphin Sanctuary.							
3. Air Quality								
3.1 Air pollution due to due to vehicular movement near jetty area	• Material carrying vehicles should be covered • All transportation vehicle shall carry PUC certificate • Tree plantation should be carried out in areas near jetty if land available and avenue plantation should be carried out an access road • Species selected for development of green belt shall also be tolerant to expected pollutants and shall have the ability to adsorb the pollutants. Suggested species are suitable for different areas are also listed under CPCB guidelines for green Belt development[84]. • Monitoring of air quality shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP	Environmental Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981	Jetty locations	MI: Ambient air quality (PM_{10}, CO, SO_2 NO_x) PT: Levels are equal to or below baseline levels given in the EIA report	• As per CPCB requirements • Site inspection	Included in Operation / Maintenancecost	IWAI	IWAI
4. Land and Soil								
4.1 Soil erosion at embankment during heavy rainfall.	• Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching etc. • Necessary measures to be followed wherever there are	Project requirement	Along river bank and embankmentnea	MI: Existence of soil erosion sites Number of	On site observation	Included in Operation / Maintena	IWAI	IWAI

[84] CPCB guidelines for green Belt development http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	failures		r jetty sites	soil erosion sites PT: Zero or minimal occurrences of soil erosion		ncecost		
4.2 Soil contamination	•	Project requirement	Jetty site	MI: Existence of soil erosion sites Number of soil erosion sites PT: Zero or minimal occurrences of soil erosion	On site observation	Included in Operation / Maintenancecost	IWAI	IWAI
5. Water resources/Flooding and Inundation								
5.1 Siltation	• Regular checks shall be made for soil erosion along the banks near jetty location and conditions of bank protection structures effective control.	Project requirement	Near surface Water bodies	MI: Water quality PT: No turbidity of surface water bodies due to the terminal	Site observation	Included in Operation/ Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
				activity				
5.2 Waste Water treatment and conservation	• Toilets to be provided with running water facility to prevent open defecation. • Sewage generated at site should be disposed through septic tanks/soak pits • Water conservation fixtures shall be installed in toilets and kitchen area. Some of the water conservation fixtures which can be installed are dual flushing cisterns, sensor taps, low water urinals etc. • No wastewater shall be received from vessels and vessels should not be allowed to discharge their wastewater and solid waste in river • No waste/wastewater shall be discharged in river or dumped into the ground • Fuel shall be stored in leak proof containers and containers shall be placed on paved surfaces	Project requirement	Project area	MI: proper treatment PT: treated water quality check	Treatment parameter, ph, BOD, TDS etc.	Included in Operation/Maintenance cost	IWAI	IWAI
5.3 Water Quality	• Oil should be stored in leak proof containers and storage area should be provided with facility of collecting the oil in case of spillage. The storage facility should be so designed that spilled oil shall not enter the storm water	Project requirement	River stretch along the jetty	MI: Prevention of spills from ships and leakage of oil	Treatment parameter, ph, BOD, TDS etc.	Included in Operation/Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	and sewage drains or storm water storage pits			PT: surface water quality				
4. Flora& Fauna								
4.1 Vegetation 4.2 Dolphin, Turtles and other aquatic species protection	• Planted trees, shrubs, and grasses to be properly maintained. • The tree survival audit to be conducted at least once in a year to assess the effectiveness • Regular watering and cleaning of the leaves to remove the accumulated dust on the leaves • Propeller shall have net system to avoid any accident with dolphins, international practices shall be adopted. • No wastewater or waste shall be disposed in river from terminal site or from vessel into the water. Penalty shall be imposed on the vessels reported of disposing waste/wastewater in the river • Run-off from stockpile area, storage yards, parking areas & roads shall enter a dump pond first. Run-off should be allowed to retain for some time in the pond to allow the settlement of dust contained in it. The clear run-off shall be used for dust	Forest Conservation Act 1980, Wild Life Protection Act, 1972	Project tree plantation sites. Dolphin & Turtle sanctuary area and the remaining river stretch	MI: Tree/plants survival rate PT: Minimum rate of 70% tree survival and accidents of aquatic mammals if any	Records and field observations. Information from Forestry Department	Operation/ Maintenance Cost	IWAI/Forest Department	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	suppression and other activities • Nesting grounds, breeding & spawning grounds shall be identified and project activities shall be minimized in those areas • Vessels shall be instructed for not using sharp lights and sounds all the time as they may disturb aquatic organisms • No developments shall be brought up on other bank of river opposite to jetty site so as to provide the ground to aquatic organisms for their activities • Dust suppressors shall be used at site and access road • Quick clean-up operations shall be carried out in case of accidents. Vessel owner shall be responsible for paying the clean-up expenses in case of the accidents and pollution of river water quality							
5. **Noise & Vibration**								
5.1 Increased noise due to vehicular movement	• Honking shall be prohibited at the project site • DG sets (if any) shall be provided with acoustic enclosure • Monitoring of Noise levels shall be carried out on monthly basis to check the	Noise Pollution (Regulation and Control) Rules, 2000	Access Road &Jetty site	MI: Noise levels at the site and access road PT: No accidents due	Visual inspection Check accident	Included in operation/Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	level of pollutants and effectiveness of proposed EMP			to vegetation growth	records			
6. Safety								
6.1 Accident Risk due to uncontrolled growth of vegetation	• Efforts shall be made to make shoulder of access road to jetty site completely clear of vegetation. • Regular maintenance of plantation along the roadside • No invasive plantation near the road.	Project requirement	Access Road	MI: Presence and extent of vegetation growth on either side of road. Number of accidents. PT: No accidents due to vegetation growth	Visual inspection Check accident records	Included in operation/Maintenance cost	IWAI	IWAI
7.2 Accident risks associated with traffic movement.	• Traffic control measures, including speed limits should be forced strictly. • Monitor/ensure that all safety provisions included in design and construction phase are properly maintained • Movement of traffic shall be restricted to designate hours and routes • Adequate illumination should be provided at the site during evening	IRC:SP:55	Throughout the Project route	MI: Number of accidents Conditions and existence of safety signs, rumble strips etc. on the road PT: Fatal and non-fatal accident rate is reduced after improvement	Review accident records Site observations	Included in operation /Maintenance cost	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
7.3.Transport of Dangerous Goods	• Existence of spill prevention and control and emergency responsive system with the vessel operators & jetty authority • Emergency plan for vehicles carrying hazardous material	-	At jetty sites	MI: Status of emergency system – whether operational or not PT: Fully functional emergency system	Review of spill prevention and emergency response plan Spill accident records	Included in operation/Maintenance cost.	IWAI	IWAI
7.4 Accidents Risks Due to Movement of Vessels and other hazards associated with site	• Implementation of the environment management plan as proposed to prevent the environmental pollution during operation phase • Safety norms should be followed for all operational phase activities at terminal • Fishing activity should not be restricted in the river. Alternate provision for fishermen should be given in case fishing activity is restricted. • Safety training should be given to the terminal staff for managing the floods, earthquake, fire, ship accidents like situation. Emergency collection area should be designated at the site which is safe. All workers should be directed to collect at this area in case	-	Throughout the project stretch	MI: Status of emergency system – whether operational or not PT: Fully functional emergency system	Review of spill prevention and emergency response plan Spill accident records	Included in operation/Maintenance cost.	IWAI	IWAI

Environmental Issue/ Component	Avoidance/Mitigation/ Compensation Measures	Reference to laws/ guideline	Location	Monitoring indicators (MI)/ Performance Target (PT)	Monitoring Methods	Mitigation Costs	Institutional Responsibility	
							Implementation	Supervision
	of emergency. • Firefighting facility should be provided at site and trained personnel should be available at site who can operate the fire extinguishers and other fire-fighting equipment. • All the vessels/ships should have the safety equipment like safety jackets, rescue boats, fire extinguishers, oxygen cylinders, first aids, buoys etc.							

Table 7.8 : Environment Monitoring Plan for Construction & Operation Phase

S. No.	Aspect	Parameters to be monitored	No of sampling locations & frequency	Standard methods for sampling and analysis	Role & Responsibility	
					Implementation	Supervision
Construction Period						
1.	Air Quality (Ambient & Stack)- terminal, lock & jetty sites	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO	Three Locations up wind and downwind direction including project site. Once in 3 months	• Fine Particulate Samplers for $PM_{2.5}$ • Respirable Dust Sampler for PM_{10}fitted with Gaseous sampling arrangements for SO_2 and NO_x, • CO analyser;	Contractor	IWAI & PMC
2.	Surface Water Quality- terminal, lock & jetty sites	Physical, chemical and biological	River u/s & d/s of the proposed facility Once a month	Grab sampling and analysis by using standard methods	Contractor	IWAI & PMC
3.	Drinking water Quality- terminal, lock & jetty sites	Physical, chemical and biological	Drinking water for labour camps Once a month	Grab sampling and analysis by using standard methods	Contractor	IWAI & PMC
4.	Noise Level- terminal, lock & jetty sites	Day time and night time noise level (max, min & Leq levels)	Construction labour camp, construction site and nearest habitation Once a month	Noise meter	Contractor	IWAI & PMC
5.	Soil Quality - terminal, lock & jetty sites	Soil texture, type, Electrical conductivity, pH, infiltration, porosity, etc.,	Construction site, labour camps and debris disposal site Once in 6 months	Collection and analysis of samples as per IS 2720	Contractor	IWAI & PMC
6.	River Bed Sediment- terminal, lock, jetty sites	Texture, type, Electrical conductivity, pH, infiltration, porosity, etc., and biological	River bed near sites of terminals/locks/jetty Once in 6 months	Collection and analysis of samples as per IS 2720	Contractor	IWAI & PMC

		compounds				
7.	Green Belt-terminal & lock site (jetty site if green belt developed)	Plantation survival rate	Green belt area at site-periphery of site and along roads Once in year	Survey, counting, recording & reporting	Contractor	IWAI & PMC
8.	Soil Erosion-terminal/lock & jetty site, site for river bed and bank protection and sites of river training structures development	---	Upstream & downstream of civil intervention sites and sites of river bank protection/river training works Six monthly	Survey & observation; Extent and degree of erosion; Structures for controlling soil erosion	Contractor	IWAI & PMC
9.	Aquatic ecology-terminal/lock & jetty site, site for river bed and bank protection and sites of river training structures development	Phytoplankton, Zooplankton and species diversity index	U/s and d/s of the civil intervention sites and location of river training works/bank protection works Six monthly	Plankton net of diameter of 0.35 m, No.25 mesh size 63 and analysis by using standard methods.	Contractor	IWAI & PMC
10.	Integrity of embankment- locations of existing & newly constructed embankments along NW-1	---	locations of existing & sites of proposed sites for embankments construction along NW-1	Survey & observation; Extent and degree of erosion; Structures for controlling soil erosion	Contractor	IWAI & PMC
Operation Phase						
1.	Air Quality (Ambient & Stack)-terminal, lock & jetty sites	PM_{10}, $PM_{2.5}$, SO_2, NO_2, HC and CO	Three Locations up wind and downwind direction including project site. Once in 6 months	• Fine Particulate Samplers for $PM_{2.5}$ • Respirable Dust Sampler for PM_{10}fitted with Gaseous sampling arrangements for SO_2 and NO_x • CO analyser	NABL accredited Lab to be contracted by IWAI	IWAI
2.	Surface Water	Physical, chemical and	River u/s & d/s of the	Grab sampling and analysis by using	NABL accredited	IWAI

	Quality-terminal, lock & jetty sites	biological	proposed facility Once in quarter	standard methods	Lab to be contracted by IWAI	
3.	Drinking water Quality-terminal, lock & jetty site	Physical, chemical and biological	Drinking water for staff Once a quarter	Grab sampling and analysis by using standard methods	NABL accredited Lab to be contracted by IWAI	IWAI
4.	Noise Level-terminal, lock & jetty sites	Day time and night time noise level (max, min & Leq levels)	Two locations: Project site & nearest habitation - Once in quarter	Noise meter	NABL accredited Lab to be contracted by IWAI	IWAI
5.	Wastewater Managemen t -terminals	Physical, chemical and biological of sewage and STP treated water	Terminal site, testing of sewage and STP treated water Once in quarter	--	NABL accredited Lab to be contracted by IWAI	IWAI
6.	Plantation-terminal & lock site (jetty site if green belt developed)	Plantation survival rate of 70%	Maintenance and survival loss of existing - Once in year	Survey, counting, recording & reporting	IWAI	IWAI
7.	Soil Erosion-terminal/lock & jetty site, site for river bed and bank protection and sites of river training structures development	---	Upstream & downstream of civil intervention sites and sites of river bank protection/rive r training works Six monthly	Survey & observation; Extent and degree of erosion; Structures for controlling soil erosion	IWAI	IWAI
8.	Aquatic ecology-terminal/lock & jetty site, site for river bed and bank protection and sites of river training structures development	Phytoplankton, Zooplankton and species diversity	U/s and d/s of the civil intervention sites and location of river training works/bank protection works Six monthly	Plankton net of diameter of 0.35 m, No.25 mesh size 63 and analysis by using standard methods.	IWAI	IWAI
9.	River Bed Sediments-	Physio-Chemical	River bed near sites of	Depth Sampler	IWAI	IWAI

	terminal, lock, jetty sites	Parameters	terminals/locks/jetty Once in 6 months			
10.	Integrity of embankment- locations of existing & newly constructed embankments along NW-1	---	locations of existing & newly constructed embankments along NW-1	Survey & observation; Extent and degree of erosion; Structures for controlling soil erosion	IWAI	IWAI

Table 7.9 : Training Schedule

S. No.	Target group	Subject(s)	Method	Time Frame and Estimated Cost (INR or Rs)	Basis for Costs Estimation	
					Training Material Preparation	Total (INR)
1	All Project Staff of EA involved in implementation of the project	**Environmental Overview:** Environmental Regulations, new regulations, Project related provisions of various Acts/ Guidelines, process and methodology for EIA / EMPs	Lectures cum interaction	Six monthly to be organized for all the staffs involved in EA	2,00,000 per training and 6 such trainings	12,00,000
2	Contractor staff at site responsible for implementation of EMP, PMC & PMU	**Implementation of EMPs:** Basic features of an EMP, Planning, designing and execution of environmental mitigation and enhancement measures, monitoring and evaluation of environmental conditions – during construction and operation	Workshops and Seminars	Before beginning of the implementation of each sub project and annually after that	1,00,000 per training 20 sites for 2 years	20,00,000
3	Contractor staff at site	**Environmentally Sound**	Workshops and Site visits	Before beginning of the	1,00,000 per training 20 sites	20,00,000

	responsible for implementation of EMP, PMC & PMU	**Construction Practices:** Clean construction technology, alternatives materials and techniques for construction, Waste Management and minimization in construction, pollution control devices and methods for construction sites and equipment, Environmental clauses in contract documents and their implications, protection of flora and fauna, Environmental monitoring during construction		implementation of each sub project and annually after that	for 2 years	
4	Contractor staff at site responsible for implementation of EMP, PMC & PMU	**Monitoring Environmental Performance during Construction:** Air, Water, Soil and Noise, tree survival Monitoring requirement and techniques,	Lectures, Workshop and site visits	Before beginning of the implementation of each sub project and annually after that	1,00,000 per training 20 sites for 2 years	20,00,000

		Evaluation and Review of results, Performance indicators and their applicability, possible corrective actions, reporting requirements and mechanisms				
5	Health & Safe trainings, mock drills for fire & earthquake situation and handling other emergencies like floods, cyclones for contractor work force, environmental specialist, health & safety officers and environmental specialists of PMU & PMC	Emergency Preparedness, Health, Safety, Risk and Contingency Management and Disaster Management	Mock drills, training, lectures	Before beginning of the implementation of each sub project and six monthly after that till the construction continues	1,00,000 per training 20 sites for 2 years	40,00,000
6	Public /contractors' workers with involvement of environmental specialists of contractor, PMC & PMU	**Awareness programmes** on environmental protection and measures being implemented by EA and their role in sustaining the	Workshops and trainings	Before beginning of the implementation of each sub project and six monthly after that till the construction	1,00,000 per training 20 sites for 2 years	40,00,000

		measures taken including for noise pollution, air pollution, safety, soil conservation, and tree plantation, tree plantation and importance of tree loss prevention to minimize C-loss.		continues		
7	PMU, PMC and Engineering Staff of Contractor. DFO	Restoration of sites viz borrow areas, construction Camps, Occupational health and safety, management systems, tree plantation, Faunal protection and sustainability. tree plantation and importance of tree loss prevention to minimize C-loss Reporting Formats/procedure	Lecture/Presentations	Annually (prior excavation of borrow area)	1,00,000 per training 20 sites for 2 years	20,00,000
8	PMU, IWAI	**Long-term Environmental Issues in Project Management:** Designing and implementing environmental surveys for ambient	Workshops and seminars	Every six monthly during operation phase of project	1,00,000 per training 20 sites for 2 years	40,00,000

		air, noise, vibration, biological and water quality surveys, data storage, retrieval and analysis, contract documents and environmental clauses, risk assessment and management, contingency planning and management and value addition				
Total Cost for Training						**2,12,00,000**

Table 7.10 : Detail Break-up of Environment Management Budget

Component	Item	Unit	Quantity	Rate	Amount
DESIGN AND CONSTRUCTION STAGE					
Technical Support	• Technical support for preparation of guidelines, bio-diversity conservation plan for turtle and dolphin sanctuary and performance indicators	Lump sum	1 Nos.	90,00,000	90,00,000
Greenbelt development	• Plantation in intervention sites (terminal/jetty/locks)-provisional	No. of trees	25000 trees	500 Rs/tree	1,25,00,000
	• Survival loss including aftercare	No. of trees	25000 trees	100 Rs/tree	25,00,000
Drainage Congestion and disposal of accumulated water	• Provision of adequate surveillance	Covered in project design and engineering cost			--
Erosion & Sedimentation	• Embankment and River Bank Protection Measures	Covered in project design and engineering cost			--
Measures to Reduce dredging requirement	• River training works • Bandalling • Catchment treatment	Covered in project design and engineering cost			--
Measures to Reduce GHGs	• Green buildings certification • Plantation	Lump sum Rs 1500000 for certification of each terminal sites for 6 locations. Cost of plantation covered under plantation head Any building improvement-part of construction cost			90,00,000
Land	• Compensation against land	As required for specific site and is included separately under SIA/RAP reports.			--
Soil	• Soil contamination protection (Septic tanks, grease taps etc) and rehabilitation of borrow areas/debris disposal site/plant site & labour camps	Covered in project design and engineering cost			--
Noise	• Canopy for DG sets • PPEs like ear plug • Timely maintenance of the machinery, equipment and vehicles • Barricading the site	Covered in project design and engineering cost			--
Water	• Provision of storm water and wastewater management system	Estimated @ RS 3,00,000 for construction site & 3,00,000 for labour camps (40 camp sites max. & 20 construction sites)			1,80,00,000
	• Construction of soak pits at construction sites & labour camps	Estimated @ RS 3,00,000 per site estimated 40 camp sites max. & 20 construction sites			1,80,00,000

Component	Item	Unit	Quantity	Rate	Amount
	• Provision of clean drinking & domestic water facility at labour camps and construction site	20,000 Per month for 20 months' average for 20 sites			80,00,000
	• STP construction, Zero Discharge management (collection of storm water and its distillation and use, and rain water harvesting	Including I project design and engineering costs			-
Air Quality - Dust Management during construction	• Water Sprayer / Watering for Dust suppression	Covered in project design and engineering cost			--
	• Green belt development, dust control system, mechanized material handling systems for material loading and unloading at terminal and vessel.	Covered in project design and engineering cost			
Safety	• Appointment of Safety Officers	Covered in project design and engineering cost			--
	• Safety signage, fire-fighting measures& water ambulance etc.	Covered in project design and engineering and cost			--
	• Provision of trainings and PPE to workers	Covered in project design and engineering and cost			1,72,00,000
Health	• Health check-up camps for construction workers	Camps	2 camp /year/site-20 sites for 2 years of construction period	4 lakhs/camp	3,20,00,000
Enhancement Measures	• Institutional Support for Vikramshila Wild Life Sanctuary through reputed institutions	No	1	Lump sum	1,00,00,000
	• Support for Fish Nurseries Development for enhancing Fish productivity, and training of fishermen from CIFRI or similar institute of repute	No	1	Lump sum (@ Rs 1,50,00,000 per year for three years)	4,50,00,000
	• Bath shelter for women along NW-1 for maintaining privacy from vessel movement	No	305 shelter	On average one shelter per village @ Rs 2,00,000 per shelter	6,10,00,000
	• Support for cleanliness at Ghats and improvement of Ghats such as for Durga Chak Emersion Ghat	No	1	Lump sum	1,00,00,000
Environmental Monitoring in the construction phase	• Terrestrial and Aquatic Fauna	3,00,000 per season per site (Once in six month) 20 sites for 2 years			2,40,00,000
	• Ambient Air Quality	50,000 per monitoring per site (Once in three month) 20 sites for 2 years			80,00,000

Component	Item	Unit	Quantity	Rate	Amount
	• Surface Water Quality	24,000 for upstream & downstream (Once in month) 20 sites for 2 years			1,15,20,000
	• Drinking Water Quality	12,000 (Once in month) 20 sites for 2 years			57,60,000
	• Noise & Vibration	10,000 per monitoring (Once in month) 20 sites for 2 years			48,00,000
	• Soil Quality, Erosion & Siltation and River Bed Sediment	50,000 per Site (Once in six month) 20 sites for 2 years			40,00,000
		SUB TOTAL (DESIGN AND CONSTRUCTION STAGE)			**310280000 31.03 Crores**
OPERATION STAGE					
Erosion Control and landscaping	• Visual Check	Lump Sump	To be part of Regular maintenance and operation costs		-
Measures to Reduce GHGs	• Green buildings • Modern designed vessels complying with MARPOL for emissions • Adoption of alternate energy options like solar power, LNG based vessels as possible	Covered in project design and engineering cost			--
Emergency Preparedness: Accident Response	Ambulance equipped with requisite emergency medical aid facility, First Aid Facility, Fire-fighting Equipment, Safety Trainings, Mock Drills etc.	Lump Sump	Lump sum provision of Rs 16800000 per year (@ Rs 2400000 per site for 7 site for 3 years, one doctor and one paramedical officer and one driver per site) +1,75,0000 (onetime costs of ambulance and other requirements @ Rs 25,00,000 per site for 7 sites) (		6,79,00,000
Waste Water Management	• STP Operation, rainwater harvesting management and maintenance	Lump Sump	To be part of Regular maintenance and operation costs Lump sum provision of Rs 1200000 per site per annum for 6 sites for 3 years		2,16,00000
Storm Water Management System	• Maintenance of Storm water drains • maintenance of Storm water storage ponds and dump ponds	Lump Sump	To be part of Regular maintenance and operation costs (provision made under waste water management head)		-
Waste Management System	• Collection, segregation and disposal of municipal waste, hazardous waste (used oil) and dredged soil	Lump Sump	To be part of Regular maintenance and operation costs		-
Monitoring of performance	• Terrestrial and Aquatic Fauna including surveillance audit	3,00,000 per season per site (Once in six month) 20 sites for 3 years			3,60,00,000

Component	Item	Unit	Quantity	Rate	Amount
indicators	• Ambient Air Quality	50,000 per monitoring (Once in six month) 20 sites for 3 years			60,00,000
	• Surface Water Quality	24,000 for upstream & downstream (Once in quarter) 20 sites for 3 years			57,60,000
	• Ground Water /Drinking Water Quality	12,000 (Once in quarter) 20 sites for 3 years			28,80,000
	• Noise & Vibration	10,000 per monitoring (Once in quarter) 20 sites for 3 years			24,00,000
	• Soil Quality, River Bed Sediments, Soil Erosion & Siltation, Integrity of embankments	50,000 ((Once in six month) 20 sites for 3 years			60,00,000
		SUB TOTAL (OPERATION PHASE)			**1,48,540,000(14.85 Cr)**
TRAINING and AWARENESS					
Training	• Environmental training & awareness	-	-	Included in overall NW-1 Project Budget	40,00,000
ESTABLISHMENT AND SYSTEMS					
Establishment	• Supervision Consultant (environment and Social)	-	-	Included in overall NW-1 Project Budget	-
	• Construction Stage (Site Environmental officer)		-	Included in overall NW-1 Project Budget	-
	• Operation Stage	-	-	Included in overall NW-1 Project Budget	-
Management Systems	• Adoption of EHS management systems	1	1	Lump sum	50,00,000
	• Management Information and tracking system	1	1	Lump sum	75,00,000
SUBTOTAL (ESTABLISHMENT & TRAINING and MANAGEMENT SYSTEM)					**1,65,00,000**
SUB TOTAL (Construction, and Operation and mobilization)					**450258000 45.025 Cr**
CONTINGENCIES @ 5 % on total Environmental Costs					**2,37,66,000 Or say 2.38 Cr**
GRAND TOTAL (in Rs)					**499086000 Or say 49.91 Cr**

Chapter 8. SUMMARY, CONCLUSION and RECOMMENDATIONS

Summary and Conclusions

Jal Marg Vikas Project involves navigation capacity augmentation of the NW-1 so as to ensure the navigation through IWT mode throughout the year in entire NW-1. NW-1 is natural waterway, extends from Haldia (Sagar) to Allahabad and spans 1620 km crossing the states of Bihar, Jharkhand, Uttar Pradesh & West Bengal. Project area includes entire reach NW-1 (Haldia to Allahabad) including the areas proposed for development of project related facilities & infrastructure, i.e. terminal sites, lock site, Ro-Ro jetty sites and sites for other planned development. NW-1 stretch traverses through various major cities and towns which are well connected by roads and railways. Developments proposed under Jal Marg Vikas project includes maintenance of LAD in navigation channel (3 m from Haldia to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi), development of navigation infrastructure such as navigation aids, terminals (6 nos.)/ro-ro jetties (10 nos.)/locks (1 no.), procurement of barges/dredgers and other necessary equipment, development and implementation of river information system, treatment of navigational hazards and carrying out bank protection and river training works at required locations.

Studies were carried out by survey consultant, existing cargo movement across the stretch of NW-1 through road & rail is 121426130 tonnes. Forecasted cargo studies are carried out by the survey consultant and cargo generation potential across NW-1 (Haldia to Varanasi) by year 2045 is expected to be 4,80,11,367 tonnes. The project being of large spatial extent, is planned to be developed in phases. At present planning has been carried out at 3 terminal sites, i.e. at Sahibganj, Varanasi and Haldia. Sahibganj, Varanasi and Haldia terminal are designed to handle the cargo of 2.24 MTPA, 0.54 MTPA and 4.07 MTPA respectively for phase I depending on available infrastructure. Navigation channel of 64 m width is planned to be maintained from Haldia to Varanasi stretch through dredging between Haldia and Varanasi. No dredging beyond Varanasi is planned to be undertaken at present. Dredging quantity of app. 15.76 million cum is estimated to be undertaken between Haldia and Varanasi to ensure year round navigation. Apart from dredging for maintenance of LAD in navigation channel, dredging of 0.10-0.20 million cum/year is required at the Haldia terminal. For purpose of dredging, 16 nos. of dredgers are estimated to be required. CSD along with agitation dredgers and backhoe dredgers are proposed to be used for carrying out dredging. Dredged material will majorly be disposed within the river and will be taken to land for disposal, if found to be contaminated.

Baseline study has been carried out in the project area to study the existing conditions of environmental and social parameters at site. The whole NW-1 (Allahabad to Haldia) falls within a relatively flat terrain of the Indogangetic plain. The elevation within the 10 km area of the NW-1 stretch ranges between 321 m to 1 m. highest elevation was observed at Sahibganj area (Jharkhand) that is because of small hills present in this area. Land use within the 10 km Radius of the NW-1 is majorly dominated by agricultural land. The predominant wind direction in all IMD stations located along NW-1 is from North and Northwest direction in winters and South and Southeast direction during rest of the season. The wind speed in the area was mostly ranges between 1.9 km/hour at Patna IMD and maximum of 8.7 km/hour at Kolkata IMD for all the months of a year. December and January constitutes winter months with daily mean minimum temperature of around 9.1^{0}C at Patna (IMD Station) and daily mean maximum temperature of around 26.9^{0}C at Kolkata. April and May are the hottest months with daily mean maximum temperature varying around

40.4^{0}C at Varanasi and daily mean minimum temperature around 24^{0}C at Malda. Relative humidity ranges between 25-84%. The annual total rainfall in all IMD stations (representing respective city/towns) ranges between 1000.3 mm at Varanasi and 1728.5 mm at Kolkata.

PM_{10} values in all locations are within the specified limit of 100 $\mu g/m^3$ except at Varanasi, Patna and Howrah location. All value of $PM_{2.5}$ is within the specified limit of 60 $\mu g/m^3$ except Varanasi, Patna and Howrah locations. The observed SO_2 and NOx level was found within the national Ambient Air Quality Standard. Carbon Mono-oxides was detected in few locations i.e. Haldia, Howrah, Patna and Varanasi and is found within the national Ambient Air Quality Standard. Ambient noise levels of the entire NW-1 stretch are within the prescribed National Ambient Noise Quality Standard for respective residential and commercial category at all the monitored locations. The Physico-chemical characteristics of the ground water samples collected for study purpose were in good agreement with IS:10500 permissible limits except TDS & total hardness values at Haldia, Sahibganj, Howrah & Kolkata. As is found to be present in ground water of Bhagalpur & Munger but in low concentration. As per surface water quality monitoring, river water quality observations reflect that water quality meets with BDU Class D Criteria of CPCB barring few parameters PH, DO which meets A class criteria. Metallic and pesticide level is within prescribed limit of Drinking water standard. Most of the NW-1 stretch is dominated by alluvial soil type. The texture of soil along NW-1 stretch is sandy clay and clay loam type. The analysis reflected that the soils are generally neutral to slightly alkaline nature. Overall soil along the NW-1 area is of moderately fertile. The concentration level of heavy metal in river bed sediments was found low in concentration and within acceptable limit as per standard (Criteria for Off-Shore Dumping of Dredged Material, USA) except cadmium which is slightly above the USA standard at some location in UP stretch that may be due to industrial effluent discharge in this section. Pesticide concentration in all sample were found far below the USA criteria. The pesticides presence is on expected line as these are predominantly used for various agriculture applications. There are three notified wild life sanctuaries (Kashi Turtle Sanctuary, Varanasi, UP, Dolphin Sanctuary, Bihar and Hilsa Sanctuary, WB located within the NW-1 stretch. There are 6 nos. of important bird areas including Udhwa bird sanctuary, located within 10 km area of the NW-1 stretch. Gangetic dolphin (Schedule-1) and fresh water turtle species are present in the river stretch of the NW-1.

On the basis of the baseline data and associated project activities, impacts of the project activities on social and environmental parameters were analysed. It is predicted that project will have impact on air, water, noise, soil, drainage, hydrology and ecology and socio-economy of the area. However, mitigation measures and management plans are proposed for mitigating the anticipated negative impacts of the project.

Environment management plans are prepared to prevent/control/abatement of pollution resulting from project activities in different stages. Environment management plan defines the institutional framework responsible for implementation of EMP, environment monitoring plan and environment management budget.

As per the EIA study, it is concluded that the development of project “Jal Marg Vikas” is beneficial for the economic development of country by increasing the freight transportation and is beneficial for environment by shifting freight load from road/railway to waterways and cutting down carbon emission. However, project development will have many impacts on social and environmental parameters. Mitigation measures and management plans are prepared in line with impacts anticipated. If the proposed mitigation measures are taken and

environment management plan is implemented, anticipated negative impacts of project can be reduced and benefits can be further enhanced. The project will overall bring development in the area.

Recommendations:

It is recommended that IWAI should provide desired resources for implementation of EMPs and ensure that EMPS are effectively implemented. It must institutionalize the system of period monitoring against the defined performance indicators and establish the system of half yearly reporting. It should also develop its own EHS guidelines and protocols for managing all the projects uniformly from environment health and safety prospective. System should be self-responding in nature for initiating timely corrective and preventive action if any required for the protection of environment.

Adequate training shall be imparted as proposed under environmental management plan to enhance the capability of concerned EA officials. Awareness programme for contractor and workers shall also be organised for effective implementation of EMP.

The EIA was carried out while the feasibility study was being prepared and initial finding of DPR preparation stage. Therefore, the detailed engineering design was not available. In this regard, any major changes during detailed design, or any major additional work other than the proposed project activities will require updating this environmental assessment. Also it may have to be sent to World Bank for concurrence before works commence.

Annexures

Annexure 2.1: International Maritime Conventions, Protocol and Agreements Relevant to Project

International Maritime Conventions, Protocols and Agreements Relevant to the Project

S. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
1.	International Maritime	IMO Convention, 1948	The Convention establishing the IMO was adopted in 1948 but the Organization started life as the Inter-Governmental Maritime Consultative Organization (IMCO) until it was changed to the IMO in 1982. The Aims of the IMO include a range of objectives: 1. To provide machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade, and to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation; 2. To provide for the consideration by the Organization of any matters concerning shipping that may be referred to it by any organ or specialized agency of the United Nations; 3. To provide for the exchange of information among Governments on matters under consideration by the Organization. There have been a series of amendments to the Convention which are 1975 amendments, 1977 amendments, 1991 amendments.
2.	Maritime safety	SOLAS Convention, 1974	The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The 1974 version includes the tacit acceptance procedure - which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties. The Convention came into force on May 25, 1980
3.	Measurement of ships	Load Lines Convention,1966	It has long been recognized that limitations on the draught to which a ship may be loaded make a significant contribution to her safety. These limits are given in the form of freeboards, which constitute, besides external weather tight and watertight integrity, the main objective of the Convention.

4.	Preventing collisions at sea	Convention on International Regulations for Preventing Collisions at Sea (COLREG), 1972	The 1972 Convention was designed to update and replace the Collision Regulations of 1960 which were adopted at the same time as the 1960 SOLAS Convention. One of the most important innovations in the 1972 COLREGs was the recognition given to traffic separation schemes - Rule 10 gives guidance in determining safe speed, the risk of collision and the conduct of vessels operating in or near traffic separation schemes.
5.	International Maritime Satellite System	Convention on International Maritime Satellite Organization (INMARSAT), 1976	IMO recognized the potential for satellite communications to assist in distress situations at sea soon after the launch of the world's first telecommunications satellite, Telstar, in 1962. In February 1966, IMO's Maritime Safety Committee (MSC) decided to study the operational requirements for a satellite communications system devoted to maritime purposes. In 1973, IMO decided to convene a conference with the object of establishing a new maritime communications system based on satellite technology.
6.	Prevention of Pollution from Ships	International Convention for the Prevention of Pollution from Ships (MARPOL), 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997(MARPOL)	The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and also includes the Protocol of 1997 (Annex VI). It has been updated by amendments through the years.
		Convention on Facilitation of International Maritime Traffic (FACILITATION), London, 1965	The Convention's main objectives are to prevent unnecessary delays in maritime traffic, to aid cooperation between Governments, and to secure the highest practicable degree of uniformity in formalities and other procedures. In particular, the Convention reduces the number of declarations which can be required by public authorities.
7.	Safety of maritime navigation	Convention for The Suppression of Unlawful Acts of Violence Against the Safety of Maritime Navigation (SUA convention), 1988	The main purpose of the convention is to ensure that appropriate action is taken against persons committing unlawful acts against ships. These include: • the seizure of ships by force; • acts of violence against persons on board ships; and • the placing of devices on board a ship which are likely to destroy or damage it. The convention obliges Contracting Governments either to extradite or prosecute alleged offenders.
8.	Environmental Safety	Convention Relating to Intervention on the High Seas, 1969	Contracting States are empowered to act against ships of other countries which have been involved in an accident or have been damaged on the high seas if there is a grave risk of oil pollution occurring as a result.

9.	Standards of Training, Certification and Watch keeping for Seafarers	International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW) as amended, including the 1995 and 2010 Manila Amendments	The main purpose of the convention is to ensure the safety of seagoing personnel. Convention in explained in two codes A & B. Code A is mandatory while Code B is recommendation. It intends to help parties implement the convention.
10.	Maritime Search and Rescue (SAR)	SAR Convention 79	Aimed at developing an international SAR plan, so that, no matter where an accident occurs, the rescue of persons in distress at sea will be coordinated by a SAR organization and, when necessary, by co-operation between neighbouring SAR organizations.
11.	Safe containers	International Convention for Safe Containers (CSC) 72/77	The 1972 Convention for Safe Containers has two goals. • to maintain a high level of safety of human life in the transport and handling of containers by providing generally acceptable test procedures and related strength requirements • to facilitate the international transport of containers by providing uniform international safety regulations, equally applicable to all modes of surface transport to avoid proliferation of divergent national safety regulations The requirements of the Convention apply to the great majority of freight containers used internationally, except those designed especially for carriage by air. As it was not intended that all containers or reusable packing boxes should be affected, the scope of the Convention is limited to containers of a prescribed minimum size having corner fittings - devices which permit handling, securing or stacking.
12.	Safety of Fishing vessel	The Torremolinos International Convention for the Safety of Fishing Vessels (SFV),1977, superseded by the 1993 Torremolinos Protocol; Cape Town Agreement of 2012 on the Implementation of the Provisions of the 1993 Protocol relating to the Torremolinos International Convention for the Safety of Fishing Vessels	The Protocol applies to fishing vessels of 24 metres in length and over including those vessels also processing their catch. The general trend in modern designed fishing vessels, if they are to be economically profitable, must include improvements in machinery and fishing gear, improvements in safety features as a whole and better working conditions for fishermen. The safety provisions include automatically controlled machinery spaces, improved life-saving appliances, immersion suits and thermal protective aids, satellite communication systems and other components of the global maritime distress and safety system.

13.	Standards of Training, Certification and Watch keeping for Fishing Vessel Personnel	International Convention on Standards of Training, Certification and Watch keeping for Fishing Vessel Personnel (STCW-F), 1995	General Provisions & certifications of Safety of Skippers, Officers, Engineer Officers and Radio Operators.
14.	Space Requirements for Special Trade Passenger Ships, 1973	Special Trade Passenger Ships Agreement (STP), 1971 and Protocol on Space Requirements for Special Trade Passenger Ships, 1973	Following the International Conference on Special Trade Passenger Ships, 1971, IMO, in cooperation with other Organizations, particularly the World Health Organization (WHO), developed technical rules covering the safety aspects of carrying passengers on board in special trade passenger ships (ships carrying large nos. of unberthed passengers such as in pilgrim area)
15.	Prevention of Marine Pollution by Dumping of Wastes and Other Matter	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LC), 1972 (and the 1996 London Protocol)	London Convention, one of the first international conventions for the protection of the marine environment from human activities, came into force on 30 August 1975. Since 1977, it has been administered by IMO. It contributes to the international control and prevention of marine pollution by prohibiting the dumping of certain hazardous materials. In addition, a special permit is required prior to dumping of a number of other identified materials and a general permit for other wastes or matter.
16.	Oil Pollution Preparedness, Response and Co operation	International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC), 1990	As per convention, Ships are required to carry a shipboard oil pollution emergency plan. Operators of offshore units under the jurisdiction of Parties are also required to have oil pollution emergency plans or similar arrangements which must be coordinated with national systems for responding promptly and effectively to oil pollution incidents. Ships are required to report incidents of pollution to coastal authorities and the convention details the actions that are then to be taken. The Convention calls for the establishment of stockpiles of oil spill combating equipment, the holding of oil spill combating exercises and the development of detailed plans for dealing with pollution incidents. Parties to the convention are required to provide assistance to others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided.
17.	Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious	Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances, 2000	Convention aims to establish national systems for preparedness and response and to provide a global framework for international co-operation in combating major incidents or threats of marine pollution. Parties to the OPRC-HNS Protocol are required to establish measures for dealing with pollution incidents,

	Substances	(OPRC-HNS Protocol)	either nationally or in co-operation with other countries. Ships are required to carry a shipboard pollution emergency plan to deal specifically with incidents involving hazardous and noxious substances. The OPRC-HNS Protocol ensures that ships carrying hazardous and noxious substances are covered by preparedness and response regimes similar to those already in existence for oil incidents.
18.	Control of Harmful Anti-fouling Systems	International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS), 2001	Under the terms of the AFS Convention, Parties to the Convention are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a Party. Anti-fouling paints are used to coat the bottoms of ships to prevent sealife such as algae and molluscs attaching themselves to the hull – thereby slowing down the ship and increasing fuel consumption. n the early days of sailing ships, lime and later arsenic were used to coat ships' hulls, until the modern chemicals industry developed effective anti-fouling paints using metallic compounds. These compounds slowly "leach" into the sea water, killing barnacles and other marine life that have attached to the ship. But studies have shown that these compounds persist in the water, killing sea-life, harming the environment and possibly entering the food chain. One of the most effective anti-fouling paints, developed in the 1960s, contains the organotin tributyltin (TBT), which has been proven to cause deformations in oysters and sex changes in whelks.
19.	Safe and Environmentally Sound Recycling of Ships	The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009	Convention aimed at ensuring that ships, when being recycled after reaching the end of their operational lives, do not pose any unnecessary risk to human health and safety or to the environment. It intends to address all the issues around ship recycling, including the fact that ships sold for scrapping may contain environmentally hazardous substances such as asbestos, heavy metals, hydrocarbons, ozone depleting substances and others. It will address concerns about working and environmental conditions in many of the world's ship recycling facilities. Regulations in the new Convention cover: the design, construction, operation and preparation of ships so as to facilitate safe and environmentally sound recycling, without compromising the safety and operational

			efficiency of ships; the operation of ship recycling facilities in a safe and environmentally sound manner; and the establishment of an appropriate enforcement mechanism for ship recycling, incorporating certification and reporting requirements. Ships to be sent for recycling will be required to carry an inventory of hazardous materials, which will be specific to each ship.
20.	Control and Management of Ships' Ballast Water and Sediments	International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004	Convention aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediment. Under the Convention, all ships in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. The ballast water management standards will be phased in over a period of time. As an intermediate solution, ships should exchange ballast water mid-ocean. However, eventually most ships will need to install an on-board ballast water treatment system
21.	Tonnage convention	International Convention on Tonnage Measurement of Ships 69/82	The Convention, adopted by IMO in 1969, was the first successful attempt to introduce a universal tonnage measurement system. The Convention provides for gross and net tonnages, both of which are calculated independently.
22.	Salvage Convention, 1989	International Convention on Salvage (SALVAGE), 1989	As per convention, "special compensation" to be paid to salvors who have failed to earn a reward in the normal way (i.e. by salving the ship and cargo). The compensation consists of the salvor's expenses, plus up to 30% of these expenses if, thanks to the efforts of the salvor, environmental damage has been minimized or prevented. The salvor's expenses are defined as "out-of-pocket expenses reasonably incurred by the salvor in the salvage operation and a fair rate for equipment and personnel actually and reasonably used".

Annexure 2.2: Applicable Environmental Standards / Norms

Ambient Air Quality Standards: The MoEF has the overall responsibility to set policy and Standards for the protection of environment along with Central Pollution Control Board (CPCB). Ambient Air Quality Standard given below:

Revised National Ambient Air Quality Standards (16th November 2009)

Pollutants	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural, other areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), µg/m^3	Annual * 24 Hours **	50 80	20 80
Nitrogen Dioxide (NO_2), µg/m^3	Annual * 24 Hours **	40 80	30 80
PM_{10}, µg/m^3	Annual * 24 Hours **	60 100	60 100
$PM_{2.5}$, µg/m^3	Annual * 24 Hours **	40 60	40 60
Ozone (O_3) µg/m^3	8 Hours * 1 Hour **	100 180	100 180
Lead (Pb) µg/m^3 in particulate matter	Annual * 24 Hours **	0.50 1.0	0.50 1.0
Carbon Monoxide (CO), mg/m^3	8 Hours ** 1 Hour **	02 04	02 04
Ammonia (NH_3), µg/m^3	Annual * 24 Hours **	100 400	100 400
Benzene (C_6H_6), µg/m^3	Annual *	05	05
Benzo(a)Pyrene (BaP) ng/m^3 in particulate matter	Annual *	01	01
Arsenic (As), ng/m^3 in particulate matter	Annual *	06	06
Nickel (Ni), ng/m^3 in particulate matter	Annual *	20	20

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Ambient Noise Standards: Ambient standard with respect to noise have been notified by the Ministry of Environment and forest vide gazette notification dated 26th December 1989 (amended in February 2000). It is based on 'A' weighted equivalent noise level (Leq). The ambient noise standards are presented in table below:

Ambient Noise Quality Standards

Area code	Category of Area	Limits in dB(A) Leq	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Sensitive Area	50	40

Note: *Day time is from 6 am to 10 pm, Night time is 10 pm to 6.00 am; ** Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones.

Ground Water Quality Standards

Bis Standards For Drinking Water (Is:10500)

	Parameters	Unit	Acceptable Limit IS:10500	Permissible Limit IS:10500
1	Colour	Hazen units	5	15
2	Odour	-	Agreeable	Agreeable
3	Taste	-	Agreeable	Agreeable
4	Turbidity	NTU	1	5
5	Total Dissolved Solids	mg/l	500	2000
6	pH	-	6.5 to 8.5	No Relaxation
7	Total Hardness as $CaCO_3$	mg/l	200	600
8	Iron as Fe	mg/l	0.3	No Relaxation
9	Aluminium	mg/l	0.03	0.2
10	Copper as Cu	mg/l	0.05	1.5
11	Manganese as Mn	mg/l	0.1	0.3
12	Zinc as Zn	mg/l	5	15
13	Magnesium as Mg	mg/l	30	No Relaxation
14	Barium	mg/l	0.7	No Relaxation
15	Calcium as Ca	mg/l	75	200
16	Silver	mg/l	0.1	No Relaxation
17	Selenium as Se	mg/l	0.01	No Relaxation
18	Molybdenum	mg/l	0.07	No Relaxation
19	Boron	mg/l	0.5	1.0
20	Nitrates as NO_3	mg/l	45	No Relaxation
21	Sulphate	mg/l	200	400
22	Sulphide		0.01	No Relaxation
23	Fluoride as F	mg/l	1.0	1.5
24	Chlorides as Cl	mg/l	250	1000
25	Ammonia	mg/l	0.5	No Relaxation
26	Chloramines	mg/l	0.2	No Relaxation
27	Residual, Free chlorine	mg/l	0.2	1.0
28	Total Alkalinity as calcium carbonate	mg/l	200	600
29	Phenolic compounds (as C_6H_5OH)	mg/l	0.001	0.002
30	Mineral Oil	mg/l	0.03	No Relaxation
31	Anionic detergents (as MBAS)	mg/l	0.2	1.0
32	Chromium	mg/l	0.05	No Relaxation
33	Arsenic as As	mg/l	0.01	0.05
34	Mercury as Hg	mg/l	0.001	No Relaxation
35	Cadmium as Cd	mg/l	0.003	No Relaxation
36	Lead as Pb	mg/l	0.01	No Relaxation
37	Nickel as Ni	mg/l	0.02	No Relaxation
38	Cyanide as CN	mg/l	0.05	No Relaxation
39	Polynuclear Aromatic Hydrocarbons (as PAH)	mg/l	0.0001	No Relexation
40	Polyclorinated biphenyls	mg/l	0.0005	No Relaxation
41	Total Coliform	MPN/100ml	Nil	No Relaxation

Surface Water Quality

Best Designated Use Criteria for Surface Waters Streams

Designated-Best-Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml <50 pH between 6.5 - 8.5 Dissolved Oxygen > 6mg/l Biochemical Oxygen Demand < 2mg/l
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml < 500 pH between 6.5 - 8.5 Dissolved Oxygen > 5mg/l Biochemical Oxygen Demand < 3mg/l
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml < 5000 pH between 6 - 9 Dissolved Oxygen > 4 mg/l Biochemical Oxygen Demand < 3mg/l
Propagation of Wild life and Fisheries	D	pH between 6.5 - 8.5 Dissolved Oxygen > 4mg/l Free Ammonia (as N) < 1.2 mg/l
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 - 8.5 Conductivity at 25°C:.< 2250 umhos/cm Sodium Absorption Ratio < 26 Boron < 2mg/l

Soil Quality

Standard Soil Classification

The standard soil classification is shown below:

Sr. No.	Soil test	Classification
1.	Ph	5.51 - 6.0 Moderately acidic 6.01 - 6.50 Slightly acidic 6.51 - 7.30 Neutral 7.31 - 7.80 Slightly alkaline 7.81 - 8.50 Moderately alkaline
2.	Salinity as electrical conductivity (milli mhos/cm)	Upto 1.00 Average 1.01-2.00 Harmful to germination 2.01-3.00 Harmful to crops
3.	Organic carbon (%)	0.21-0.4 Less 0.41-0.5 Medium 0.51-0.8 On an average sufficient 0.81-1.00 sufficient
4.	Nitrogen (kg/ha)	51-100 Less 101-150 Good 151-300 Better >300 Sufficient
5.	Phosphorus (kg/ha)	16-30 Less 31-50 Medium 51-65 On an average sufficient
6.	Potassium (kg/ha)	120-180 Less 181-240 Medium 241-300 Average 301-360 Better

Annexure 3.1 : Estimated Suspended Sediments Generation Standards from Dredging and Dumping operations

Estimations had been made in Assessment Manual for dredging and Reclamation, Ministry of Transport, Japan for suspended sediment generation from dredging and dumping operations is given in**Table 1**. These can be used for estimating the suspended sediments to be generated from dredging for construction and operation of terminal

Table 1: Approximate Suspended Sediment Generation from Dredging Operation

Activity / Type of the Bottom	**SS generated by dredging or dumping of one cubic metre of sandy material**	**SS generated by dredging or dumping of one cubic meter of silt / clay**
Pump dredging	Kg/m^3	Kg/m^3
Ordinary 4,000 PS[1/]	(2) 2.2 – 4.5	(2) 1.2 – 1.4
Ordinary 2,000 PS	(3) 0.1 – 0.3	NA
Low – pollution type 1,600 PS	NA	(3) 1.2 – 1.6
Low – pollution type 800 PS	NA	(2) 1.5 – 3.5
Grab dredging		
Ordinary 8m^3 bucket	NA	(2) 10 – 89
Ordinary 3 m^3 bucket	(1) 8.4	(4) 12 – 84
Water – tight type 8 m^3 bucket	NA	(1) 3.5
Bucket dredger	(1) 17	(1) 56
Dumping		
By grab bucket	(11) 0.4 – 5.0	NA
From hopper barge	(2) 2.4 – 5.2	(5) 12 – 203

Note: Parentheses are the number of times of observations

NA: Not Available

[1/]: Capacity of pump in Horse Power

Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992

Annexure 3.2 : Estimated Suspended Sediments Generation Standards from Dredging and Dumping operations

Cutter Suction Dredgers

CSD (cutter section dredgers) is a hydraulic based system. CSD consists of a centrifugal pump and the suction tube that has cutting mechanism (rotary blade) at the end. The main technique is applied in dredging is that loosening the sand and cutting are done simultaneously, and the dredged material is sucked by the dredging pump and transported through a pipeline. Typical diagram of CSD in river is given in **Figure 1.1** below.

Figure 1.1 : Schematic Diagram of CSD

Dredged Disposal Through CSD

Dredged disposal can be off-shore or on-shore in case of CSD. Both the type of disposal has their own associated environment and social impacts. Comparative analysis of both the method of disposal is given below in **Table below.**

Table : Comparative Analysis of Dumping of Dredged Material

S. No.	Considerations	Off-shore Dumping	On-shore Dumping
1	Aquatic ecology	Threat to the benthic community due to smothering, impact on habitat of water birds and other aquatic species especially during breeding & spawning seasons.	Comparatively lesser direct impact but requires large no. of barge movement for disposal of dredged material on land which again impact the aquatic life

2	Impact on land	Nil	requires large area of waste land which can be used for disposal of the dredged spoil
3	Water Pollution	Release of sediments while placement operation. No overflow expected as CSDs are being used	Ground water pollution anticipated, in case sediments are toxic and stored in unlined/unpaved pits
4	Cost	Lesser	More
5	Photograph of disposal through CSDs		

Conclusion for Disposal of Dredged Material

Since the CSDs are proposed to be used for dredging, barges will be required to load the dredged material in barges and unload at on-shore location if onshore disposal is proposed. Large nos. of barges will be required to carry this large quantity of sand which is economically not viable. Movement of large nos. of barges for dredged disposal will have associated environmental, economic and social impacts. Thus it is recommended that only off-shore (within River) disposal of dredged material should be undertaken. This dredged material should be disposed to land in control manner only when the dredged spoil is toxic or contaminant. One of such site is approved off-shore dumping ground of Haldia Dock Complex/Kolkata Port Trust at Sagar at about 60 km from Haldia terminal. Impacts of off-shore disposal can be minimized by proposed mitigation measures in Chapter 5.

Annexure 4.1:List Flora and Fauna observed Along NW-1 (Allahabad to Haldia)

Table-1: Riparian Flora Observed/Reported along the NW-1 stretch (Allahabad to Haldia)

S. No.	Scientific Name	Local Name	Family
	A. Trees		
1.	*Acacia arabica*	Babul	Fabaceae
2.	*Acacia catechu*	Khair	Fabaceae
3.	*Adina cordifolia*	Karam	Rubiaceae
4.	*Aegle marmelos*	Bel	Rutaceae
5.	*Ailanthus excelsa*	Ghorkaranj/Ghorkaram	Simaroubaceae
6.	*Alangium Lamarckii*	Dhela	Cornaceae
7.	*Albizzia lebbeck*	Black Siris	Fabaceae
8.	*Albizzia odoratissima*	Jang Siris	Fabaceae
9.	*Albizzia procera*	Safed Siris	Fabaceae
10.	*Alstonia scholaris*	Chatni	Apocynaceae
11.	*Anogeissus latifolia*	Dhatura	Combretaceae
12.	*Artocarpus intigrifolia*	Kathal	Moraceae
13.	*Azadirachta indica*	Neem	Meliaceae
14.	*Bauhinia retusa*	Kathul	Caesalpiniaceae.
15.	*Bauhinia purpurea*	Koenar	Fabaceae
16.	*Bauhinia racemosa*	Katmauli	Fabaceae
17.	*Bauhinia variegata*	Kachnar	Fabaceae
18.	*Bombax ceiba*	Semal	Malvaceae
19.	*Boswellia serrata*	Salia	Burseraceae
20.	*Buchanania lanzan*	Piar	Anacardiaceae
21.	*Butea frondosa*	Palas	Fabaceae
22.	*Careya arborea*	Kumbhi	Lecythidaceae
23.	*Cassia fistula*	Dhanraj/Amaltas	Fabaceae
24.	*Dalbergia lanceolaria*	Hardi	Fabaceae
25.	*Dalbergia latifolia*	Kala Shisham	Fabaceae
26.	*Dalbergia sissoo*	Shisham	Fabaceae
27.	*Diospyros melanoxylon*	Tend/Kend/Tiril	Ebenaceae
28.	*Delenia pentagyna*	Rai	Dilleniaceae
29.	*Emblica officinalis*	Amla	Phylanthaceae
30.	*Ficus benghalensis*	Barh	Moraceae
31.	*Ficus religiosa*	Pipal	Moraceae
32.	*Ficus tomentosa*	Barun	Moraceae
33.	*Gardenia latifolia*	Papra	Rubiaceae
34.	*Gmelina arborea*	Gamhar	Lamiaceae
36.	*Grewia asiatica*	Patdhaman	Malvaceae
37.	*Holarrhena antidysentrica*	Koreya	Apocynaceae
38.	*Lagerostroemia parviflora*	Sidha	Lythraceae
	Litchi chinensis	Litchi	Sapindaceae
39.	*Madhuca latifolia*	Mahua	Sapotaceae
40.	*Mallotus philippinensis*	Rohan	Euphorbiaceae
41.	*Mangifera indica*	Aam (Mango)	Anacardiaceae
42.	*Melia azadirach*	Bakain	Meliaceae
43.	*Michelia champaca*	Champa	Magnoliaceae
44.	*Mitrgyna parviflora*	Guri/Gurikaram	Rubiaceae
45.	*Morus alba.*	Tut	Moraceae
46.	*Murraya exotica*	Kamini/Otel	Rutaceae
47.	*Oroxylum indicum*	Sonapatta	Bignoniaceae

48.	*Ougeinia oojenesis*	Sandam	Fabaceae
49.	*Pongamia glabra*	Karanj	Fabaceae
50.	*Pterocarpus marsupium*	Bia/Paisar	Fabaceae
51.	*Randia uliginosa*	Piurar	Rubiaceae
52.	*Rubia cordifolia*	Jotsingh	Rubiaceae
54.	*Sapindus mukorossi*	Ritha	Sapindaceae
55.	*Schleichera oleosa*	Kusum	Sapindaceae
56.	*Semecarpus anacardium*	Bhelwa	Anacardiaceae
57.	*Shorea robusta*	Sal/Sakhua	Dipterocarpaceae
58.	*Soymida febrifuga*	Rohena	Meliaceae
59.	*Spondias mangifera*	Amra	Anacardiaceae
60.	*Sterculia urens*	Keonjhi	Malvaceae
61.	*Stereospermum suaveolens*	Padar	
62.	*Tamarindus indica*	Imli/Jojo	Fabaceae
63.	*Tectona grandis*	Sagwan/Teak	Lamiaceae
67.	*Terminalia arjuna*	Arjun	Combretaceae
68.	*Terminalia belerica*	Bahera	Combretaceae
69.	*Terminalia chebula*	Harra	Combretaceae
70.	*Terminalia tomentosa*	Asan	
71.	*Zizyphus mauritiana*	Ber	Rhamnaceae
72.	*Zizyphus xylopyra*	Katber	Rhamnaceae

Table-2: Riparian Flora (Herbs and Shrubs) Observed/Reported along the NW-1 stretch (Allahabad to Haldia)

Name of the Plant	Medicinal Importance	Name of the Plant	Medicinal Importance	Name of the Plant	Medicinal Importance
Shrubs					
Abelmoschus esculentus	-	*Calotropis gigantean*	M	*Mallotus repandus*	-
Abutilon indicum	M	*C. procera*	M	*Polyalthia suberosa*	-
Acanthus ilicifolius	-	*Clerodendrum inerme*	M	*Plumbago zeylanica*	M
Adhatoda zeylanica	M	*Datura sp.*	-	*Rouwolfia serpentina*	M
Barleria spp.	-	*Glycosmis arborea*	-	*Solanum khasianum*	M
B. cristata	-	*Hibiscus rosasinensis*	-	*S. indicum*	M
B. prionitis	-	*Jatropha curcus*	M	*S. torvum*	-
Caesalpinia crista	-	*J. gossypifolia*	-	*S. erianthum*	-
Casearia tomentosa	-	*Kirganelia reticulate*	-	*Urena lobata*	-
Cassia occidentalis	M	*Lantana camara*	-	*Vernonia anthelmintica*	M
C. sophera	M	*Leonurus sibiricus*	-	*Withania somnifera*	M
Herbs					
Acalypha indica	-	*Desmodium gangeticum*	M	*Parthenium hysterophorus*	-
Achyranthes aspera	M	*D. trifolia*	-	*Pedalium murex*	M
Ageratum conyzoides	M	*Digera muricata*	-	*Phaseolus trilobus*	-
Alhagi pseudoalhagi	-	*Echinops echinatus*	-	*Phyla nodiflora*	-
Alternanthera pungens	-	*Eclipta prostrate*	M	*P. simplex*	-
Alternanthera sessilis	-	*Erigeron asteroids*	-	*Physalis minima*	-
Alternanthus spinosus	-	*E. thymifolia*	-	*Polygonum glabrum*	-
Amaranthus spinosus	-	*Evolvulus plumbaginifolia*	-	*P. hydropiper*	-

A. spirtosus	-	*E. alsinoides*	-	*P. plebeium*	-
A. viridis	-	*Glinus lotoides*	M	*Portulaca oleracea*	-
Ammannia baccifera	-	*Gomphrena celosiodes*	-	*P. quadrifida*	--
Anagallis arvenis	-	*Grangea maderasptana*	-	*Potentilla supine*	-
Anisomeles indica	-	*Heliotropium hirsutum*	-	*Primula umbellata*	-
Argemone mexicana	-	*H. indicum*	-	*Psoralea corylifolia*	M
Asphodelus tenuifolius	-	*Hibiscus vitifolius*	-	*Ranunculus sceleratus*	-
Bergia ammannioides	-	*Hygrophila auriculata*	-	*Ricinus communis*	-
Blainvillea acmella	-	*Indigofera linifolia*	-	*Rumex dentatus*	-
Boerhavia diffusa	M	*I. linnaei*	-	*Rungia pectnata*	-
Caesulia axillaris	-	*Justicia peploides*	-	*Salvia plebeian*	-
Callicarpa nudiflora	-	*Lathyrus sativus*	-	*Scirpus articulates*	-
Cannabis sativa	-	*Launaea asplenifolia*	-	*Scoparia dulcis*	-
Canscora decussate	-	*Leucas aspera*	-	*Sida acuta*	-
Cassia tora	-	*Lindenbergia indica*	-	*S. cordata*	M
Catharanthus roseus	M	*Lindernia crustacean*	-	*S. obovata*	-
Celosia argentea	-	*Malvastrum*	-	*S. rhombiolia*	-
Centella asiatica	M	*Mazus pumilus*	-	*Solanum nigarum*	-
Chenopodium album	-	*Mecardonia procumbens*	-	*S. surattense*	-
Chrozosphora rottleri	-	*Medicago polymorpha*	-	*Trianthema portulacastrum*	-
Cleome gynandra	-	*Melilotus alba*	--	*Tribulus terrestris*	M
C. viscose	-	*M. indica*	-	*Tridax procumbens*	-
Commelina bengalensis	-	*Murdannia nudiflora*	-	*Ureria picta*	M
Convolvulus arvensis	-	*Nasturtium indicum*	-	*Verascum chinense*	-
C. microphyllus	-	*Nepeta hindostana*	-	*V. thaspus*	-
Costus speciosus	--	*Nicotiana plumbaginifolia*	-	*Vernonia cinerea*	-
Crotalaria medicaginea	-	*Ocimum canum*	-	*Vicia sativa*	-
Croton bonplandianum	-	*O. sanctum*	M	*Volutarella divaricata*	-
Cyanotis axillaris	-	*Oldenlandia corymbosa*	M	*Wedelia calendulacea*	-
Cynoglossum lancelatum	-	*O. paniculata*	-	*Xanthium strumarium*	-
Depteracanthus prostrates	-	*Oxalis comiculata*	-		
Climbers					
Asparagus spp.	M	*Derris trifoliate*	-	*I. sepiaria*	-
Bryonopsis laciniosa	-	*Dioscorea bulbifera*	M	*Leptadenia reticulate*	-
Celastrus paniculatus	-	*Hemidesmus indicus*	M	*Mikania cordata*	-
Cissampelos pareira	M	*Ichnocarpus fructescens*	M	*Pueraria tuberose*	M
Cuscuta reflexa	M	*Ipomoea cairica*	-	*Tinospora cordifolia*	-
Dalbergia spinosa	-	-	-	*Tylophora indica*	M
Grasses					
Cynodon dactylon	-	*Imperata cylindrica*	-	*Saccharum spontaneum*	-
Dichanthium annulatum	-	*Panicum repens*	-	*Setaria verticillata*	-
Hygroryza aristata	-	*Paspalum distichum*	-	-	-

Table-3: Ichthyo-faunal diversity of Ganga River at different locations from Allahabad to Haldia

S.No.	Name of Fishes	Local Name	Famiy	All.	Vara.	Pat.	Bha.	Sah.	Fara.	Hald.
1.	Acanthocobitisbotia (Hamilton)		Balitoridae	-	-	+	-	-	-	-
2.	Ailiacoila(Hamilton)		Siluridae	+	+	+	+	+	+	+
3.	Amblypharyngodongora(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
4.	Amblypharyngodonmicrolepis (Bleeker)		Cyprinidae	+	+	+	+			
5.	Amblypharyngodonmola(Hamilton-Buchanan)	Marwa	Cyprinidae	+	+	+				
6.	Anabas testudineus (Bloch)	Kawai		+	+	+				
7.	Anguilabengalensis(Gray)	Bamach		+	+	+				
8.	Aspidopariajaya(Hamilton)			+	+	+				
9.	Aspidopariamorar(Hamilton)	Pehora		+	+	+				
10.	Bagariusbagarius(Hamilton)	Baghar, Padhan	Siluridae	+	+	+	+	+	+	+
11.	Bagariusyarellii(Sykes)				+	+				
12.	Bariliusbendelisis(Hamilton)		Cyprinidae	+	+	+				
13.	Botiadario(Hamilton)	Baghi	Balitoridae	+	+	+	+	+	+	+
14.	Botialohachata(Hamilton)		Cobitidae	+	+	+				
15.	Cabdiamorar(Hamilton)			+	+	+	+	+	+	+
16.	Catla catla(Hamilton)	Catla	Cyprinidae	+	+	+	+	+	+	+
17.	Chaca chaca (Hamilton)		Chacidae	+	+	+	+	+	+	+
18.	Chaguniuschagunio(Hamilton)		Cyprinidae	+	+	+				
19.	Chandanama	Chanda	Ambassidae	+	+	+	+	+	+	+
20.	Channagachua(Hamilton)	Chenga	Channidae	+	+	+	+	+	+	+
21.	Channamarulius(Hamilton)	Gajal	Channidae	+	+	+	+	+	+	+
22.	Channaorientalis(Hamilton)		Channidae	+	+	+	+	+	+	+
23.	Channapunctatus(Bloch)	Garai	Channidae	+	+	+	+	+	+	+

24.	Channastriatus(Bloch)	Sauri	Channidae	+	+	+	+	+	+	+
25.	Chela atpar (Hamilton)		Cyprinidae	+	+	+	+	+		
26.	Chela labuca (Hamilton)		Cyprinidae	+	+	+	+	+		
27.	Cirrhinusmrigala(Hamilton)	Nain, Mirka	Cyprinidae	+	+	+	+	+	+	+
28.	Cirrhinusreba(Hamilton)	Mirka	Cyprinidae	+	+	+	+	+	+	+
29.	Clariasbatrachus(Linnaeus)	Mangur	Clariidae	+	+	+				
30.	Clupisomagarua(Hamilton)	Charnak wa		+	+	+	+	+	+	+
31.	Colisafasciatus(Bloch & Schneider)	Khesra	Osphronemidae	+	+	+	+	+	+	+
32.	Crosocheilluslatiuslatius(Hamilton)		Cyprinidae		+	+	+	+		
33.	Cyprinuscarpio(Linnaeus)		Cyprinidae	+	+	+	+	+	+	+
34.	Devariodevario(Hamilton)		Cyprinidae	+	+	+				
35.	Esomusdanricus (Hamilton)		Cyprinidae	+	+	+				
36.	Eutropiichthysmurius(Hamilton)	Sugwa	Siluridae	+	+	+				
37.	Eutropiichthysvacha(Hamilton)	Sugwa		+	+	+				
38.	Gadusachapra(Hamilton)			+	+	+	+	+		
39.	Gagatacenia (Hamilton)		Siluridae	+	+	+	+	+	+	+
40.	Garragotyla (Gray)		Cyprinidae	+	+	+				
41.	Glossogobiusgiuris(Hamilton)			+	+	+	+	+	+	+
42.	Glyptothoraxbotia (Hamilton)		Siluridae	+	+	+				
43.	Glyptothoraxcavia (Hamilton)		Siluridae	+	+					
44.	Glyptothoraxtelchitta (Hamilton)		Siluridae	+	+					
45.	Gogangraviridescense(Hamilton)				+	+	+	+		
46.	Gonialosamanmina(Hamilton)				+	+	+	+		
47.	Hemibagarusmenoda (Hamilton)		Bagridae	+	+	+	+			
48.	Heteropneustusfossilis(Bloch)	Singhi	Clariidae	+	+	+	+	+	+	+

49.	Hypopthalmichthysnobilis(Valenciennes)		Cyprinidae	+	+					
50.	Hyporamphuslimbatus(Valenciennes)			+	+	+				
51.	Johniuscoitor(Hamilton)		Sciaenidae	+	+	+	+			
52.	Labeobata(Hamilton)		Cyprinidae	+	+	+	+			
53.	Labeoboga(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
54.	Labeocalbasu(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
55.	Labeogonius(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
56.	Labeopangusia(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
57.	Labeorohita(Hamilton)	Rohu	Cyprinidae	+	+					
58.	Leiodoncutcutia(Hamilton)			+	+	+	+	+	+	+
59.	Lepidocephalichthysguntea (Hamilton)		Cobitidae	+	+	+	+	+	+	+
60.	Macrognathusaral (Bloch and Schneider)	Gainchi		+	+	+	+	+	+	+
61.	Mastacembeluspancalus(Hamilton)	Gainchi	Mastacembelidae	+	+	+	+	+	+	+
62.	Mastacembelusarmatus(Lacepede)	Baam, baami	Mastacembelidae	+	+	+	+	+	+	+
63.	Monopterusalbus(Zuiew)				+	+	+			
64.	Monopteruscuchia(Hamilton)				+	+	+			
65.	Mystus aor(Hamilton)		Bagridae	+	+	+	+	+	+	+
66.	Mystus bleekery(Day)		Bagridae	+	+	+	+	+	+	+
67.	Mystus carcio(Bloch)		Bagridae	+	+	+	+	+	+	+
68.	Mystus cavasius(Hamilton)	Palwa	Bagridae	+	+	+	+	+	+	+
69.	Mystus tengara(Hamilton)	Sonipalwa	Bagridae	+	+	+	+	+	+	+
70.	Mystus vittatus(Bloch)	Hadda	Bagridae	+	+	+	+	+	+	+
71.	Nandusnandus(Hamilton)	Dhalo	Nandidae	+	+	+	+	+	+	+
72.	Nangranangra(Hamilton)			+	+	+	+	+	+	+
73.	Nangrapunctata(Hamilton)			+	+	+	+	+	+	+
74.	Neotropiusantherinoides(Bloc			+	+	+	+	+	+	+

	h)									
75.	Notopteruschitala(Hamilton)	Chital, Moi	Notopteridae	+	+	+	+	+	+	+
76.	Ompokbimaculatus(Bloch)			+	+	+	+	+	+	+
77.	Ompokpabda(Hamilton)		Siluridae	+	+	+	+	+	+	+
78.	OmpokPabo(Hamilton)	Papta		+	+	+	+	+	+	+
79.	Oriochromismossambicus(Peters)			+	+	+	+	+	+	+
80.	Osteobramacotio(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
81.	Pangasiuspangasius(Hamilton)	Pangas	Pangasiidae	+	+	+	+	+	+	+
82.	Pangiopangia(Hamilton-Buchanan)			+	+	+	+	+	+	
83.	Pannamicrodon(Hamilton)			+	+	+	+	+	+	
84.	Pterigoplichthysanisitsi(Jonathan Armbruster)			+	+	+	+	+	+	
85.	Puntiuschola(Hamilton)		Cyprinidae	+	+	+	+	+	+	+
86.	Puntiusconchonius(Hamilton-Buchanan)		Cyprinidae	+	+	+	+	+	+	+
87.	Puntiussarana(Hamilton)			+	+	+	+	+	+	+
88.	Puntiussophore(Hamilton-Buchanan)	Potia	Cyprinidae	+	+	+	+	+	+	+
89.	Puntiusticto(Hamilton-Buchanan)		Cyprinidae	+	+	+	+	+	+	+
90.	Rhinomugilcorsula (Hamilton)	Arwari, Harwari		+	+	+	+	+	+	+
91.	Rita rita(Hamilton)	Rita	Bagridae	+	+	+	+	+	+	+
92.	Salmostomabacaila(Hamilton)	Chelwa	Cyprinidae	+	+	+	+			
93.	Salmostomaphulo(Hamilton)			+	+	+	+			
94.	Securiculagora(Hamilton)		Cyprinidae	+	+	+	+			
95.	Setipinnabrevifilis(Hamilton)			+	+	+	+			
96.	Setipinnaphasa(Hamilton)			+	+	+	+			
97.	Sicamugilcascasia(Hamilton)	Khaksi		+	+	+	+			

98.	Siloniasilondia(Hamilton)	Silan		+	+	+	+	+	+	+
99.	Sisorrabdophorus (Hamilton)		Sisoridae	+	+	+	+	+	+	+
100.	Somileptesgongota(Hamilton)		Cobitidae	+	+	+	+	+	+	+
101.	Systomussarana(Hamilton-Buchanan)		Cyprinidae	+	+	+	+	+	+	+
102.	Tenualosailisha(Hamilton)		Clupeidae	+	+	+	+	+	+	+
103.	Tetraodonfluviatalis(Hamilton-Buchanan)			+	+	+	+	+	+	+
104.	Trichogasterfasciatus(Bloch & Schneider)			+	+	+	+	+	+	+
105.	Wallagoattu(Schneider)	Lachi, Buari	Siluridae	+	+	+	+	+	+	+
106.	Xenentodoncancila(Hamilton)	Kawa	Belonidae	+	+	+	+	+	+	+

Table-4: Phyto-planktonic diversity of Ganga River at different locations from Allahabad to Haldia

S.No.	Taxa	All.	Vara.	Pat.	Bha.	Sah.	Fark	Hal.
Bacillariophyceae								
1.	Amphora sp.	+	+	+	+	+	+	+
2.	Amphipleura	+	+	+	+	+	+	+
3.	Achnanthes sp.	+	+	+	+	+	+	+
4.	Asterionella sp.	+	+	+	+	+	+	+
5.	Bacillaria sp.	+	+	+	+	+	+	+
6.	Biddulphia sp.	+	+	+	+	+	+	+
7.	Brebissonia sp.	+	+	+	+	+	+	+
8.	Caloneis sp.	+	+	+	+	+	+	+
9.	Ceratoneis sp.	+	+	+	+	+	+	+
10.	Coconeis sp.	+		+	+	+	+	+
11.	Chaetoceros sp.	+	+	+	+	+	+	+
12.	Cosinodiscus sp.	+	+	+	+	+	+	+
13.	Cyclotella sp.	+	+	+	+		+	+
14.	Cymatopleura sp.	+	+	+	+	+	+	+
15.	Cymbella sp.	+	+	+	+	+	+	+
16.	Denticula sp.	+	+	+	+	+	+	+
17.	Diatoma sp.	+	+	+	+	+	+	+
18.	Diatomella sp.	+	+	+	+	+	+	+
19.	Epithelmia sp.	+	+	+	+	+	+	+
20.	Fragilaria sp.	+	+		+	+	+	+
21.	Frustulia sp.	+	+	+	+	+	+	+
22.	Gomphoneis sp.	+	+	+	+	+	+	+
23.	Gomphonema sp.		+	+	+	+		+

24.	Gyrosigma sp.	+	+	+	+	+	+	+
25.	Hantzchia sp.	+	+	+	+	+	+	+
26.	Melosira sp.	+	+		+	+	+	+
27.	Meridian sp.	+	+	+	+	+	+	+
28.	Navicula sp.	+	+	+	+	+	+	+
29.	Nedium sp.	+	+	+	+	+	+	+
30.	Nitzschia sp.	+	+	+	+	+	+	+
31.	Opephora sp.	+	+	+	+	+	+	+
32.	Pinnularia sp.	+	+	+	+	+	+	+
33.	Pleurosigma sp.	+	+	+	+	+	+	+
34.	Rhicosphenia sp.	+	+	+	+	+	+	+
35.	Stephanodiscus sp.	+		+	+	+	+	+
36.	Surirella sp.	+	+	+	+	+		+
37.	Synedra sp.	+	+		+	+	+	+
38.	Tabellariasp	+	+	+	+	+	+	+
39.	Tetracylus sp.	+	+	+	+	+	+	+
Chlorophyceae								
1.	Actinastrum sp.	+	+	+	+	+	+	+
2.	Chlamydomonas sp.	+	+	+	+	+	+	+
3.	Chlorella sp	+	+	+	+	+	+	+
4.	Chlorococium sp.	+	+	+	+	+	+	+
5.	Cladophora sp.	+	+	+	+	+	+	+
6.	Closterium sp.	+	+	+	+	+	+	+
7.	Coelastrum sp.	+	+	+	+	+	+	+
8.	Conococcus sp.	+	+	+	+	+	+	+
9.	Cosmarium sp.	+	+	+	+	+	+	+
10.	Desmidium sp.	+	+	+	+	+	+	+
11.	Eudorina sp.	+	+	+	+	+	+	+
12.	Gonatozygon sp.	+	+	+	+	+	+	+
13.	Gonium sp	+	+	+	+	+	+	+
14.	Hormidiumsp	+	+	+	+	+	+	+
15.	Hydrodictyon sp.	+	+	+	+	+	+	+
16.	Microsporasp	+	+	+	+	+	+	+
17.	Oedogonium sp.	+	+	+	+	+	+	+
18.	Pandorina sp.	+	+	+	+	+	+	+
19.	Pediastrum sp.	+	+	+	+	+	+	+
20.	Spirogyra sp.	+	+	+	+	+	+	+
21.	Tetraspor sp.	+	+	+	+	+	+	+
22.	Ulothrix sp.	+	+	+	+	+	+	+
23.	Zygnemasp	+	+	+	+	+	+	+
24.	Debaryasp	+	+	+	+	+	+	+
25.	Mesotaeniumsp	+	+	+	+	+	+	+
26.	Stigecloniumsp	+	+	+	+	+	+	+
27.	Tetradesmussp	+	+	+	+	+	+	+
28.	Rhizocloniumsp	+	+	+	+	+	+	+

Cyanophyceae								
1.	Spirulinasp	+	+	+	+	+	+	+
2.	Rivularia sp.	+	+	+	+	+	+	+
3.	Schizothrix sp.	+	-	+	+	+	+	+
4.	Phormidium sp.	-	+	+	+	+	+	+
5.	Oscillatoria sp.	+	+	+	+	+	+	+
6.	Anabaena sp .	+	+	+	+	+	+	+
7.	Calothrix sp.	+	+	+	+	+	+	+
8.	Microcystis sp.	+	+	+	+	+	+	+
Xanthophyceae								
1.	Bumillaria sp.	-	+	+	+	+	+	+
2.	Chlorobotrys sp.	+	-	+	-	+	+	+
3.	Tribonema sp.	-	+	+	+	-	+	+
4.	T. bombycinum	-	+	+	+	+	+	+
5.	Voucheria sp.	+	+	+	+	+	+	+
Euglenophyceae								
1.	Astasis sp.	+	+	+	+	+	+	+
2.	Euglena sp.	+	+	+	+	+	+	+
3.	Peronia sp.	-	+	+	+	+	+	+
4.	Phacus sp.	+	+	+	+	+	+	+
Rhodophyceae								
1.	Bostrychia radicans	-	-	-	+	-	+	+
2.	Catenella impudica	-	-	-	-	+	-	+
3.	Ceramium elegans	+	+	+	+	-	+	+

Table-5:- Zooplankton diversity of Ganga River at different locations from Allahabad to Haldia

S.No.	Taxa	All.	Vara.	Pat.	Bha.	Sah.	Fark	Hal.
Protozoa								
1.	Arcellasp .	+	+	+	+	+	+	+
2.	Chilodonellasp .	+	+	+	+	+	+	+
3.	Difflugiiasp.	+	+	+	+	+	+	+
4.	Globigerina sp .	+	+	+	+	+	+	+
5.	Holophryasp .	+	+	+	+	+	+	+
6.	Noctilucasp .	+	+	+	+	+	+	+
7.	Paramecium sp .	+	+	+	+	+	+	+
8.	Spathidiumsp .	+	+	+	+	+	+	+
9.	Sphenoderiasp	+	+	+	+	+	+	+

10.	Tintinnopsissp.	+	+	+	+	+	+	+
11.	Vorticella sp	+	+	+	+	+	+	+
Rotifera								
1.	Anurasp	+	+	+	+	+	+	+
2.	Asplanchnasp	+	+	+	+	+	+	+
3.	Brachionussp.	+	+	+	+	+	+	+
4.	Filiniasp.	+	+	+	+	+	+	+
5.	Horaellasp.	+	+	+	+	+	+	+
6.	Keratellasp .	+	+	+	+	+	+	+
7.	Lecanesp.	+	+	+	+	+	+	+
8.	Notholcas p.	+	+	+	+	+	+	+
9.	Rotariasp.	+	+	+	+	+	+	+
10.	Testudinellasp	+	+	+	+	+	+	+
Copepoda								
1.	Cyclops sp.	+	+	+	+	+	+	+
2.	Diaptomus	+	+	+	+	+	+	+
3.	Nauplii	+	+	+	+	+	+	+
Cladocera								
1.	Bosminasp	+	+	+	+	+	+	+
2.	Ceriodaphniasp.	+	+	+	+	+	+	+
3.	Cydorussp.	+	+	+	+	+	+	+
4.	Daphnia sp .	+	+	+	+	+	+	+
5.	Diphanosomasp.	+	+	+	+	+	+	+
6.	Moinasp	+	+	+	+	+	+	+
7.	Simocephalussp	+	+	+	+	+	+	+

Table-6:- Macro-benthos of Ganga River at different locations from Allahabad to Haldia

S.No.	Taxa	All.	Vara.	Pat.	Bha.	Sah.	Fark	Hal.
				Gastropoda				
1.	Bellamyasp .	+	+	+	+	+	+	+
2.	Gabbiasp .	+	+	+	+	+	+	+
3.	Lymnaeasp .	+	+	+	+	+	+	+

4.	Thiaria sp.	+	+	+	+	+	+	+
Annelids								
1.	Polychaetes	+	+	+	+	+	+	+
2.	Oligochaetes	+	+	+	+	+	+	+
Insects								
1.	Argiasp .	+	+	+	+	+	+	+
2.	Caenissp .	+	+	+	+	+	+	+
3.	Cloeonsp .,	+	+	+	+	+	+	+
4.	Enallgmasp	+	+	+	+	+	+	+
5.	Nepa sp.	+	+	+	+	+	+	+

Table-7:- List of Avi-fauna diversity along the periphery of River Ganga

S.No.	Scientific Name	Common Name	Family
1.	*Ardeapupurea*	Purple Heron	Ardeidae
2.	*Nycticoraxnycticorax*	Black crowned Night-Heron	Ardeidae
3.	*Tachybaptusruficollis*	Little Grebe	Podicipitidae
4.	*Pelecanusonocrotalus*	Great White Pelican	Pelecanidae
5.	*Ciconiaepiscopus*	Wooly necked stork	Ciconiidae
6.	*Ephippiorhynchusasiaticus*	Black necked stork	Ciconiidae
7.	*Leptoptilosjavanicus*	Lesser Adjutant	Ciconiidae
8.	*Leptoptilosdubius*	Greater Adjutant	Ciconiidae
9.	Threskiornismelanocephalus	Black headed Ibis	Threskiornithidae
10.	*Pseudibispapillosa*	Black Ibis	Threskiornithidae
11.	*Dendrocygnajavanica*	Lesser Whistling Duck	Anatidae
12.	*Anasplatyrhynchos*	Mallard	Anatidae
13.	*Anasacuta*	Northern pintail	Anatidae
14.	*Anascrecca*	Common teal	Anatidae
15.	*Aythyanyroca*	Ferruginous pochard	Anatidae
16.	*Aythyafuligula*	Tufted Duck	Anatidae
17.	*Milvusmigrans*	Black kitell	Accipitridae
18.	*Elanuscaeruleus*	Black shouldered kite	Accipitridae
19.	*Heliasturindus*	Brahminy kite	Accipitridae
20.	*Circus aeruginosus*	Eurasian Marsh	Accipitridae
21.	*Buteorufinus*	Long legged Buzzard	Accipitridae
22.	*Aquila clanga*	Greater Spotted Eagle	Accipitridae
23.	*Hieraaetuspennatus*	Booted Eagle	Accipitridae
24.	*Falco tinnunculus*	Common Kestrel	Falconidae
25.	*Falco peregrines*	Peregrine Falcon II	Falconidae
26.	*Grusgrus*	Common crane	Gruidae
27.	*Amaurornisphoenicurus*	White Breasted Waterhen	Rallidae
28.	*Fulicaatra*	Common cootll	Rallidae
29.	*Charadriusdubius*	Little Ringed Plover II	Charadriidae
30.	*Charadrius alexandrines*	Kentish Plover	Charadriidae
31.	*Limosalimosa*	Black-tailed Godwit	Scolopacidae
32.	*Tringa tetanus*	Common Redshank	Scolopacidae
33.	*Tringastagnatilis*	Marsh Sandpiper	Scolopacidae
34.	*Tringaochropus*	Green Sandpiper	Scolopacidae
35.	*Calidristemminckii*	Temminck’s Stint	Scolopacidae

36.	*Recurvirostraavosetta*	Pied Avocet	Recurvirostridae
37.	*Glareola lacteal*	Small Prantincole	Lasreolidae
38.	*Larusichthyaetus*	Pallas's Gull	Laridae
39.	*Larusbrunnicephalus*	Brown Headed Gull	Laridae
40.	*Larusridibundus*	Black Headed Gull	Laridae
41.	*Sterna caspia*	Caspian tern	Laridae
42.	*Sterna hirundo*	Common tern	Laridae
43.	*Columba livia*	Rock Pigeon	Columbidae
44.	*Ripariapaludicola*	Plain Martin	Hirundinidae
45.	*Hirundorustica*	Barn Swallow	Hirundinidae
46.	*Motacillaflava*	Yellow wagtail	Motacillaidae
47.	*Anthusrufulus*	Paddy Field Pipit	Motacillaidae
48.	*Saxicolatorquata*	Common Stonechat	Turdinae
49.	*Passer domesticus*	House sparrow	Passerinae
50.	*Sturnus contra*	Asian pied Starling	Sturnidae
51.	*Acridotherestristis*	Common Myna	Sturnidae
52.	*Acridotheresginginianus*	Bank Myna	Sturnidae
53.	*Dendrocittavagabunda*	RufousTreepie	Corvidae

Annexure 5.1-Standards for Off-shore and On-Shore Disposal of Dredge Material

Criteria for Disposal of Harmful Bottom Sediments: No specific standards are defined in India for disposal of dredged material. If dredged material is toxic / harmful then these sediments should either be disposed off in landfill or in Sea. Criteria followed in Japan are given in the **Table 1**.

Table 1: Criteria for Harmful Bottom Sediments, Japan (unit: mg/l)

Contaminated Material	Dumping in Landfills (mg/l)	Dumping at sea (mg/l)
Alkylmercuric compounds	Not detectable	Not detectable
Mercury and its compounds	0.005	0.005
Cadmium and its compounds	0.1	0.1
Lead and its compounds	1	1
Organophosphorus compounds	1	1
Chromium (VI) compounds	0.5	0.5
Arsenic and its compounds	0.5	0.5
Cyanogen compounds	1	1
PCB	0.003	0.003
Copper and its compounds	-	3
Zinc and its compounds	-	5
Fluoride	-	15

Note: Criteria are based on the examination of dissolution of contaminated materials

Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992

Criteria for Off-shore dumping of Dredged material: No criteria are defined for off-shore disposal of dredged material in India, thus reference to the UN standards can be made and is given in **Table 2**.

Table 2: Criteria for Off-Shore Dumping of Dredged Material (unit: ppm or ppb)

Substance	Canada	USA
PCB (ppb)	100	380
Hg (ppm)	0.5	0.15
Cd (ppm)	0.60	0.7
Zn (ppm)	169	105
Cu (ppm)	45	68
As (ppm)	(5 – 25)	12.5
Pb (ppm)	45	33
Organochlorine pesticide (ppb)	10 for any compound	5.0 Sum of DDT, DDE and DDD
Polyaromatic hydrocarbon (ppb)	(1,000) Sum of 16 compounds	680 Sum of six low mol. Wt.

Substance	Canada	USA
		compounds 2,690 Sum of 10 high mol. Wt. compounds

Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992

Annexure 5.2- Standards for Wastewater Discharge, MARPOL (Annex IV)

Vessel/Voyage type/Area	Sub-Category	Discharge Conditions
All vessels (other than passenger ships within special areas)	Comminuted and disinfected sewage using an approved system in accordance with regulation 9.1.2 of MARPOL Annex IV	Permitted as long as no less than 3 nm from nearest land; and Sewage originating from holding tanks, or sewage originating from spaces containing live animals is discharged at a moderate rate* while the ship is proceeding en route at a speed not less than 4 knots. * The rate of discharge shall be approved by the Administration based upon standards approved by the Organisation. Recommended standards for the rate of discharge of sewage from ships can be found in Marine Order 96.
All vessels (other than passenger ships within special areas)	Sewage not comminuted or disinfected	Permitted as long as no less than 12 nm from nearest land; and Sewage originating from holding tanks, or sewage originating from spaces containing live animals is discharged at a moderate rate* while the ship is proceeding en route at a speed not less than 4 knots * The rate of discharge shall be approved by the Administration based upon standards approved by the Organisation. Recommended standards for the rate of discharge of sewage from ships can be found in Marine Order 96
All vessels (other than passenger ships within special areas) on International voyages to and continuing in Australian waters	Treated sewage effluent discharged through an approved Sewage Treatment Plant (STP) certified by the Administration to meet the operational requirements referred to in regulation 9.1.1 of MARPOL Annex IV	Permitted provided: Effluent does not produce visible floating solids nor cause discolouration of the surrounding water Local laws may prohibit discharges in ports Additionally: When within port limits, check with port authority as permission may be required All vessels should ensure that the STP is operating at optimum performance when in Australian waters Food or biological waste removed from filtration units of vessels on international voyages is prohibited from discharge within 12nm from land (DAFF requirements)
Passenger ships within special areas* * further information on special areas can be	Treated sewage effluent from new passenger ships on, or after 1 January 2016	Permitted provided: The ship has in operation an approved sewage treatment plant certified by the Administration to meet the operational

found in circular MEPC.1/Circ.778/Rev.1	and for existing passenger ships on, or after 1 January 2018	requirements referred to in regulation 9.2.1 of MARPOL Annex IV; and Effluent does not produce visible floating solids nor cause discolouration of the surrounding water. Note: local laws may prohibit discharges in ports
Great Barrier Reef Marine Park Vessels on International voyages to and continuing in Australian waters	All sewage discharges	In accordance with Annex IV requirements and where applicable with any additional restrictions imposed as conditions of a GBRMP permit
Great Barrier Reef Marine Park Vessels on domestic voyages	All sewage discharges	Recommended to comply with MARPOL Annex IV Or, in accordance with requirements of Part 3A of the GBRMPA Regulations (93A-93G) for both treated and untreated sewage AND, where applicable, in accordance with any additional restrictions imposed as conditions of a GBRMP permit
Queensland State Waters (small vessels/State registered and recreational)	If vessel does not have a sewage treatment system on board, options include: Using onshore toilet facilities whenever possible Using a portable toilet to be later emptied to a sewerage/septi c system Retain sewage in onboard holding tank for pumping out to shore facilities.	If a vessel has 16 or more persons on board, no discharge of untreated sewage is permitted anywhere in Queensland waters. If a vessel has 7 to 15 persons on board, no discharge of untreated sewage is permitted within 1 nm of a reef or the mean low water mark of an island or the mainland. No discharge of untreated sewage is permitted within 1 nm of aquaculture fisheries resources, or within 0.5 nm of a wharf or jetty other than a jetty that is a marina.

Annexure 5.3 : Standards for Garbage Management, MARPOL Annex V- Applies To All Vessels

Type of garbage	Ships outside special areas[85]	Ships within special areas[1]	Offshore platforms (more than 12 nm from land) and all ships within 500m of such platforms
Food[86] waste comminuted or ground to particle size < 25mm	Discharge permitted, while en route[87], as far as practicable from the nearest land, but in any case, ≥ 3nm from the nearest land.	Discharge permitted[88], while en route[3], as far as practicable from the nearest land, but in any case, ≥ 12nm from the nearest land.	Discharge permitted
Food[2] waste not comminuted or ground	Discharge permitted, while en route[3], as far as practicable from the nearest land, but in any case, ≥ 12nm from the nearest land.	Discharge prohibited	Discharge prohibited
Cargo residues[89] that cannot be recovered	Discharge permitted, while en	Discharge	Discharge prohibited

[85]Under MARPOL Annex V, the areas of: the Mediterranean Sea; the Baltic Sea; the Black Sea; the Red Sea; the "Gulfs" area; the North Sea; the Antarctic area; and the Wider Caribbean region (including the Gulf of Mexico and the Caribbean Sea) are provided with a higher level of protection than other sea areas. Further information on special areas can be found in circular MEPC.1/Circ.778/Rev.1.

[86]Small quantities of food released directly into the sea for the specific purpose of fish feeding in connection with fishing or tourist operations is permitted.

[87]The **en route** requirement does not apply to the discharge of food wastes, where it is clear that retention on board presents an imminent health risk to the people on board. See MARPOL Annex V, Regulation 7.2.1

[88]The discharge of introduced avian products, including poultry and poultry parts, is prohibited within the Antarctic special area (sea area south of latitude 600S), except where those introduced avian products are incinerated, autoclaved or otherwise treated to be made sterile.

[89]These substances must not be harmful to the marine environment. When in port, check with the port authority as local regulations may also apply. The above restrictions do not apply to the wash down of cargo residues from deck areas of vessels undertaken for safety purposes including:

• Safe operation of a helicopter within the landing area and its immediate vicinity to avoid dust being raised by the down-draft of the rotors;

using commonly available methods for unloading, not contained in wash water.	route, as far as practicable from the nearest land, but in any case, ≥ 12nm from the nearest land.	prohibited	
Cargo residues[5] that cannot be recovered using commonly available methods for unloading, contained in wash water		Discharge permitted, while en route, as far as practicable from the nearest land, but in any case, ≥ 12nm from the nearest land. Subject to two additional conditions[90].	Discharge prohibited

• Where there is a need to avoid navigational hazards such as dust being blown onto the wheelhouse or bridge wings;
• Where residues may cause a serious safety hazard to personnel if spillages are not cleaned from deck areas, adjacent walkways and working areas

[90]Discharge is permitted where conditions (a) and (b), as follows, both apply: (a) both the port of departure and the next port of destination are within the special area and the ship will not transit outside the special area between theses ports; and (b) if no adequate reception facilities are available at these ports. See MARPOL Annex V Regulation 6.1.2.

Annexure 5.4 : Standards for Oily Wastes, MARPOL Annex I- Applies To All Vessels

Vessel/Voyage type/Area	Sub-Category	Discharge Conditions
For more information and definitions refer to MARPOL consolidated edition 2011* * Can be purchased at 'www.imo.org/Publications'.		
Oil tankers All waters	Oily waste from cargo tanks	• More than 50 nautical miles from the nearest land; and • Tanker is proceeding en route; and • Instantaneous rate of discharge < 30 litres per nautical mile; and • Total quantity discharge does not exceed 1/15,000 or 1/30,000 of the total cargo (depending on the age of the vessel); and • Oil discharge monitoring and control system and slop tank arrangement to be operating.
All vessels ≥ 400 gross tons All waters	Machinery space bilges	• Proceeding en route; and • Oil content less than 15 parts per million; and • Oil discharge monitoring and control system and oil filtering equipment to be operating • In some circumstances, oil or oily mixtures, may be retained onboard for discharge to port reception facilities – see MARPOL Annex I, Regulation 14. Note: 15ppm discharges can be anywhere at sea (not within port limits) including the Great Barrier Reef Marine Park and Marine Protected Areas. Vessel must not be stationary when undertaking discharge.
All vessels <400 gross tons All waters	Machinery space bilges	• Oil and all oily mixtures retain onboard for on shore disposal • OR • Proceeding en route; and • Has in operation equipment of a design approved by the administration that ensures oil content less than 15 parts per million. Note: 15ppm discharges can be anywhere at sea (not within port limits) including the Great Barrier Reef Marine Park and Marine Protected Areas. Vessel must not be stationary when undertaking discharge.
Vessels operating in Great Barrier Reef Marine Park	Bunkering utilising ship to ship transfers	A Permit is required from GBRMPA under which certain conditions may be imposed.

Cargo material[5] contained in cargo hold bilge water	Discharge permitted, from a loaded hold[91] through the ships' fixed piping bilge drainage system.		Discharge prohibited
Cleaning agents and additives[5]contained in cargo hold wash water	Discharge permitted	Discharge permitted, while en route, as far as practicable from the nearest land, but in any case, ≥ 12nm from the nearest land. Subject to two additional conditions[6].	Discharge prohibited
Cleaning agents and additives[4]in deck and external surfaces wash water		Discharge permitted	Discharge prohibited
Carcasses of animals carried on board as cargo and which died during the voyage	Discharge permitted, while en route, as far as practicable from the nearest land and at maximum water depth, but in any case, ≥ 100nm[92]from the nearest land.	Discharge prohibited	Discharge prohibited
Grey water	Discharge permitted[93]	Discharge permitted[9]	Discharge permitted9
All other garbage including plastics, synthetic ropes, fishing gear, plastic garbage bags, incinerator ashes, clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery and similar refuse	Discharge prohibited	Discharge prohibited	Discharge prohibited
Mixed garbage	When garbage is mixed with or contaminated by other substances prohibited from discharge or having different discharge requirements, the more stringent requirements apply.		
Note: The above conditions apply except where the disposal of garbage from a ship is necessary for the purpose of securing the safety of a ship and those on board or saving life at sea – see MARPOL Regulation 7.1.1			

[91]Vessels at anchorage for a period of time with empty holds may discharge hold bilge water through the ships' fixed piping bilge drainage system as long as the water is not directly related to a hold washing/cleaning operation.

[92]If a threat to human health and safety of the crew or the remaining live animals on board exists, discharge to take place ≥ 12nm from the nearest land.

[93]In all cases, check with local authorities as local regulations may apply. Within the Great Barrier Reef Marine Park, as far as practicable from reefs and islands.

Annexure 5.5- Standards for Vessel Carrying Noxious Liquid Substances, MARPOL Annex II and Harmful Packaged Substances MARPOL Annex III

Vessel/Voyage type/Area	Sub-Category	Discharge Conditions
Chemical and Product Tankers	Category X	Tanks to be prewashed before leaving unloading port, residues to be pumped ashore until the concentration of the substance in the effluent is 0.1% by weight or less, as indicated by analysis of samples of the effluent taken by an AMSA marine surveyor. When the required concentration level has been achieved, remaining tank washings to be discharged to the reception facility until the tank is empty. Appropriate entries to be made in the Cargo Record Book and endorsed by the AMSA marine surveyor. Any water subsequently added may be discharged if: Ship is proceeding en route at a speed of at least 7 knots; and Discharge below the waterline; and Ship is > 12 nm from nearest land and depth of water is >25m
	High-viscosity or solidifying Category Y	Prewash in accordance with Convention, residues to be pumped ashore until tank is empty. Any water subsequently added may be discharged if: Ship is proceeding en route at a speed of at least 7 knots; and Discharge below the waterline; and Ship is > 12 nm from nearest land and depth of water is >25m
	Category Y Category Z	Ship is proceeding en route at a speed of at least 7 knots; and Concentration of substance in wake of ship < 1 part per million; and Amount not to exceed 1m3 or 1/3,000 of tank capacity, whichever is greater; and Discharge below the waterline; and Ship is > 12 nm from nearest land and depth of water is >25m
MARPOLHarmful Packaged Substances (Annex III)	Jettisoning of harmful packaged substances into the sea	Prohibited, except where necessary for the purpose of securing the safety of the ship or saving life at sea

Annexure 5.6: Standards for Air Emissions MARPOL Annex VI - Applies To All Vessels

Vessel/Voyage type/Area	Sub-Category	Discharge Conditions
All vessels	Ozone-depleting substances	Prohibited
	Nitrogen Oxides	Operation of diesel engines >130kW prohibited unless engine is certified to meet prescribed emission standards. New Engines: • Tier I - 17 g/kW from 1 January 2000 • Tier II - 14.4 g/kW from 1 January 2011 • Tier III - 3.4 g/kW from 1 January 2016 (in Emission Control Areas (ECA)) Existing Engines (installed on ship on or between 1 January 1990 to 1 January 2000) • 17g/kW for diesel engine with power output >5000kW and displacement per cylinder => 90 litres • Approved method by Administration
	Sulphur Oxides	Sulphur content of fuel oil not to exceed 4.5%. ** From 1 January 2012, sulphur content of fuel oil not to exceed 3.5% ** From 1 January 2020 sulphur content if fuel oil not to exceed 0.5% ** ** Fuel oil to be purchased from a registered supplier Note: Feasibility review to be completed 2018
	Incinerators	Incinerators installed after 1 January 2000 must be type approved and certified to meet prescribed emission standards. Do not use within port limits

Annexure 6.1: List of Stake Holders for formal Consultation

List of Stakeholders for Farakka Lock

S. No.	Name	Designation	Department	Mobile No.
1	Mrs. Moonmoon Roy	Panchayat Pradhan	Bewa Gram Panchayat	8820194794
2	Mr. Jaihid Hussain	Director	Farakka Welfare Society(NGO)	9732807273
3	Santunu Dutta	Land revenue inspector	Farakka LRO	9851970202
4	Kesang Dhendup Bhutia	BDO & Block Executive Officer	BDO,Farakka	9434770026
5	Mr. Prasun K Dhara	BLRO	Farakka BLRO	9474308250
6	Mr. Santosh Mujherjee	Executive Officer	TINI(NGO)	8906689465
7	Mr. Subhra Khan	Executive Engr.	PWD,Farakka Circle	9433956762
8	Mr. Arnab Chakraborty	Journalist (Malda & Farakka Division)	Journalistfrom Uttarbanga Sangbad	9609442670
9	Mr. A.K.Paul	Executive Engr.	FBP Welfare Department	7074957614
10	Nikhil Sinha	Executive Engr.	FBP Anti-Erosion Dept	8348886678
11	Prof. Sutapa Dutta	Prof dept. Of Social Science	S.Nurul Hasan College	9434183507
12	Asesh Deyashi	Asst.Director	WB Agriculture Dept. (Farakka Circle)	9563273466
13	--	Officers	MRSW,NGO,Farakka	--

List of Stakeholders for Sahibganj Terminal

S. No.	Name	Designation	Department	Mobile No.
1	Shri Umesh Prasad Singh	Deputy Commissioner	Office of the Deputy Commissioner	06436-222100
2	Shri K.K. Tiwari	Divisional Forest Officer	Divisional Forest Office, Sahibganj	--
3	Mr. Sushil Soren	District Forest Officer	DFO, Van Pramandal Awas, Sakrogarh, Sahibganj	--
4	Sh. Faiku Ram	District Mining Officer	District Mining Department	--
5	Shri Vinay Kumar Mishra	District Land Acquisition Officer	Distt. Land acquisition Department	9934096667
6	Er. Ras Bihari Singh	Executive Engineer	Public Health Engineering Department	9934884808
7	Er. Vishal Chandra	Executive	Jharkhand Rajya	9431135857

	Toppo	Engineer	Vidhut Vitran Nigam Ltd.	
8	Er. Santosh Kumar Tiwari	Superintending Engineer	Irrigation Circle, Sahibganj	9135308972
9	Er. Abhdesh Kumar	Executive Engineer	Ganga Pump Nahar Pariyojna (Irrigation)	9431194614
10	Dr. Bhagwat Marandi	CMO	Health Department	9334776755
11	Shri Mithlesh Kumar Singh	Executive Officer cum BDO	Nagar Parishad	9955229279
12	Er. Shushil Kumar	Executive Engineer	Public Works Department	9431366639
13	Shri Marshel Khalko	District Agriculture Officer	Agriculture Department	9431193417
14	Smt. Munni Gaund	Mukhiya (Samda Nala, Samadaasi Aasharam, SakariBajar)	Gram Panchayat Head	7808789116
15	Smt. Usha Khalko	Mukhiya (HaathiGarhi)	Gram Panchayat Head	9801018326
16	Local People Villages Rampur & Samdha Nalla	--	--	--
17	Shri Niranjan Kumar	A.D.C	DC Office, Sahibganj	--
18	----	District Fisheries Officer	District Fisheries Office, Sahibganj	--
19	Mr. Ram Dayal Ravidas	Assistant Engineer	Drinking Water and Sanitation Department, Sahibganj	--
20	Mr. Vidya Nand Singh	Executive Engineer	Small Irrigation Department, Sahibganj	--
21	---	Additional Principal Chief Conservator of Forest (W/L)	Environment & Forest Department, Sinchai Bhawan, Patna	--
22	--	Conservator of Forest	Bhagalpur, Bihar	--
23	--	District Forest Officer	Bhagalpur, Bihar	--
24	---	Director Ecology	Environment & Forest Department, Sinchai Bhawan, Patna	--
25	--	Principal Chief Conservator of Forest (HOFF)	Environment & Forest Department, Sinchai Bhawan, Patna	--
26	Prof. Subhasis Dey	Professor	Vikramshila Bio-diversity Research and Education Centre, TM Bhagalpur	--

			University, Bhagalpur	
27	Prof. Sunil Chaudhary	Professor	Vikramshila Bio-diversity Research and Education Centre, TM Bhagalpur University, Bhagalpur	--
28	---	Member Secretary	JPCB, Nagar Prashasan Bhawan, HEC, Dhurva, Ranchi, Jharkhand	--
29	--	PCCF Wildlife & CWLW	Department of Forest & Environment, van Bhawan, Doranda, Ranchi	--
30	--	Principal Chief Conservator of Forest (HOFF)	Department of Forest & Environment, van Bhawan, Doranda, Ranchi	--
31	--	Officers	Talijari Matsya Jeev Samiti	--
32	--	Officers	Jan Kalyan Abhiyan	--

Annexure 6.2: Invitation Letter Sent to Government Dept. and NGO's

Eqms
Since 1998
Environment Quality Management Services

EQMS INDIA PVT. LTD.

304-305, III Floor, Rishabh Tower, Plot No. 16
Community Centre, Karkardooma, Delhi - 110 092
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Fax : (011) 2237 4775
E-mail : eqms@eqmsindia.org
Url : www.eqmsindia.com
CIN : U85199DL1998PTC094954

Date: 13.10.2015

To,
Mr. Vidya Nand Singh
Executive Engineer
Small Irrigation Department
C/O Shankar Jha, Chaudhary Colony
Sahebganj, Jharkhand

Subject: Request for Support & Participation in Public Consultation Meetings at Sahibganj to be Organized by EQMS India Pvt. Ltd. along with JV Partners AIAID & IRGSSA for upcoming Project of IWAI "Capacity Augmentation of Navigational Infrastructure of National Waterway-1, i.e. Haldia to Allahabad"

Dear Sir,

Inland Waterways Authority of India (IWAI) has undertaken above mentioned project to enhance the freight movement along the NW-1. In this regard IWAI has appointed Environmental & Social Consultants to study the associated Environmental & Social Sensitivities of the project. Consultants are carrying out socio-economic survey at Sahibganj at present and have organized a formal public consultation meeting on 16th October, 2015. Details of Venue and Time for meeting is given below

Venue: Ashram, Village Saindha Ghat, Sahibganj

Time: 11:00 AM

We thus request you to kindly attend the meeting to provide the inputs and suggestions for the project.

We look forward to kind cooperation.
Thanking you

Sanjay Kumar Jain
Director-Technical
EQMS India Pvt. Ltd.

14/10/15

Sound Legal Compliance

Safe Work Place

Annexure 6.3- Proceedings of Informal Consultation for NW-1

Proceedings of Informal Consultation at different Locations of NW-1

. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome .
Informal Consultation in Varanasi				
1.	IWAI,Varanasi & Date:20.06.2015	A.K.Mishra, Deputy Director,IWAI,Varanasi	**1**	According to him site location is suitable for development of terminal from HFL prospective. Other points he added are 1. Economic Feasible 2. Reduce Air and noise pollution, 3. Increased Employment
2.	Varanasi & Date: 21-6-2015	Group Discussion with Locals, Fishermen and Boatmen,Baluaghat,Varanasi 1. Suresh Saki 2. Hariyan 3. Savajeet Sahni 4. Kashim Nishad 5. Rambabu Nishad 6. Syambabu nishad	52	1. People consulted involved local resident of the area, fishermen and boatmen and squatters at Balua Ghat 2. People affected here are indirectly 3. Most of them are educated till higher secondary level. All

		7. Sidhunishad 8. Jaikishan 9. Bholusankar 10. Vishunnishad 11. Dablu Sahni 12. Takkan majhi 13. Ramnath Majhi 14. Gopal Nishad 15. Sidhu Sahni 16. Kashi 17. Dakhhi 18. Somnath 19. Hiralal 20. Shankar 21. Ramnahe 22. Visnu 23. Syambabu 24. Banarsilal 25. Seva lal 26. Manish 27. Gopal ji 28. Manish kumar 29. Vivek Chorasiya 30. Sankar Sahni 31. Bittu 32. Ramesh 33. Banarsi 34. Gaurisankar 35. Ranku Sahni 36. Pancham Mallah 37. Dilesh Sahni 38. Mirtu Kumari 39. Dhobelal 40. Bichanu 41. Sumeru 42. Bablu kumar		of them are well aware about the project. 4. Some of them wants this project because more job opportunity will create in the area. 5. Some of the fishermen showed concern the development of project may lead to **fish** kill and in turn will affect the fishing businesses. They expect some allowances from the Government in lieu of their affected income.

		43. Chedi Sahni 44. Raju Sahni 45. Rajesh 46. Mohit 47. Anans Sahni 48. Mote Nath 49. Banarsi lal 50. Chote lal 51. Sri Ram 52. Gopal Ji		
3.	PWD, Varanasi & Date: 21-6-2015	M.P Singh (Administrative Office)	1	1. PWD officials are not aware about the project development 2. When the details were shared with him about the project, he presented a favourable view towards the project 3. He stated that development of waterways will reduce the freight load from highways, will reduce the air and noise pollution in area and will make transportation of goods cheaper 4. However, he suggested that the nearby roads to the terminal facility should be strengthened and widened, as there

				may be substantial increase in traffic movement in the roads connecting the terminal site after development of terminal. Thus IWAI should carry out traffic assessment due to project development and should coordinate with PWD in this regard
4.	UPSIDC, Varanasi & Date-22-6-2015	Sushash Tripathi	1	1. Development of terminal site may generate necessity of development of industrial zone near the terminal site as industries will be willing to find a location close to terminal site 2. Development of terminal will facilitate low cost transportation of goods which will enable industries to produce goods at low cost, however no such industry exists in the industrial area at present in the nearby industrial area which

				may avail the facility of raw material movement by waterways
5.	Kashi Van Mandal, Kacchua sanctuary, Varanasi&Date: 23.06.2015	Ajay roy,DFO, Kashi Van Mandal, Kacchua sanctuaryVaranasi	1	Discussion was carried out to identify environmental issues may associate with Turtle Sanctuary. Following are the main concerns of the officer: 1. There turtle will get impacted due to regular movement of ships and vessels in river. 2. Because the Turtle is very shy in nature the noise generated from the waterway transport will affect them. 3. Siltation during the construction period will create a problem to aquatic fauna. 4. Chance of oil spillage from the ships will contaminate the Ganga water quality. Solid waste generation management shall be done in scientific

				manner.
6.	District Industry Centre (DIC), Varanasi & Date: 23-6-2015	Umesh Kumar Singh (Join Commissioner Industry)-	1	1. They were not aware about the project development 2. When project information was shared with them they said that there are 2 industrial areas in Chandauli District. These industries are generally agro based, small scale and non-polluting types. However, development of terminal may interest industrialist to develop industries in nearby areas 3. He suggested waterways are cost effective and environment friendly mode of transportation.

				However, water pollution may occur, if wastewater is discharged by ships and terminal facility into river. This may also affect the aquatic life of the river and fishing activity
7.	Bharat Hindu University &Date: 24.06.2015	Dr.B.D. Tripathi, UGC-BSR, BHU, Ganga pollution Research, NMCGA	1	Discussion was carried out with him regarding this project. Following are the main concerns of Dr. Tripathi was: 1. Ganga River has anti bacterial quality on itself. Execution of this project, Ganga will lose its anti bacterial property. 2. Aquatic flora and fauna will be disturbed 3. Religious point of view he was not satisfied. 4. Overall he is not in favour of this project.
8.	Irrigation Department, Varanasi & Date: 24.06.2015	E.S.P.Srivastava, Sacchiv,Jal Nigam Irrigation Department, Varanasi	1	1. He is concerned about the vibration generated due to heavy traffic movement can disturb the strata of pump wells located in Ganga River for

				drinking water purposes.
9.	Ganga Pollution Unit at Varanasi & Date: 24-6-2015	Er. J.B Rai, General Manager	1	1. He was aware about the project development 2. He does not have any favour and opposition for the project development
10.	Public Health department (PHD), Varanasi & Date: 26.06.2015	Dr. M.P.Chaurasiya, (C.M.O), Public Health Department, Varanasi.	1	1. They are not aware about the project 2. They do not have any existing and upcoming health schemes in the area near to the site development 3. They suggested IWAI should contact them for development of health
11.	Vikas Bhawan at Varanasi & Date: 26.06.2015	R.K.sharma (DESTRO), C.M.Srivastava: Statics Depatment	2	1. They are not aware about the project 2. They do not have any upcoming development scheme in the area near to site 3. They did not have any say about the project development
12.	USPCB, Varanasi & Date: 27.06.2015	DR. Mohd. Sikandar R.O, UPPCB	1	1. He was aware about the project development 2. He was concerned regarding the water

				quality issues which may be there due to construction of terminal facility and operation of cargos, spillage in case of accidents, discharge of waste and sewage, oil leakage and other related activities 3. He suggested environment management plan should be prepared for the construction and operation phase and that should be strictly followed by IWAI and cargo operators to ensure no pollution to occur due to them 4. In case of accidents, cargo operator should be responsible to clean the spills
13.	Ralhupur, Village, Varanasi & Date-8-7-2015	Project Affected Families: 1. Dinesh Singh 2. Ashok Singh 3. Santosh Kumar Singh 4. Alok Kumar Singh 5. Gopal Singh 6. NarenderBahadur Singh 7. LaxamiPrasedRai and Family.	7	1. People are aware about the project development 2. Discussion was carried out with Farmers, students and PAF regarding the impact of this project. People are well aware about the project. The main

				issues of the villagers are: ✓ Most of them want this project because more job opportunity will create in the area. ✓ People were expecting permanent job in this project. ✓ Majority of people have positive attitude towards the project. ✓ People also expect infrastructure development such as good roads, water supply, power supply in their area after coming up of proposed terminal. ✓ People expects that the upcoming project is of less polluting industries so as no pollution related problems will observed in the area. ✓ They wished and expect from authority that their compensation should be on current market price. ✓ They got notification from government before acquisition of

				their land. ✓ As per villagers, officers from block/anchal never talked to them regarding compensation and land acquisition. ✓ They have been growing crops like Jau, Pulse, Arhar, Masoor for a long time on their landbut now they have been gradually losing their irrigation land. ✓ Villagers are requesting that compensation of their land should be as per prevailing market rate, if it is not feasible at least compensation should be disbursed to them on circle rate. 3. Some Project affected families have filed petitions in the court for higher compensation.
14.	Balwa Ghat Ramnagar Date:9.7.2015	Fishermen, Boatmen and Squatters at Ghatand local community 1. Jaikishan 2. Ramlal	12	1. Yes, Supporting project 2. Fishermen, Boatmen Squatters at Ghat and local community were happy from the NW-1

		3. Kamlu 4. Roshan Lal 5. Majhi lal 6. Kamlulal 7. Sankar 8. Ramnahe 9. Vivek 10. Aman 11. Banarsi 12. Kamlesh		3. The main concern of the local community is to provide them the livelihood based activities in the project works. 4. Second concern is to provide them skill based training which can help them to provide employment
15.	Land Owne(Local People), Dated-23.8.2015	Vieswar Dravin, Land owner for proposed access road to Terminal	1(The land belongs to one family of three brothers)	1. Mr. Vieswar has some issues. Total land to be acquired as per the Government notification dated 19thMarch 2015 is 0.592 ha. The land belongs to one family of three brothers. The owner of the land opined that the valuation of land is being done based on the circle rates and is not justified. He is requesting for the revision of the land value 2. Compensation amount and circle rates for the proposed land should be revised with the consent of the affected families in the meeting before finalization of

				the circle rates 3. Loss of this land will lead to loss of livelihood to the family
Informal Consultation in Sahibganj				
16.	Samda Nala Ghat, Near Project site, Sahibganj**&**Date**:** **1**6-09- 2015	General Public and Fisherman • Shiv ji maldar • Chanchal kumar yadav • Jawahar yadav • Rmaan • Narayan yadav • Shiv Shankar yadav • Rupan Mandal • Shivshankar yadav • Sudeshan Yadv • Sushila devi • Mahendra yadav • Kanhayia yadav • Bal Krishna Yadav	13	Participants included farmers, students, affected people, fishermen, Boatmen and females. Most of the people in the area are farmers and depend on agriculture for livelihood. Villagers are aware about the IWAI planning for construction of terminal. Following issues/concerns were raised by the participants. 1. Land owners are highly concerned as they depend on the agriculture and mango plantation for their livelihood 2. Students however see the project as positive development in the area in terms of infrastructure, power, roads and water supply facilities and

				employment generation 3. Fishermen stated that fish catch will reduce in the area after construction of terminal due to increase in water pollution and killing due to barge movement 4. Farmer practice river terrace cultivation in the river bed area and they are worried that they will not be allowed to practice the same after construction of terminal due to restrictions by authority
17.	Ashram,Samda Nala Village&Date:9th -10-2015	Villagers from Rampur & SamdaNala village	10	Participants included farmers, students and females. Following issues/concerns were raised by the participants 1. Loss of livelihood is major concern due to loss of agriculture land 2. Land owners were demanding compensation should be as per prevailing market rates

				3. Local people only should be considered for provision of employment 4. Proper R & R should be done before displacement of affected people. Affected people/land owners are worried about the loss of houses and place of relocation 5. Religious sentiments of locals are associated with River Ganga so they want place near to River Ganga for relocation 6. Employment and home should be provided to affected people before displacement/land acquisition and loss of livelihood 7. Project development will lead to increase in pollution in area and water. Water pollution may significantly impact the fish catch
18.	Ashram,SamdaNala Village & Date**:** 9th -10-2015	Villagers Rampur, Ashram,SamdaNala Village (8 Participants)	8	Participants included farmers, fishermen & students. Following issues/concerns were

				raised by the participants 1. Land owners categorically said that land will be given only, if they will get appropriate compensation 2. Also they require employment, if complete land will be taken away from them 3. They mentioned large nos. of trees are planted in the land which is under planning to be acquired, cutting of large no. of trees will affect the environment of village thus equal nos. of trees should be planted before cutting the trees in nearby land areas 4. They said some dolphins are seen in the water, operation of barges may be danger to life of dolphin 5. They are scared as they think fishing will be banned in the area after development of terminal which is major livelihood source of

				most of the people
19.	Ashram,Samda Nala Village & Date:9th -10-2015	Ashram, Village Rampur	15	Participants included farmers, fishermen & students. Following issues/concerns were raised by the participants 1. Land owners are expecting appropriate compensation for their land and also assistance in alternative livelihood of their land will be acquired 2. They demanded job for them and their children and they mentioned they should be given skill generation training for job offered as they have practised only agriculture throughout their life 3. They insisted that they worship River Ganga and they will not bear addition of pollutants and waste in the River 4. They want to get assurance about that they can continue fishing activity in the river after construction of terminal

				5. They wanted to ask what other developments will be taken up by IWAI in village for betterment of villagers
20.	NayaTola & Samda Nala Village & Date:5th-11-2015	Villagers from Naya Tola &SamdhaNala	10	Participants included farmers, students and females. Following issues/concerns were raised by the participants 1. Farmers whose land will be acquired are worried due to loss of land and loss of livelihood as they are practising agriculture since generation 2. Land owners demanded alternate housing facility and employment prior to land acquisition and displacement 3. Fishing activity will be hampered in the river due to development of terminal and plying of large nos. of cargos 4. Cutting of large nos. of trees within the project site will impat the climate of the area 5. Local people should be considered for

				providing employment 6. Community facility in the area, if any to be disturbed should be relocated at the accessible and appropriate location
21.	Asharam Ashram, Naya Tola &Samda Nala Village & Date:8th November, 2015	Villagers from Naya Tola & Samdha Nala	20	Participants included farmers, students and females. People are aware about the project. Following issues/concerns were raised by the participants 1. Land owners are worried about the compensation rates and the loss of livelihood 2. They demanded provision of employment for the affected people. Authority committed for provision of employment to locals after coming up of project 3. Locals demanded compensation should be given as per market rates 4. Displaced population want the relocation

				near or inside the village only 5. Assistance should be given for alternate livelihood for affected people 6. Water quality can be affected due to project development, this will affect the aquatic life in the area 7. Air pollution in the area will increase due to increased movement of vehicles in the area
22.	Department of Environment and Forest, AranyaBhawan, ShahidPir Ali Khan Path (Riding Road), Shekhpura, Patna-14**&**Date:15th September 2015	Dr. D K Shukla **Designation:** Principal Chief Conservator of Forest (PCCF) Department of Environment and Forest.	1	1. Dr. D.K. Shukla gave idea on extent of the dolphin sanctuary. VGDS boundary starts from Sultangunj block boundary and ends at Kahalgaon subdivision boundary. He also advised to meet Chief Wildlife Warden, Bihar for more information on VGDS. He raised the following concern 2. Dolphins will be impacted with barge & cargo movement especially the baby dolphins. 3. Development of

				terminal may increase the water pollution which will significantly affect the aquatic life 4. Strict norms and measures are required to be followed and taken towards the protection of habitat of the dolphins, if this project is being developed. 5. Discharge of waste in the river should be strictly prohibited by anybody (terminal/vessels/barges). Waste management facilities should be developed at site and waste should be treated and disposed off at other safe locations 6. Mechanical movement of barges will impact the dolphins thus the speed of the cargos movement in these water should be regularized
23.	Department of Environment and Forest , AranyaBhawan, ShahidPir Ali Khan Path (Riding Road), Shekhpura, Patna-14**&**Date:15th-09- 2015	Shri S S Chaudhary **Designation:** Additional Principal Chief Conservator of Forest	1	1. Shri S.S. Chaudhary was aware about the project development. He gave more

		(PCCF) and Chief Wildlife Warden, Bihar		information about the extent of VGDS. He told that river stretch between Sultanganj and KahalgaonPahar (50 kms) is declared as VGDS. Copy of notification for declaration of VGDS as Dolphin Sanctuary was provided by him. He raised the following concerns: 2. Project may have significant impact on dolphin thus proper measures should be taken during operation phase to minimize this impact. 3. It may be required to obtain Wildlife clearance for the project 4. Interference in this zone should be minimized to the extent possible. 5. Minimal disturbance to the dolphin should be done as they are sensitive 6. Waste management is key requirement. Waste disposal, disposal of coal ash

				and contaminated run-off to the river may pollute the river water quality significantly which inturn may affect the aquatic life.
24.	Gangetic Plains Regional Centre, Zoological Survey of India, 11-D Rajendra Nagar, Patna - 800 016, **Date:** 15th-09- 2015	Dr. Gopal Sharma **Designation:** Scientist D and Officer-In-Charge at Gangetic Plains Regional Centre	1	1. Dr. Gopal Sharma was aware about the IWAI Project. He opined that the project will have impact on Dolphins. He told that VGDS extends about 60-65 kms. Coordinates for starting and end points are as follows: ✓ Sultanganj (Ajgaivinath Temple) N 28°15.247' and E 86°44.758' ✓ Kahalgaon (3 hillocks in river) N 25°15.402' and E 87°13.246' 2. He told that this stretch is preferred habitat of the dolphin due to availability of confluence points, meandering locations and deep pools of river. About 127 dolphins have been

				recorded in VGDS. Other aquatic fauna of VGDS include Otter, gharial, turtle, etc. VGDS provides breeding ground of such species. He raised the following concerns: ✓ VGDS is rich in bio-diversity thus care should be taken that minimal or no disturbance should be caused to aquatic life ✓ Dredged material may contain toxic compounds so should not be dumped on river bank as river banks are habitat for otter, birds feeding on aquatic organisms and other species ✓ Dolphins are affected by the vibrations. Plying vessels create ripples which causes energy losses in dolphin for its movement and carrying out

				other functions. ✓ At present dolphins are distracted by vessels plying in NW-1. Mitigation measure for propellers to avoid dolphin getting hit should be considered, e.g. propeller guard. ✓ This leads to entanglement of dolphins in fishing nets in Ganga causing mortality. ✓ In the current situation, plying vessels get stuck in lean season. In the event of larger vessels plying in NW-1, the situation will be aggravated. 3. Also there are various sites of socio-cultural importance like Ajgaivinath temple, Sultangunj, which should not be impacted due to project development.
25.	Department of Fisheries, Sahibganj &Date:16th	Shri Jayant Ranjan, **Designation:**	1	1. During the consultation, Mr.

	September 2015	District Fisheries officer :jayant.ranjan21@gmail.com		Jayant Ranjan made the following comments ✓ He appreciated the efforts to engage with local communities through public consultation. ✓ He said app. 5000 fishermen are dependent on fisheries for livelihood in this stretch and their livelihood may get impacted due to development of project ✓ Some of the commercial fisheries in the area are Indian Major carps, singhi, shrimps, Mystus sp. Catfishes &tengra ✓ The river banks at Bejlighar, Maharajpur, Mahadevganj, etc in Sahibganj are known as breeding and spawning grounds. Fish

				breeding takes place in shallow water. Fish seedlings are collected by fishermen in this region. ✓ During lean season, siltation is high and water current is low. Thus dredging will be required to carry out which will significantly impact the water quality ✓ Dredging may have significant impact on breeding and spawning season ✓ Impacts which may result due to project development are oil spills from barge vessels, cargo spillage, ballast water, anti-fouling paints etc ✓ Dredged material should not be disposed off on the bank of river as they are

				breeding and spawning grounds of fishes ✓ In Jharkhand District, decline in Rohu fish is recorded. ✓ Project will open up the opportunity for movement of frozen fish in Sahibganj and will open up opportunity for livelihood of local communities 2. There is potential for growth of commercial fisheries including cage culture fisheries, which is being promoted in Jharkhand
26.	District Forest officer, Bhagalpur, Patna &Date: 16th-09- 2015	Mr. S.K.Sinha, Designation: DFO, Bhagalpur	1	1. Mr. S. K. Sinha made the following comments and suggestion ✓ He discussed that it may require to clear large nos. of trees for development of project ✓ He suggested permission should be taken from

				forest depament before cutting any tree ✓ He also suggested that compensatory aforestation should be carrid out in lieu of trees cut ✓ He suggested to consider impacts on aquatic life and terrestrial flora & fauna while designing the project and to include mitigation measures in environment management plan ✓ He suggested a thick green belt should be developed all around the boundary of the terminal site 2. He also suggested that terminal boundary should be high enough to prevent entry of cattle/animals
27.	Gram Panchyat, SamdaNala and Rampur village &Date: 9th -09- 2015	Mrs. Munni Gaud **Designation:** Gram Panchyat Head, Panchyat, SamdaNala and	1	1. Mrs. Munni Gaud is aware about the project and she opined the following

		Rampur village		✓ She said the project will bring development in the area and will have positive socio-economic impact on large scale. However people who are losing land will lose their livelihood and their housing ✓ People are expecting employment generation from the project and also the infrastructure development ✓ Traffic may increase in the village and nearby area which will pollute the air so mitigation measures should be taken to minimize air pollution ✓ Villagers have emotional values attached with the River Ganga, thus terminal project

				should not cause water pollution else there will be opposition from the villagers ✓ Adequate compensation should be given provided to the people. 2. Alternate employment options should be suggested for people who are completely losing their land.
28.	Gram Panchyat, Hathigarhi**&**Date: 9th-09-2015	Mrs. UshaKhalkoo **Designation:**Gram Panchyat Head,Gram Panchyat, Hathigarhi	1	1. Mrs. Usha Khalkoo is aware about the project and she told the following ✓ Land owners are worried as some are losing their complete land and they will lose their livelihood, if land will be taken away from t hem ✓ Adequate compensation and assistance should be provided to land owners to find new livelihood options. ✓ Employment should b provided

				to local people preferably ✓ Tree cutting should be minimized and compensation should be provided to owners for all their assets as per law ✓ River water will be polluted due to construction of terminal and villagers may have concerns about this as they worship River Ganga 2. Traffic may increase in the area which may increase chances of accidents
29.	District Collectrate Office Sahibganj, Jharkhand&Date: 7th-09-2015	Mr Niranjan Kumar **Designation:** Additional Deputy Collector + Land Acquisition officer, Sahib ganj District Collect rate OfficeSahibganj, Jharkhand	1	Meeting was held in the Collectorate office regarding the proposed terminal activities. In the meeting Mr Niranjan kumar ADC Sahibganj told that their office is carrying out the land acquisition which is in progress and it may take some more time to

				finalize the final individual award list. After completion of the the work they can provide the final award list and land details to the IWAI. He also suggest to carry out the SIA activities and they can provide security for survey team as necessary.
Informal consultation in Farakka:				
30.	Bewavillage–cognitive interview**&**Date:5/10/2015	Villagers of BewaPanchayat • Ajay Mondal • Arun Ghosh • Ashoke Ghosh • Banu Ghosh • Bapan Ghosh • Binoy Ghosh • Bharat Ghosh • Bikash Ghosh • Biren Ghosh • Dukhu Sekh • Abddul Mannan • Barqat Sekh • Gani Sekh • Aftab Sekh • Hamsad Sekh • Ahmad Sekh • Tufani Sekh • Sarju Sekh	21	Participants included farmers, non-title holder's farmer and community member.Following issues/concerns were raised by the participants 1. People were aware about the project. 2. Some of them were doing agriculture on Farakka Barrage project land without any agreement and lease navigational lock to be constructed. 3. They had already given their land to FBP during Farakka barrage project

		• Gaju Sekh • siraj Sekh • Abdul Sekh		installation in 1965 4. Most of them were disagree with the compensation provided by FBP. 5. All the non-title holders expecting proper compensation and re-settlement. 6. Erosion occurs along the bank of feeder canal and that is creating problem. Ship movement has further enhanced erosion
31.	Near Primary school Ghoraipada village **&**Date:6/102015	Villagers of Ghoraipada village 1. Nikil ghosh 2. Pawan ghosh 3. Pappu ghosh 4. Ravi ghosh 5. Rakesh ghosh 6. Ram Chandra ghosh 7. Ratan Ghosh 8. Sadan Ghosh 9. Sanjay Ghosh.	9	Participants included farmer and small traders.. Following issues/concerns were raised by the participants 1. Non-Title holder are cultivating the land frost many years and dependent on the land. They are expecting appropriate compensation and also assistance in alternative lively hood. 2. They demanded job for them and their children and they mentioned they should be given skill generation training for job offered as they

				have practiced only agriculture throughout their life 3. Most of them were disagree with the compensation provided by FBP. 4. They need compensation for damage of fishing nets and other accessories due to barrage movement and project development (if any 5. They need employment during construction and operation phase of the proposed navigation lock.
32.	Central Inland Fisheries Research Institute ,Barrackpore, 700120, West Bengal &Date:1.07.2015	Director. Central Inland Fisheries Research Institute,Barrackpore,	1	They are aware about the project development 1. They suggested project will have significant impact on aquatic life and sensitive species like dolphins and turtles 2. Water quality is already polluted and will be affected further due to project development. 3. Dredging activity have significant impact on

				the aquatic life 4. This will lead to disturbance of the sediments which may contain haz. material, increase in turbidity which may impact the visibility and gills of the aquatic organisms etc 5. Mechanical movement of barges will impact the fish and other aquatic animals thus the speed of the cargos movement in these water should be regularized
33.	Department of Environment, Government of west Bengal&Date-31.06.2015	Mr. Siddhartha Roy, IFS, Senior Environment Officer, Government of West Bengal, Kolkata	1	He was aware about the project and they were highly concerned about the environment issues related with the project development 1. Clearances and NOCs should be obtained as applicable for the project as per the laws and Acts of Govt. of India 2. Project will significantly reduce air emission, noise level & traffic loads from highways but may add

				to water pollution 3. Surface water quality may be degraded due to discharge o waste/sewage from ships and lock gate facility, increased human activities near river, accidental spillage, leakage of oils etc. 4. Ground water may also get polluted as this surface water seeps into ground water aquifers
34.	State Warehousing Corporation, WB&Date -30.06. 2015	Mr. A.K. Sinh, Executive Secretary, WBSWC& Mr. Kaushik Mukherjee, Dy. Commercial Manager, WBSWC	2	The officials were aware about the project and added the following: 1. They have expressed positive attitude towards project development 2. Project will boost the freight movement, cheap raw material transportation and thus the industrial sector 3. With boost in freight transportation and industrial activity, need of warehouses will increase with time 4. Thus some projects

				may come near to lock gate sites 5. Cost effective, energy efficient and environment friendly mode of transportation
35.	Farakka Block Development Office, Farakka, Murshidabad&Date:8th October 2015	Mr Niranjan Kumar, KesangDhendupBhutia, BDO& Block Executive Office Ph-9434770026 E-mail-bdo.farakka@gmail.com	1	BDO, Farakka was aware and happy with the project development and assured his and local administration cooperation for the project implementation. 1. He was also invited for public consultation meeting. 2. Any kind of toxic pollution by the vessel like oil spillage and chemicals in the river water, transport emissions, needs to be considered.
36.	Divisional Forest Office, Nadia &Murshidabad Range&Date:15 th October 2015	Mr. Rana Dutta,IFS, DFO -mail: dfomnd@rediffmail.com	1	He was aware about the project. He says that there is no reserve and protected forest in the area and also added that there is no sensitive ecosystem present in the area. He was highly concerned about river

				bank erosion.
37.	Coal India, Kolkata.	Mr. Niranjan Das, CGM (Env.), Coal India, Kolkata.	1	He was aware about the project he further added that the project is highly beneficial. Insufficient transportation facility available at present. 1. Project development will increase the transportation of coal to user agencies, especially NTPC thus enhancing the power generation capacity 2. IWT is environment friendly mode of transportation 3. Transportation of coal should be carried out only in covered cargo 4. However, project can impact the aquatic life by disturbing its habitat 5. Environment management plan should be prepared and for all the stages of project and should be implemented as suggested to minimize environmental impacts of the project.

38.	Community members of local Villages at PCM	Community members of local Villages at PCM	50	1. The villagers also informed that there is no forest area. Further, they did not anticipate any adverse impacts on their livelihood due to construction works. 2. They further opined that there would be positive impacts on the sources of livelihood due to increased economic opportunities which will provide good earning sources to the local families due to the project implementation. It was also informed that there is no Schedule Tribe (ST) population in the project area. 3. Representatives from Beoapanchayat extended their support during the construction and operational phase of the proposed project. -They also suggested that public consultation meetings should be held at different places for

				awareness of the people and Grievance Redressal Committee should be active with timely conflict resolution.
39.	PatnaAranyaBhawan, ShahidPir Ali Khan Path (Riding Road), Shekhpura, Patna-14 Phone: 0612-2545074 Date: October 15, 2015	Dr. D K Shukla, Principal Chief Conservator of Forest (PCCF), Department of Environment and Forest	1	Wildlife Protection Act, 1972 will be applicable if the project intervention is within the boundary of VikramshilaGangetic Dolphin Sanctuary (VGDS)
40.	AranyaBhawan, ShahidPir Ali Khan Path (Riding Road), Shekhpura, Patna-14 & Date: October 15, 2015	Additional PCCF and Chief Wildlife Warden, Bihar, Department of Environment and Forest	1	1. Management Plan of VGDS is under preparation by ZSI, Patna 2. 10 kms is Eco-sensitive Zone of VGDS, notification of ESZ of VGDS not brought out by department 3. Approval of Department of Environment and Forest 4. State Board of Wildlife not required if project intervention outside the boundary of VGDS and ESZ. 5. Impact of navigation of large vessels on

				dolphin, is anticipated, hence mitigation plan should be provided.
41.	Zoological Survey of India, 11-D Rajendra Nagar, Patna - 800 016 Ph-0612-2360054& Date: October 15, 2015	Scientist D and Officer-In-Charge, GangeticPlains Regional Centre, Zoological Survey of India 11-D Rajendra Nagar, Patna - 800 016 Ph-0612-2360054	1	1. Preferred habitat of dolphin includes, confluence points, meandering locations and deep pools of river 2. 127 dolphins have been recorded in VGDS. 3. Other aquatic fauna of VGDS include Otter, gharial, turtle, etc. VGDS provides breeding ground of such species. Therefore, focus should also be kept on such species, besides dolphin. 4. As per ZSI's survey (2012) conducted in 525 kms stretch between Buxar and Manihari, 825 dolphin have been recorded. 5. Dredged material should not be dumped on the banks of river in NW-1 as river banks are habitat of otter, birds and other species which will be

				affected. 6. Plying vessels create ripples which causes energy losses in dolphin for its movement and carrying out other functions. 7. At present dolphins are distracted by vessels plying in NW-1. This leads to entanglement of dolphins in fishing nets in Ganga causing mortality. 8. In the current situation, plying vessels get stuck in lean season. 9. In the event of larger vessels plying in NW-1, the situation will be aggravated. 10. Mitigation measure for propellers to avoid dolphin getting hit should be considered, e.g. propeller guard.
Informal Consultation in Haldia				
42.	Tamluk,East Medinipur& Date: September 21, 2015,	Mr. S K Chakraborty, DFO, East Medinipur Division	1	DFO sought directions from Headquarters of Department of Environment and Forest for providing relevant

				data.
43.	Tamluk,East Medinipur& Date: September 21, 2015	Mr. SatikantaBairagi, Assistant Director of Fisheries (ADF) in Directorate of Fisheries and Fish Farmers Development Agency	1	Provided information on Nayachar and Nutanchar Islands in the project area of proposed Haldia Terminal.
44.	Tamluk, East Medinipur & Date: September 22, 2015,	Mr. Jay Sengupta, Director (Technical) and Mr. B D Saha, Manager (Process)	2	The officials of Sanjana Cryogenic Storages Ltd. were aware of the proposed terminal at Haldia in the neighbourhood of Sanjana Cryogenic Storages Ltd. The issue of over ground pipeline was raised which runs along the proposed site
45.	Kolkata, September 23, 2015,	Dr R P Saini, Special Additional PCCF and Chief Conservator of Forests (HQ) Department of Environment and Forests	1	Instructions were issued to DFOs in Nadia and East Medinipur Division for collection of relevant data
46.	HaldiaMunicipality,Haldia, PurbaMedinipur& Date: 25th September, 2015	Mr. DeboprasadMondal Chairman of Haldia Municipality Email: haldmuni@yahoo.com	1	Support the project. The main issues are: 1. Hooghly River which is very much close to the proposed terminal 2. Any kind of toxic

				pollution by the vessel like oil spillage and chemicals in the river water, transport emissions, needs to be considered. 3. He appealed to the authority that they should provide jobs to the local unemployed youth based on their skill and should give business opportunities to the local people. 4. As part of social development the local immersion Ghat at Durgachak(near to the project site) should be expanded by the project sponsors to overcome the current congestion especially during the local festival. 5. The access road needs to be carpeted as present road is not in good condition. 6. Our request is to develop the road as it will be needed for the proposed terminal access movement also.

				7. He requested to make provisions for appropriate parking facilities inside the proposed terminal for better management of container carrying vehicles. 8. Finally he gave the assurances that local government (ULB) will give all help for smooth operation of the project activities.
47.	Haldia,P Haldia Development Authority(HDA),Haldia,PurbaMedinipur.urbaMedinipur& Date: 28th September 2015	Mr. Purnendu S. Naskar,WBCS	1	Support the project, The main issues discussed are: 1. The project sponsors should consider the fact that the vessel navigation should be planned appropriately as there could be an impact to the river bank which is adjacent to the proposed terminal. 2. Due to increased river cargo traffic management of incoming and outgoing vessels in terms of loading and unloading will have to be planned and

				executed appropriately. 3. During dry and winter season the river water depth is low, this will create issue of cargo movement from and to the terminal. Measures should be taken to address this problem either by ensuring minimum water flow in the river or provide appropriate warehousing facilities for storing the cargo material during the lean period. 4. Oil from vessel may flow into the river and pollute the water. This pollution will affect the terrestrial flora and fauna. Their needs strict control to be imposed by the project sponsors. 5. The IWAI authority have to be prepared for any kind of accidents occurring with maximum preparedness like – havinga rescue team on call, good communication with

				the civil volunteers, fire services and local administration contacts.
48.	HaldiaMunicipality, Haldia, PurbaMedinipur& Date: 25th September, 2015	Mr. Gopal Chandra Das,ViceChairman,Haldia Municipality	1	Support the project, The main issues discussed are: 1. The interviewee raised concerns about the existing high particulate matter concentration in the area and recommended that theproposed project should ensure that no further particulate matter is created by the proposed project. Concerns about oil spillage was raised and hoped that proper emergency response to tackle any accidental spillage would be in place. 2. The access road needs to be widened and upgraded to ensure smooth traffic movement. A traffic management plan needs to be in place. 3. The interviewee suggested that the

				project should employ local people in the proposed terminal on a priority basis provided they have the required skills.
49.	Haldia Block Development office,Brajlalchak,HaldaPurbaMedinipur& Date: 23rdSeptember 2015	Mr. Suman Kumar Sahoo, Fisheries Extension officer	1	Support the project, The main issues discussed are: 1. There is no fish sanctuary around the port site. Fish existence is found for three months during the rainy season. During the dry season the water quality is degraded and blackish which is not suitable for the fish. Thus production of fish reduces. 2. Turbulence and wave from plying vessel movement can be a cause of fish resource sheltering in safer waters. This is problem that is difficult to resolve as the waterway fish may migrate. 3. -Considering terrestrial flora and fauna, the authority

				can prepare habitat by tree plantation. 4. -There are some fishermen depending on the fishing activity in the Hooghly River for 3-4 months of the year; the authority can support them through livelihood restoration programmes. 5. The authority can prohibit the discharge of oily water into the river during fish breeding period April-May. 6. IWAI authority can invest in fish breeding in the river or nearby water bodies and employ the fishermen who are without a livelihood for nine months in a year.
50.	Sanjana Cryogenic Storges Ltd., Durgachak,Haldia,PurbaMedinipur. Date: 21st September 2015	Mr. Joy Sengupta, Director Technical, Sanjana Cryogenic Storges Ltd	1	Support the project, The main issues discussed are: 1. The terminal will be a new addition for carrying the container and goods by the river at lower rate. Once the terminal is in operation they will use

				it to vessel their export goods which will be cheaper by road transport that they are currently using. ✓ Export import business will be improved for terminal installation. ✓ Employment opportunity will be increase. ✓ The only source of pollution from proposed terminal will be sound pollution. The project implementing agency needs to take steps to abate the noise pollution. 2. Our factory is close to the proposed terminal therefore, we will help IWAI authority to operate the terminal smoothly in term of existing pipe line shifting, etc. 3. Need to work in close cooperation with the IWAI to ensure that no

				water logging takes place due to the project by integrating the drainage systems in the area. 4. Fire team should be available on call to attend to and avoid any kind of disaster situations.
51.	Durgachak,Haldia,PurbaMedinipur. Date: 27th September 2015	HaldiaVigyanParishad(NGO's,	3	1. Support the project, The main issues discussed are: ✓ Meaningful community development for the people in the affected areas was demanded ✓ Oil water from vessel washes may pollute the river water which will affect the terrestrial flora and fauna. There needs to be strict control measures to be imposed by the project authority. 2. The proper environment management plan should be prepared before the project

				operation phase.
52.	Community members living within 1.5km radius of the project location at Durgachawk& Date: 27th September 2015	Community members living within 1.5km radius of the project location at Durgachawk 1. Sanjay Kumar Maji 2. Arindam Pramanik 3. Sadhan Sardar 4. Sibsankar Patra 5. Pralay Kr. Hazra 6. Atanu Bera 7. Prabir Pusti 8. Biswajit Rana 9. Arjun Metya 10. Kamal Jana	10	1. Interviewees highlighted that the consultation – adapting the company's operations to reflect the views heard – is typically missing. They underlined that if companies wish to conduct meaningful consultation, they should be willing to revise the project terms in response to the feedback received from the community. They noted that they view the objective of the consultation not as merely explaining the project, but revising it as needed to satisfy the affected communities. 2. Consider providing access to alternative methods of gaining adequate livelihoods, such as offering vocational training for specific jobs, in addition to providing monetary compensation for

				affected structure. 3. Compensation for affected structure payments should be transferred directly to the recipients through community-based organizations. The funds should not be transferred through local authorities, land registries or other entities that could be prone to corruption. 4. Put in place grievance mechanisms so that community members have a place to go to voice concerns and resolve the issue.
53.	Durgachak,Haldia, Purba Medinipur&Date -28th -06-2015	Santanu Ghosh, Local Auto Rickshaw Drivers at Durgachak,Haldia, Purba Medinipur	1	1. We are driving our vehicle in this road from dawn to dusk. 2. We earned and derive our 6-member family by this. 3. If traffic congestion becomes severe than our income will be reduced and will have to divert our profession. 4. We expect the authority will take measures.

54.	Fisherman group at Durgachak &Date: 29th-06, 2015	SanatanDinda and other fishermen	1	1. According to the team leader Md. SanatanDinda-we are fishing here only 3 to 4 month. 2. Another time we work in the brickfield and some of us pulling rickshaw and van. There are 7-8 people in our team, every day we get 2500 to 3000 rupees by fishing. 3. September is the peak time for high income. Our concern is that if the vessel comes during this time the fishing may be affected which will hamper our livelihood.
Informal Consultations for Barge Movement in Buxar & Patna				
55.	People gathered for Ganga bath& Date: 10thFebruary 2016	Ram Rekha Ghat, Buxar	10	1. People were given brief about the project and to be increased frequency of barge movement and large size barges movement in the stretch of River 2. People welcome the project and were interested to know about the employment generation potential

				for locals due to project 3. No objection was raised to project 4. People said that if project will lead to congestion then infrastructure should be enhanced accordingly so as local people do not suffer
56.	Local People gathered for bath in Ganga (Ganga Snan) & Date: 11th Febrauary 2016	Adi Nath Ghat, Buxar	6	1. People were not aware about the project and thus brief was given to people about the augmentation of entire NW-1 to enhance the navigation 2. People were told about the increased barge movement in the area 3. People raised their concerns regarding their day to day activity in the river. 4. They inquired if the barge movement will enhance the pollution. They asked for pollution free Ganga 5. They also expect that employment

				generation should be there due to project development in their area also
57.	Local people gathered for idol emersion. & Date: 14 th February 2016	Gai Ghat, Patna	8	1. People were aware about the project as IWAI is nearby 2. Brief was given to people again about the augmentation of entire NW-1 to enhance the navigation 3. People were told about the increased barge movement in the area 4. People were worried about the enhanced pollution in the river due to project

Annexure 6.4:Attendance sheet for the PCM at Sahibganj Formal Consultation

सामूहिक परामर्श बैठक
स्थान – आश्रम सम्पदा घाट दिनांक 16-10-2015

क्रमांक	नाम	विभाग	हस्ताक्षर
1.	रवि कान्त	भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण	[illegible]
2.	जयंत रंजन	जि० मत्स्य पदा०, साहेबगंज	[illegible]
3	विनय कुमार मिश्र	जिला भू-अर्जन पदा० साहेबगंज	[illegible]
4	प्रशान्त कुमार	भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण	[illegible]
5.	[illegible]	[illegible]	[illegible]
6.	Rohini R. Mohi	IWAI	[illegible]
7.	आभा सिंघल जोशी	WB (consultant)	[illegible]
8	MRIDULA SINGH	WORLD BANK	[illegible]
9.	Dr. P. Marandi	Health (CMO)	[illegible]
10.	Ajay Shankar Chy	KC (D.L.A.O)	[illegible]
11.	कन्हाई साह	सहायक जिला भू-अर्जन पदा० साहेबगंज	[illegible] 16/10
12.	Shankar Ad Mehta Arshad Andre	D.L.A Office Sahibganj	[illegible] 16.10.15
13.	Rajendra Sah	D.L.A. Office Sahibganj	[illegible] 16/10/15
14.	[illegible]	[illegible]	[illegible] 16/10/15
15.	महाशिर साह	लालमुरी पीरी हस्तलेख मत्स्य-समिति	[illegible]
16	Krishna Kumar	IRGSSA / EOMS JV	[illegible]
17	Dr. Sushil Bhadula	DSVV, Haridwar Uttarakhand	[illegible]
18.	विवेक	IWAI	[illegible]
19 -	Ravi Ranjan	IWAI	R. R. Kumar
20 -	Sanjay Kumar	W.R.D. (Ganga pump canal)	[illegible]
21.	Kaushal Jha	CRADLE-Ranchi	[illegible]

लोक परामर्श बैठक

क्रमांक	नाम	गाँव	हस्ताक्षर
1	पारस यादव	समदा नाला	पारस यादव
2	Rajeef Yadav	Samda Siz	Rajeef Yadav
3	[illegible]	Samda Siz	[illegible]
4	[illegible] मंडल	" "	मनोज मंडल
5	प्रदीप यादव	[illegible]	प्रदीप यादव
6	नारदमुनी यादव	" "	नारदमुनी यादव
7	जयराम यादव		
8	[illegible]	समदा सिंडा	
9	[illegible]		[illegible]
10	शाह मो०		
11	अर्जुन कुमार		
12	सिधेश्वर मंडल		
13	मावला रविलास		
14	गौरव यादव		
15	गगन रविलास		

क्रमांक	नाम	गाँव	हस्ताक्षर
16	शिवजी महलदार	रामपुर	
17	चंचल कुमार यादव	समदा	
18	जवाहर यादव	समदा	
19	मन्दू यादव	समदा	
20	महेश यादव	आश्रम	
21	रामचन्द्र कृषि	समदा	
22	रूपनमंडल	रामपुर	
23	सुर्य नारायण यादव	रामपुर	
24	नारायण यादव	समदा	
25	शिवशंकर यादव	समदानात	
26	सुदर्शन यादव	समदानाला	
27	सुशिला देवी	"	
28	महेन्द्र यादव	"	
29	कन्हैया यादव	"	
30	बाल कृष्ण यादव	"	

Annexure 7.1: Tree Plantation and Management Plan

1.0 Introduction

Site for terminals/jetty/lock may support vegetation such as trees, shrubs herbs etc. Sahibganj site is the one out of four sites selected for terminals/locks support significant vegetation, i.e. mango orchards and other trees. Remaining sites supports some trees which may be required to cut or can be retained. Other sites which are not finalized may also support the vegetation which will be required to remove. Tree cutting shall be required at such sites and it should be carried out only after obtaining clearance from forest department. Only identified & permitted tree species shall be cut.

As per state forest policy compensatory afforestation should be carried out in ratio of at least at 1:2 ratios.Compensatory afforestation shall be carried out by forest department. It is preferable that compensatory afforestation is carried out in nearby land patch. Survival rate of the afforestation carried out by forest department shall be monitored by IWAI.

Apart from above compensatory plantation as part of environmental management, it is proposed to develop 15-20 m thick green belt all along the site boundary and along the roads within the site. Green belt shall be developed as per the following guidelines

1.1 Selection of Tree Species

The Project involve movement of vehicle for transportation of material Thus emissions like particulate matter, SO_2, NO_x& CO shall be generated at site. Also there is potential of generation of coal dust while unloading the materials at stock piles. Thus the plantation species tolerant to these pollutants and mitigate these from air shall be planted. Species selecting criteria is given below:

1. Tolerant to expected pollutants at site
2. Longer duration of foliage
3. Freely exposed foliage (adequate height of crown, openness of foliage, big leaves, small stomata apertures, stomata well exposed)
4. Leaves supported on firm petioles

1.2 Recommended Plant species

Based on nature of pollutants following tree species are recommended to be planted

S. No.	Plant Species	Common Name	Habit
1.	Termanilia catappal	Jagali Badam	Tree
2.	Anthocephalus cadamba	Kadam	Tree
3.	Ficus bengalensis	Badh	Tree
4.	Magnifera indica	Aam	Tree
5.	Tectona grandis	Teak	Tree
6.	Ficus religiosa	Peepal	Tree
7.	Hibiscus rosa sinensi	Hibiscus	Shrub
8.	Wrightia arboriea	Dudhi	Shrub
9.	Tabernaemontana divaricata	Chandani	Shrub
10.	Bougainvillea glavra	Bougainvillea	Shrub
11.	Codium variegates	Cockscomb	Herb

12.	Celosia argentea	Croton	Herb
13.	*Ilex rotunda*	Kurogane holly	Tree
14.	*Cassia surattensis*	Golden Senna	Tree
15.	*Cinnamomum camphora*	Camphor tree	Tree
16.	Lagerstroemia flos-reginae	Lagerstroemia	Tree
17.	Alstonia scholaris	Devil tree	Tree
18.	Cassia fistula	Golden shower	Tree
19.	Delonix regia	Gulmohar	Tree
20.	Pongamia pinnata	Indian beech	Tree
21.	Terminalia arjuna	Arjun	Tree
22.	Terminalia belerica	Baheda	Tree
23.	Butea superb	Tesu	Tree
24.	Cassuarina sp.	Cassuarina	Tree
25.	Bahunia acuminate	White orchid green	Tree
26.	Swetania mohogini	Cuban Mahagony	Tree
27.	Azadiracta indica	Neem	Tree
28.	Artocarpus integrifolia	Jackfruit	Tree
29.	Gmelina arborea	Gamhar	Tree
30.	Putranjiba roxburghii	Putranjiba	Tree

1.3 Plantation Methodology

Components of green belts on roadside fence should be both absorbers of gases as well as of dust particles, including even lead particulates. Thus the choice of plants should include pollution tolerant shrubs of height 1 to 1.5 m and trees of 3 to 5m. The intermixing of trees and shrubs should be such that the foliage area density in vertical is almost uniform. For effective removal of pollutants, it is necessary that (i) plants should grow under conditions of adequate nutrient supply, (ii) absence of water stress and (iii) plants are well exposed to atmospheric conditions (light & breeze).

Multiple rows of green belt shall be developed. Green belt should be pyramidal in shape. Plantation pattern shall be kept as given below:

- Short trees and tall shrubs shall be planted as first row (from road) followed by tall tree plantation which will be followed by another row of medium and small trees and tall shrubs.
- Planting of trees should be in appropriate encircling rows, each rows alternating the previous one to prevent further fanning and horizontal pollution dispersion;
- Since tree trunks are normally devoid of foliage, it would be appropriate to have small shrubs in front and in between the tree spaces;
- The open areas between the process installations where trees cannot be planted should be covered with lawn grasses for effective trapping and absorptions of air pollutants.
- Fast growing trees with thick canopy and perennial foliage should be selected so that the effective tree height with envisaged objective will be attained in minimum span of time

1.4 Plantation Pattern

A standard horticultural practice involving planting of saplings in pits of substantial dimensions i.e., 1m × 1m × 1m for big trees and along half of these dimensions for smaller

trees and shrubs. The pits are then filled with earth, sand, silt and manure in pre-determined proportions. Saplings planted in such pits are watered liberally during dry months.

1.5 Time of Plantation

Plantation of the tree sapling should be done only after the first shower during the rainy season. The best time for plantation is after 15 days from the day of first shower during rainy season.

1.6 Protection of Tree saplings

Circular tree guard should be placed after the plantation of the saplings for the protection of these young plants from the ravages of cattle, sheep and goat and other animals. If tree saplings died or damage occur after placing the circular tree guard, timely replacements of damaged plant and thereafter care is important.

1.7 After Care & Monitoring

The growing plants are cared at least for the first two years under favourable conditions of climate and irrigation. Nutrients in pits are supplemented and the juveniles provided protection.

Thinning shall start after the stand is 3-4 years old and repeated every 4 years until the stand is 15 years old. Between 15-25 years old, thinning should be conducted every 5 years and after 25 years old, thinning shall be done after every 10 years. When the canopy closes, at about 6 years, 30-40% of the stems shall be thinned to selectively remove suppressed, diseased and badly formed trees.

Periodic assessment shall be carried for survivability of the trees. Minimum 70% survival rate shall be achieved.

1.8 Records Keeping & Reporting

The following records shall be maintained:

6. Record of Tree plantation
7. Record of Survivability rate

Inspection shall be carried out at site to know the survival rate of the plantation. The tree plantation and survivability report shall be prepared every six monthly.

1.9 Responsibility

Compensatory plantation shall be carried out by forest department. Survival rate of plantation shall be inspected of the by IWAI. Plantation within the terminal/jetty/lock site shall be carried out by IWAI and shall be monitored by IWAI.

Annexure 7.2- Guidelines for emergency management plan

1. Introduction

An emergency is a situation that poses an immediate risk to health, life, property, or environment. Emergency can arise out of several scenarios such as natural calamity, equipment failure and human error, it will normally manifest in the following forms;

- Fire and Explosion
- Total Spillage
- Toxic/flammable gas/vapour release
- Loss of containment
- Structure Collapse
- Vessel Collision
- Dropped Object
- Ship Grounding and Drowning

Most emergencies require urgent intervention to prevent a worsening of the situation. To handle emergency situations efficiently and to mitigate the damage of potential events that could endanger an organization's ability to function, a course of action is developed which is defined in Emergency Preparedness and Response Plan.

2. OBJECTIVES

The objectives of Emergency Management Plan shall be to;

a. Provide an Emergency Management organization structure which will enable project proponent to respond rapidly and efficiently to any emergency in order to prevent injury to personnel, damage to property or the environment as well as minimizing or eliminating the impact to neighboring communities.

b. Ensure all appropriate and relevant resources are identified in advance and made available as quickly as possible during an emergency.

3. SCOPE AND ASSUMPTIONS

Project Proponent shall develop an Emergency Preparedness and Response Strategy which shall outline the potential foreseeable emergency scenarios, classification, resources, incident command structure, and a documented emergency management plan encompassing prevention, control, recovery and remediation measures to deal with any emergency event that may occur within the project during construction and operation phase.

This plan shall be adapted depending on the circumstances of a particular emergency during construction and operation phase of the project. The actions to be taken in any given emergency shall be decided by the Emergency Management Team (EMT) of Project Management Unit and Contractor during Construction and Operation phase.

This plan shall be activated by the nominated person of Contractor and PMU depending on the circumstances and severity of the incident.

4. Types of POTENTIAL Emergencies

For any development activities, potential emergencies can be categorised in to three types as listed below;

a) Man Made (Heavy Leak, Fire, Explosion, and Design Deficiency etc.)

b) Natural Calamitie (Earth Quack, Cyclone, Outbreak of Disease, and Excessive Rains etc.)
c) Extraneous (Riots/Civil Disorder/ Mob Attack, Terrorism, Sabotage, and Bomb Threat etc.)

PMU/Contractors shall identify all potential emergencies which are relevant to the nature of the project. It shall be shall be ensured that Emergency Management Plan deals with all possible emergencies scenarios. Indicative scenarios for both construction and operation phase of the project are listed down below;

A. **Construction Phase**

Primarily the potential emergencies during the construction phase (Marine and Land) could result from any of the following:

a. Collapse of structure due to design fault, soils conditions, poor quality of construction material etc.
b. Overturning of a crane during lifting / transportation of the materials
c. Overturning of motorized boat / normal boat used for transportation of workers in off shore construction
d. Leakage of Oil (HSD) in oil storage area leading to fire
e. Gas leakage from Cylinders used for the purpose of gas cutting and welding (Dissolved Acetylene, LPG etc.) leading to explosion
f. Bursting of cables due to cable breakage / over loading leading to fire
g. Mass leakage of oils leading to land contamination
h. Collapse of complete scaffolding leading to multiple fatalities

B. **Operation Phase**

During operation phase where lot of ships and barge movements are expected near the loading and unloading platforms, following types of scenarios are envisaged;

B.1 Off-Shore Emergencies

a. Major incident onboard a vessel such as fire, flooding or cargo related
b. Collision between vessels or between a vessel and a fixed object
c. Grounding and drowning of a Vessel
d. Major Oil Spillage from a Vessel or Jetty
e. Major Oil spill at sea or Oil entering the bay from a source upriver
f. A major incident involving small craft within the ports jurisdiction.
g. A security incident, involving a ship, which has the potential to escalate into an emergency situation.

B.2 On-Shore Emergencies

a. Major fire within the general bay area
b. Major oil spill
c. Major spill of hazardous material
d. A vehicle accident involving hazardous material

e. Chemical incidents (e.g. toxic cloud).

f. Major incident in an oil, gas or hazardous material storage facility.

EMP plan shall be is designed to cater for both marine and land based emergencies. A number of scenario specific sub-plans for the above shall be developed as part of this overall plan.

5. Levels of Emergencies

Depending on the scale and severity of damages, emergencies can be broadly classified into three levels: Level 1, 2 & 3. Their description is provided below;

Level of Emergency	Description
Level 1	Minor incidents that occur in localized areas of the facility. They can be quickly contained or resolved with existing resources available in the facility. Examples: localized fires, minor chemical spills, utilities failure. These emergency scenarios can be managed by using safety equipment available nearby that location. For e.g. Fire Extinguishers.
Level 2	A moderate scale incident more serious in nature involving large area that could possibly affect many people. May involve large-scale evacuation and includes the need to access off-site emergency response resources to effectively control the situation. Major components of the Plan could be fully or partially implemented, and the Emergency Control Centre is normally activated.
Level 3	A facility-wide disaster event causing widespread damage and injuries that overwhelms available resources and personnel. Such disasters pose a major threat to life and property and can impact the wellbeing of large numbers of people. Outside emergency response resources from local and state agencies plus the potential of federal assistance would be used in addition to full activation of all procedures contained within the Plan. **Examples:** Major fire, chemical contamination, explosion major flood, or extended utility outage

6. Emergency facilities

Project Proponent shall ensure that following facilities should be provided at the facility to tackle any emergency at any time;

a. Fire protection, firefighting facilities and trained personnel

b. Emergency lighting and standby power

c. Emergency Equipment and Rescue Equipment

d. Breathing apparatus with compressed air cylinder

e. Fire proximity suit

f. Resuscitator

g. Water Gel Blanket

h. Low temperature suit
i. First Aid Kit
j. Stretchers
k. Torches
l. Ladders
m. Safety Equipment
   - Respirators
   - Gum Boots
   - Safety Helmets
   - Asbestos Rubber Hand Gloves
   - Goggles and Face Shield
   - Toxic gas measuring instruments
   - Explosive Meter
   - Oxygen measuring instruments
n. Toxic gas measuring instrument
o. Wind Direction Indicator
p. Communication facilities,
q. Transport facilities,
r. Occupational Health Facilities
s. List of Emergency Drugs and Appliances, etc.

7. Emergency Organisation & Responsibilities

Project Proponent shall ensure that key personnel to combat emergency are nominated with specific responsibilities according to set procedures and make best use of the resources available. Emergency Organisation shall meet the following objective;

a. To promptly control problems as they develop at the scene
b. To prevent or limit the impact on other areas and outside the project boundary.
c. To provide emergency personnel, selecting them for duties compatible with their normal work functions wherever feasible. The duties and functions assigned to various people shall include making full use of existing organizations and service groups such as fire, safety, occupational health, medical, transportation, personnel, maintenance, and security.
d. Project Proponent should have an alternate arrangement for each function. A typical Incident Command Structure. This should at least include the following:
   - Chief Incident Controller (CIC)
   - Site Incident Controller (SIC)

8. Emergency Response Team Members

a. Administration and Communication Coordinator
b. Fire Safety Coordinator
c. Technical Services Coordinator

d. Medical Team Coordinator

e. Security Coordinator

Organisation Chart

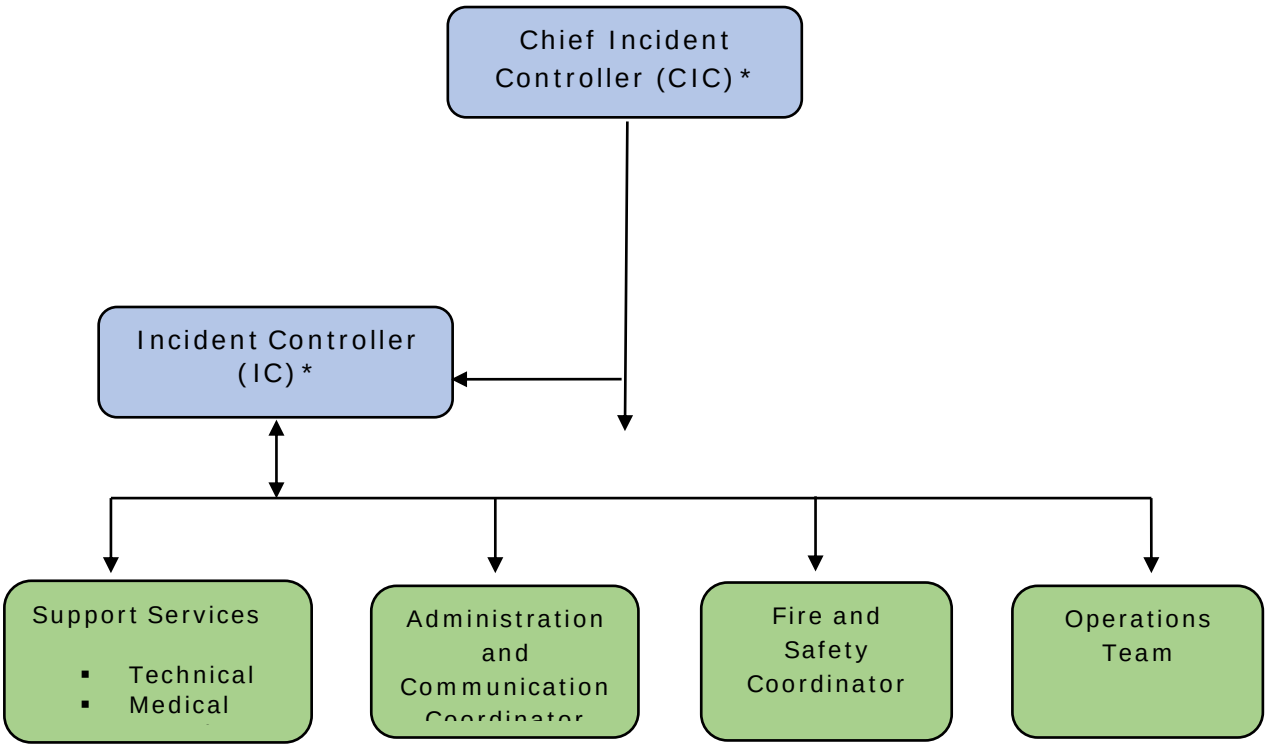

Figure 1 Emergency Organisation Structure

NOTE
* PMU Head of the facility can be assigned for this role (for Construction Phase + Operation Phase)
** Construction contractor can be assigned for this role for Emergency Preparedness and Response Plan (for Construction Phase).

Chief Incident Controller (CIC)

The Chief Incident Controller (CIC) shall have overall responsibility to protect personnel, site facilities, and the public before, during, and after an emergency. The CIC shall be present at the main emergency control centre for counsel and overall guidance. Responsibilities of the Chief Incident Controller shall include the following: -

a. Preparation, Review, and Update Emergency Preparedness and Response Plan

b. Direct operational control over areas in the facility other than those affected

c. Assess the situation and decide to evacuate from the assembly points to safe location

d. Ensure that a log of the emergency is maintained in ECC

e. Liaise with Police, Local Government, Pollution Board, and other agencies and appraise on possible affects to areas outside the facility premises
f. Advise incident controller to close out the incident when the situation is under control
g. Control rehabilitation of the affected persons after the emergency

Site Incident Controller (SIC)

The Site Incident Controller shall be identified by the Chief Incident Controller and will report directly to him. Responsibilities of the Chief Incident Controller shall include the following: -

a. Take charge of the incident site
b. Assess the situation and alert panel / field operators
c. Inform Chief Incident Controller (CIC)
d. Assess the level of emergency and instruct to actuate emergency siren
e. Evacuate personnel to the assembly point and then to safe location
f. Initiate action for isolation of source
g. Direct all operations within the affected areas
h. Advice firefighting & rescue personnel
i. Preserve all evidences to facilitate any enquiry
j. Assess damage & environmental / toxicity level before ALL CLEAR signal by CIC

Administration and Communication Coordinator

Responsibilities of the administration and communication controller shall include the following: -

a. Liaise with the statutory authorities.
b. Provide necessary support for the administration, welfare, transportation for control of emergency situation as requested by the CIC /SIC
c. Mobilize all the available company vehicles along with the drivers for emergency use.
d. Coordinate with neighbouring agencies for mutual aid support
e. Arrange for transport of victims to hospitals/ dispensaries on advice of medical services coordinator

Fire Safety Coordinator

Responsibilities of the Fire and Safety Coordinator shall include the following: -

a. Take charge of all firefighting /Rescue operations
b. Guide firefighting crew and provide logistics support for effectively combating the fire
c. Organize relieving groups for firefighting
d. Call mutual aid member/external help in firefighting.
e. Mobilize additional firefighting equipment /Consumable/PPEs in consultation with coordinator- Commercial
f. Assist in assuming the risk and upgrade/downgrade the level of emergency

Medical Team Coordinator

a. In case external medical assistance required, inform the nearest hospital for alertness and further assistance if required
b. Initiation of the medical response plan and its monitoring
c. Arrange for examination of the victim and his further treatment
d. Ensure the availability of ambulance all the time at the facility
e. Ensuring availability of water ambulance at terminal facility

Technical Services Coordinator

a. Provide all technical inputs to ECC
b. Arrange for retrieval of necessary drawings and related documents if required.
c. Coordinate with outside technical consultants and experts and seek help if required.
d. Assist CIC with necessary information, support and resources.
e. Communicate with pollution control authorities to provide / receive (if required) necessary information.

Security Coordinator

a. Take charge of all security functions like mobilization of security personnel, traffic control/ barricading, evacuation of personnel, threat analysis etc.
b. Assign evacuation coordinator & assembly point coordinator.
c. Mobilize additional / off duty security force for help, if necessary.
d. Liaise with local authorities in consultation with CIC for external help (as necessary) for evacuation of the neighbouring areas. If necessary, arrange for announcement through the mobile PA system for alerting the population in the surrounding areas
e. Depute security staff for managing gates and incident site.
f. Arrange and carry out head controls at assembly point and report to CIC.

Operation Team

a. The O & M (Operations and maintenance) personnel of the project facility being first line respondent at site shall attempt to control the emergency at the initial stage.
b. Immediately inform about the emergency situation to the ECC.
c. Review all operations carefully to ensure that systems in jeopardy are shut down.
d. Ensure critical operations are brought down to safer mode. It shall be done by the skilled and experience staff.
e. Evacuation of all non-responding staff from the areas in distress in crosswind direction
f. Personnel responsible for rescuing victims shall don full protective equipment

Flow of Information

a. Control Centre shall receive the information from field either in person or from the various systems available at the facility.

b. On receipt of information, the control room shift In-charge shall actuate the EMP and notify the emergency to site incident controller.

c. Control Room shift in-charge will act as site incident controller till arrival of designated person.

9. Emergency Control Centre

Emergency Control Centre shall be the focal point in case of an emergency from where the operations to handle the emergency are directed and coordinated. Project Proponent shall ensure that the centre is equipped with adequate resources to receive and transmit information and directions from the Chief Emergency Coordinator. It should be ensured that once the hazard is declared, communications systems immediately gets activated.

An emergency control centre should therefore contain a well-designed communication system and required information such as:

a. At least two external telephones (one incoming and the other one out going fitted with simultaneous/ selective broadcasting systems) with a PABX

b. Wireless / Radio equipment (VHF/ walkie talkie/ pager/mobile)

c. Inundation/vulnerability maps indicating risk zones, assembly points,

d. Alternate evacuation routes, safe areas, rehabilitation centres, etc.

e. Telephone directory of emergency response system

f. List of all emergency equipment and personnel for evacuation, personnel protection, medical aid, etc., under the plan as well as with Govt. agencies in the district

g. List of ambulances, base medical facilities, hospitals, rehabilitation centres, etc.

h. Plan of the facility showing-

- Storage area of hazardous materials
- Storage of safety equipment
- Firefighting system
- Facility Entrance, roadway and emergency exist
- Assembly points
- Truck parking area
- Surrounding location

i. Reference Books/ Chemical Dossiers

j. Copies of Disaster Management Plan

10. Alarm System

Project Proponent shall have and maintain an alarm system. Alarm system should use a distinctive signal for each purpose and comply with following requirements;

11. Assembly points

Project Proponent shall pre-determine and designate safe places far away from the risk prone areas of the facility where in case of emergency personnel evacuated from the affected areas shall assemble. Depending upon the location of the emergency and wind direction, the assembly points shall be selected. All assembly points should be clearly marked with directional display board along the route.

Following requirements shall be considered for the effective assembly and head count process;

a. Establish a Head-Count system for employees at the Assembly Area
b. A list of the names and last-known locations of missing employees should be made available on the assembly point as soon as possible after arriving at the assembly area
c. Evacuation coordinator should take charge of assembly point and take roll call of the employees
d. There should be an established method for the accounting of non-employees (contractors, supplier, visitors, vendors etc.
e. Establish procedures for further evacuation in case the incident expands. This may consist of sending employees home by normal means or providing them with transportation to an off-site location.
f. Identify Safe shelter space within facility or nearby safe area
g. Establish procedures for sending evacuees to shelter
h. Develop a list of necessary emergency supplies such as water, food, and medical supplies.
i. Coordinate plans with local authorities.

12. Actuation of Emergency Management Plan and Declaration

In case incident goes beyond control, Emergency Management Plan shall be actuated by Chief Incident Controller at the appropriate stage as considered necessary. Other key persons shall also start performing their defined role as per the emergency organization chart and inform to various emergency controllers for guidance and control the situation.

When emergency becomes catastrophic and evacuation beyond the plant premises is considered necessary by the Chief Incident Controller, the situation will be handed over to district authorities for implementing the off-site emergency plan.

For on-site emergency plan, the relevant authorities shall enforce directions and procedures in respect of preparation of off-site emergency plan in consultation with other Government Agencies.

13. POST EMERGENCY ACTIONS

PMU/ Contractor shall appoint an investigation team to investigate the incident, find the direct and root causes and suggest corrective and preventive actions to prevent the re-occouranes of the same incident. They shall be responsible to keep all relevant evidence records of incident.

14. Incident Investigation

Project Proponent shall ensure that all incidents including “near-miss” should be recorded and analysed to prevent their recurrence in future. The system of accident investigation, reporting and documentation to be established and monitored.

A system of communicating back the incident findings to employees and contract workers shall be ensured.

15. Communication System

Project Proponent shall ensure that after the assessment of risks and their possible environmental impacts, emergency, communication systems should be established. For advance communication on emergency preparedness, sites shall ensure that relevant information reaches to all employees, contractors, general public and local authorities. Through effective communication systems, emergency information should reach to;

a. Affected area of the facility
b. To key personnel outside normal working hours
c. To the outside emergency services and authorities and
d. To neighbouring factories and public in vicinity.

The communication system shall initiate with raising the alarm, declaring the major emergency and then follow the procedure to make it known to others. Components of communication system are explained below in brief;

C. **Raising the First Level Emergency Alarm (FLEA)**

Any person noticing an Emergency should raise First Level Emergency Alarm (FLEA). All persons working at the facility shall be trained to operate such emergency alarms. There should be an adequate number of points from which the alarm can be raised either directly, by activating an audible warning or individual signal or message to a preliminary manned location. This has the advantage of permitting the earliest possible action to be taken to control the situation, which in turn, may avoid the development of a major emergency. All such points shall be distinctively marked and known to all employees.

D. **Declaring the Major Emergency**

Declaration of the major emergency shall be done by Incident Controller and his appointed deputy as early as possible and without wasting the time.

(Note: The declaration of major emergency puts many agencies on action and the running system may be disturbed which may be very costly at times or the consequences may be serious. Emergencies should be declared by skilled, knowledgeable person who is able to envisage emergencies scenarios).

E. **Telephone Message**

Telephone operator (or communication officer) shall play an important role while receiving the emergency message on phone. He should be precise, sharp, attentive, and quick in receiving and noting the message and then for immediate subsequent action of further communication.

16. Communication of Emergency

Project Proponent shall ensure establishment of effective system to communicate emergency. As a minimum following routes of communications shall be followed;

a. At the facility i.e. to the workers including key personnel and essential workers, on duty and inside during normal working hours
b. To the key personnel and essential employees not on duty and outside during normal working hours
c. To the outside emergency services and the government authorities and

d. To the neighbouring firms and the general public in the vicinity

A. **Communication to the Employees**

Emergency prevention and control related information (as per the statutory requirements) shall be made available (in the form of a safety manual or a separate safety booklet) to the employees so that they can prepare themselves to take prompt actions in case of emergency. As a minimum following information should be communicated to the employees.

a. Statutory Requirements
b. Hazard Information

B. **Communication to the outside emergency services and the authorities**

Once the declaration of major emergency is made, sites shall ensure that is immediately communicated to the Government authorities such as local Authorities, Collectorate, Police and District Emergency Authority.

The statutory information to above authorities shall be supplied beforehand so that they can be will prepared to operate their off-site emergency control (contingent) plan. As per their advice or consultation your on-site plan should be modified and modified and updated also.

C. **Communication to neighbouring firms and the general public**

Project Proponent shall notify about the major emergencies to nearby Industries and general public. This can serve a dual purpose in that it will enable them to take prompt action to protect their own employees and to take whatever measure may be possible to prevent further escalation of the emergency due to effects on their own installations. At the same time, they may be able to provide assistance as a part of a prearranged mutual aid plan.

The statutory information to the general public shall be supplied to them for their emergency preparedness. Such information is mentioned as under:

1. The common names of the hazardous substance used which could give a rise to an accident likely to affect them, with an indication of their principal harmful characteristics.
2. Brief description of the measures to be taken to minimize the risk of such an accident in compliance with its legal obligations under relevant safety statues.
3. Salient feature of the approved disaster control measures adopted in the factory.
4. Details of the factory's emergency warning system for the General public.
5. General advice on the action, members of the public should take on hearing the warning.
6. Brief description of arrangements at the facility including liaison with the emergency services to deal with foreseeable accidents of such nature and to minimize their effects.
7. Details of where further information can be obtained.

17. TEST and Mock Drills

To evaluate the thoroughness & effectiveness of Emergency Preparedness and Response Plan, Mock Drills shall be conducted on all sites at appropriate frequencies (onsite as well as

offsite). These mock drills shall cover various levels of emergencies and variety of realistic emergency scenarios. The results of emergency drill exercises shall be communicated to appropriate personnel, including employees from the affected area.

A follow-up system shall be established at the facility to help ensure prompt and effective resolution of all emergency drill exercises. Resolution of drill recommendations shall be documented and maintained along with the drill or critique report.

The emergency mock drills shall be carried out on the objective of –

a. To evaluate the awareness of Emergency Handling team members with respect to their responsibilities during Emergency as per on site emergency management plan.
b. To evaluate the actions for effective mitigation of the emergency through team work.
c. To check efficacy, availability & healthiness of Warning system, Fire Protection & Prevention System & Medical facilities.

18. MUTUAL AID

Project Proponent shall ensure that to supplement a site's emergency control plan, services of member industries shall be requested when the emergency threatens to exceed the capability of otherwise available resources. Formation of "Mutual Aid Scheme (MAS)" is beneficial for each member in case of major fire hazards, explosion or other accidents involving threat to life and damage to plant property to a very large extent.

19. Training and Awareness

Project Proponent shall have a process in place for the training of employees, contractors & shareholders or any other affected individual or group in the subject area.

This training should cover:

a. Types of emergencies that may occur
b. Potential threats, hazards, and protective actions
c. Components of emergency preparedness and response plan
d. Individual roles and responsibilities
e. Relevant standards and Codes
f. Notification, Warning, and Communications procedures
g. Evacuation, Shelter, and Head Count procedures
h. Location and use of common emergency equipment
i. Mock Drill procedure and accounting for personnel
j. Techniques of accident investigations

20. Reference Framework

Some useful codes and standards, that may assist in designing an Emergency Management Plan

Reference	***Brief Description***
SOLAS, 1974	International Convention for the Safety of Life at Sea (SOLAS), 1974 a. Chapter II-2 – Fire protection, fire detection and fire extinction

	b. Chapter III – Life-saving appliances and arrangements c. Chapter IV – Radio-communications d. Chapter VII – Carriage of dangerous goods
International Finance Corporation (IFC)	a. Environmental, Health, and Safety Guidelines for Ports, Harbours, and Terminals
Applicable Legislation (Note* Certain requirements from these legislations may be adapted as best practices while developing EMP of the Inland Water Ways Project)	a. Manufacture, Storage and Import of Hazardous Chemicals Rule's (MSIHC Rules, 1989) http://envfor.nic.in

Annexure 7.3: Guidelines for Debris and Solid Waste Management

1.0 INTRODUCTION

Waste will be generated from the construction site and labour camps during the construction phase. Type of the waste to be generated during construction phase is given below.

Excavated Soil

Site is undulating and thus will require cut & fill for levelling. Finished level of the soil will be 37 m. Top excavated soil of 15 cm shall be stripped and shall be stored separately under covered sheds. This soil shall be used for green belt plantation.

Lower layers of excavated soil shall be re-used within the site for flling purpose, construction of approach & internal roads & railway link. If any extra soil is remained, then that should be disposed of to the approved debris disposal site

Dredged Material

Dredging shall be carried out in the river for construction of off-shore structures like jetty & berths (pilling) and navigation channels. Dredged soil shall not be disposed along the river bank as they are sensitive habitat for various aquatic species and provide as the spawning and breeding grounds also. Dredged material shall be tested for its quality. If non-toxic then should be disposed at disposal site but if toxic & contains heavy metals, then it should be disposed to TSDF site.

Construction Waste

Construction waste will comprise of broken bricks, dry cement, discarded timber, metal piece, cement bag, dry asphalt/bitumen, glass, paint/varnishes box etc. These wastes should be segregated into recyclable and non-recyclable waste. Recyclable waste shall be stored in the covered area and shall be sold to authorized vendors regularly. Non-recyclable waste shall be disposed at approved debris site in covered vehicles.

Municipal Waste

Municipal waste will be generated from labour camp. Dustbins for recyclable and non-recyclable waste shall be provided in labour camp area. Recyclable waste shall be sold to authorized vendors and non-recyclable shall be disposed through authorized agency in area responsible for waste collection and management.

Waste generated requires proper management so as to minimize the negative impacts on environment. Concept of reduce, re-use and recycle shall be followed at site. The rejected waste should be disposed in a secured manner. Thus a site should be identified for disposal of the rejected waste.

1.1 SELECTION OF DISPOSAL SITES:

The locations of Disposal sites have to be selected such that:

- Disposal sites are located at least 1000 m away from sensitive locations like settlements, water body, notified forest areas, wildlife/bird/dolphin sanctuaries or any other sensitive locations.
- Disposal sites shall not contaminate any water sources, rivers etc so the site should be located away from water body and disposal site should be lined properly to prevent infiltration of water.
- Public perception about the location of debris disposal site has to be obtained before finalizing the location.
- Permission from the village/local community is to be obtained for the Disposal site selected.
- Environment Engineer of PMC and Executive Engineer of Contract Management Unit must approve the Plan before commencement of work.

1.2 PRECAUTIONS TO BE ADOPTED DURING DISPOSAL OF DEBRIS / WASTE MATERIAL

The Contractor shall take the following precautions while disposing off the waste material.

- During the site clearance and disposal of debris, the Contractor will take full care to ensure that public or private properties are not affected, there is no dwellings around the dumpsite and that the traffic is not interrupted.
- The Contractor will dispose debris only to the identified places or at other places only with prior permission of Engineer-in-Charge of works.
- In the event of any spoil or debris from the sites being deposited on any adjacent land, the Contractor will immediately remove all such spoil debris and restore the affected area to its original state to the satisfaction of the Engineer-in-Charge of works.
- The Contractor will at all times ensure that the entire existing canal and drains within and adjacent to the site are kept safe and free from any debris.
- Contractor will utilize effective water sprays during the delivery and handling of materials when dust is likely to be created and to dampen stored materials during dry and windy weather.
- Materials having the potential to produce dust will not the loaded to a level higher than the side and tail boards and will be covered with a tarpaulin in good condition.
- Any diversion required for traffic during disposal of debris shall be provided with traffic control signals and barriers after the discussion with local people and with the permission of Engineer-in-Charge of works.
- During the debris disposal, Contractor will take care of surrounding features and avoid any damage to it. The debris should not be disposed along the bridges & culverts and near the water bodies.
- While disposing debris / waste material, the Contractor will take into account the wind direction and location of settlements to ensure against any dust problems.
- Contractor should display the board at disposal site stating the name of project, usage of the site and type of debris being disposed.
- A guard shall be kept at disposal site to prevent any unauthorized disposal of waste at the debris disposal site
- Material should be disposed through covered vehicles only
- No contaminated/hazardous/e-waste shall be disposed at the debris disposal site

1.3 RECORD KEEPING

Site approved by site engineer only can be used as disposal site. Record of all such site should be maintained along with the area of disposal site, type & quantity of material disposed daily and capacity of disposal site.

1.4 GUIDELINES FOR REHABILITATION OF DISPOSAL SITES

The dumpsites filled only up to the ground level could be rehabilitated as per guidelines below and to be decided by the Engineer and the supervision consultant.

- The dumpsites have to be suitably rehabilitated by planting local species of shrubs and other plants. Local species of trees has also to be planted so that the landscape is coherent and is in harmony with its various components.
- In cases where a dumpsite is near to the local village community settlements, it could be converted into a play field by spreading the dump material evenly on the ground. Such playground could be made coherent with the landscape by planting trees all along the periphery of the playground.
- Closure of the disposal site should be upto the satisfactory level of site engineer

1.5 PENALTIES

Stringent action & penalties should be imposed off on contractor for dumping of materials in locations other than the pre-identified locations. Grievance Redressal mechanism should be in place for taking note and action on such complaints.

Annexure 7.4: Selection and Management of Construction/Labour Campsite

1.0 Selection and layout of construction camp

Labour camps, plant sites and debris disposal site shall not be located close to habitations, schools, hospitals, religious places and other community places. A minimum distance of 500 m shall be maintained for setting up such facilities.

2.0 Facilities at workers' camps

During the construction stage of the project, the construction contractor will construct and maintain necessary (temporary) living accommodation, rest area and ancillary facilities for labour. Facilities required are listed and elaborated below.

- Site barricading
- Clean Water Facility
- Clean kitchen area with provision of clean fuel like LPG
- Sanitation Facilities
- Waste Management Facilities
- Rest area for workers at construction site
- Adequate Illumination & ventilation
- Safe access road is required at camps
- Health Care Facilities
- Crèche Facility & Play School
- Fire-fighting Facility
- Emergency Response Area

2.1 Site Barricading

Site should be completely barricaded from all the sides to prevent entry of outsiders and animals into the site. Entry gate should be provided at the site and labour camp which should be guarded by security guard. All workers should be issued ID cards and entry of outsiders shall be maintained in the register at the gate. Board should be displayed at the site and the labour camp, the name of project, capacity of project, authority carrying our projects, restriction of entry without authorization, no smoking zone and associated risks. Plant operation shall be restricted to 6:00 Am to 10:00 PM

2.2 Clean Water Facility

Potable water shall be provided for construction labour for drinking & cooking purpose. Clean water shall be provided for bathing, cleaning and washing purpose. Water quality testing for water shall be carried out on monthly basis.

2.3 Clean Kitchen Area

Provision of clean kitchen area for cooking and storage of eatables shall be provided. Clean fuels like LPG shall be provided for cooking purpose. Burning of firewood, garbage, paper and any other material for cooking or any other purpose shall strictly be prohibited at the site.

2.4 Sanitation Facilities

Construction camps shall be provided with sanitary latrines and urinals. Toilets provided should have running water availability all the time. Bathing, washing & cleaning areas shall be provided at the site for construction labour. Washing and bathing places shall be kept in clean and drained condition. Workers shall be hired especially for cleaning of the toilets and bathing area. Septic tanks and soak pits shall be provided at site for disposal of the sewage generated.

2.5 Waste Management Facilities

Waste generated should be segregated at the site by providing the different colour bins for recyclable and non-recyclable waste. Recyclable waste shall be sold to authorized vendors and non-recyclable shall be handed over to authority responsible in area for waste management. Waste management for construction site shall be as per waste management plan proposed in EMP.

2.6 Rest Area for Workers at Site

A rest area/shelter shall be provided at the site for construction workers where they can rest after lunch time and shall not lay down at site anywhere. The height of shelter shall not less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 1.0 Sq. m per head.

2.7 Adequate Illumination & Ventilation

Construction worker camps shall be electrified and adequately illuminated. Illumination level shall be maintained after 5.30 P.M. at the site to minimum 200 lux. Labour camps shall be adequately ventilated. Fans shall be provided for ventilation purpose.

2.8 Safe Access Road for Labour Camps

Temporary paved surface shall be constructed to approach the labour camp from the site. Movement shall not be hampered during monsoon season due to water logging and muddiness.

2.9 Health care Facilities:

First aid box, first aid room and personnel trained in first aid shall be available at labour camp and site all the time (24X7). Equipment in first-aid box shall be maintained as pet State Factory's Law. Ambulance/ 4 wheeler motorized vehicle shall be available at the site for carrying injured to the nearby hospital. Tie-ups should be made with nearby hospital to handle emergency, if any. Nos. of ambulance, doctors and nearby hospital s hall be displayed in first-aid room, site office & labour camps. Workers shall be made aware about the causes, symptoms and prevention from HIV/AIDS through posters and awareness programs

2.10 Crèche Facility & Play School

Crèche facility and play school should be constructed at the site temporarily so as children of construction labour can be kept there. Care takers should be hired for taking care of children. Attendance records of children shall be maintained. Children should not be allowed to enter active work areas.

2.11 Fire-Fighting facilities

Fire-fighting facility such as sand filled buckets and potable fire-extinguishers shall be provided at labour camps and at site. Fire-extinguishers shall be provided as per NBC norms.

2.12 Emergency Collection Area

Area shall be demarcated as emergency collection area near the gate where all the workers shall be guided to collect in case of any emergency like fire, flood and earthquake.

3.0 Activities prohibited at site

Activities which should be strictly prohibited at site shall include

- Open burning of wood, garbage and any other material at sit for cooking or any other purpose
- Disturbance to the local community.
- Operation of the plant and machinery between 10 pm to 6 am unless approved by team leader
- No animal (wild or domestic or bird) shall be harmed by any construction worker in any condition at site and nearby areas
- Cutting of tree without permission of team leader/authorized person

- No indigenous population shall be hurt or teased

4.0 Guidelines for night time working at the site.

No activity generating noise shall be carried out at the site after 10:00 PM. Night working protocol should be followed (if required) as per guidelines prepared by IWAI. Site should be well illuminated to maintain minimum illumination level of 200 lux. Personnel working shall obtain permit to work from the team leader prior carrying out any work in night time and the record of such working shall be maintained in register. Any accidents, if occurs at site during night time working shall be immediately reported and recorded. Penalty shall be imposed on the contractor for the accident. Analysis shall be carried out to find the reason for such accidents for future learning.

5.0 Record keeping & Maintenance

Record of entry/exit of the people in the construction site and labour camp area shall be maintained in register at gate. Record of material coming in and going out from site also shall be maintained.

6.0 Auditing & Inspection

Conditions of labour camp and site shall be inspected and audit report shall be submitted to IWAI on monthly basis.

7.0 Closure of the Construction Site and Construction labour Camps

Construction site and labour camps shall be restored back to the original site conditions. Following measures are required to be taken during closure

1. Septic tanks/soak pits should be dismantled
2. Any temporary/permanent structure constructed shall be dismantled
3. Construction/demolition waste, hazardous waste and municipal waste at site and labour camp site shall be disposed as per waste management plan in EMP
4. The site shall be cleaned properly
5. Tree plantation to be carried out, if any required for stabilizing the area
6. Any pit excavated shall be filled back
7. Closure of the site and labour camp shall be approved by authorized person.

Annexure 7.5 Borrow Area Establishment, Management & Closure Plan

1.0 Introduction

Borrow areas will be finalized as identified by Contractor as agreed by the PMC and IWAI as per the requirements of the contract. Environment clearance under EIA Notification, 2006 from competent authority and NOC from state pollution control board under Air Act, 1981 as applicable shall be obtained by contractor prior excavation. Consent from land owners and DC of the area shall also be taken prior undertaking any excavation. The Contractor in addition to the established practices, rules and regulation will also consider following criteria before finalizing the locations. Contractor should submit borrow area establishment plan along with the locations marked in map and the environmental settings of the planned area to PMC/IWAI for approval of the "Engineer" through RFI.

1) The borrow area should not be located in agriculture field unless unavoidable i.e. barren land is not available.
2) The borrow pits should not be located along the roads, close to project site
3) The loss of productive and agricultural land should be minimum.
4) The loss of vegetation is almost nil or minimum.
5) Sufficient quality of soil is available.
6) The Contractor will ensure the availability of suitable earth.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme as approved by the concerned Engineer. It shall be ensured that the fill material compacted to the required density. The Contractor shall submit the following information to the Engineer for approval at least 7 working days before commencement of compaction.

- The values of maximum dry density and optimum moisture content obtained in accordance with ARE: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.
- A graph of density plotted against content from which, each of the values in (i) above of maximum dry density and optimum moisture content are determined.

After identification of borrow areas based on guidelines and full filling the following requirements are to be fulfilled

- Quantification of Earth
- Land Agreement
- Clearance from local authorities
- Environmental Clearances from SEIAA should be obtained. All EC conditions are to be followed by contractor and contractor should submit EC to IWAI/PMC/PMU

After receiving the approval Contractor will begin operations keeping in mind following:

- Haulage of material to the areas of fill shall proceed only when sufficient spreading and compaction plants are operating at the place of deposition.
- No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Contractor should be permitted to remove acceptable material from the site to suit his operational procedure, then be shall make good any consequent deficit of material arising there from.

- Where the excavation reveals a combination of acceptable and un-acceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carryout the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the un-acceptable materials. The acceptable material shall be stockpiled separately.
- The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.

1.1 Borrow Area Management

Borrow areas located in different land will require different management. Management measures to be taken in different land types are given below.

1.1.1 Borrow Areas located in Agricultural Lands

- The preservation of topsoil will be carried out in stockpile.
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- Borrowing of earth will be carried out up to a depth of 1.5m from the existing ground level.
- Borrowing of earth will not be done continuously throughout the stretch.
- Ridges of not less than 8m widths will be left at intervals not exceeding 300m.
- Small drains will be cut through the ridges, if necessary, to facilitate drainage.
- The slope of the edges will be maintained not steeper then 1:4 (Vertical: Horizontal).

1.1.2 Borrow Areas located in Agriculture Land in un-avoidable Circumstances:

- The preservation of topsoil will be carried out in stockpile.
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- The depth of borrow pits will not be more than 30 cm after stripping the 15 cm topsoil aside.

1.1.3 Borrow Areas located on Elevated Lands

- The preservation of topsoil will be carried out in stockpile
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- At location where private owners desire their fields to be levelled, the borrowing shall be done to a depth of not more than 1.5m or up to the level of surrounding fields.

1.1.4 Borrow Areas near Riverside

- The preservation of topsoil will be carried out in stockpile

- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- Borrow area near to any surface water body will be at least at a distance of 15m from the toe of the bank or high flood level, whichever is more.

1.1.5 Borrow Areas near Settlements

- The preservation of topsoil will be carried out in stockpile
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- Borrow pit location will be located at least 0.75 km from villages and settlements. If un-avoidable, the pit will not be dug for more than 30 cm and drains will be cut to facilitate drainage.
- Borrow pits located in such location will be re-developed immediately after borrowing is completed. If spoils are dumped, that will be covered with layers of stockpiled topsoil in accordance with compliance requirements with respect MOEF&CC/CPCB guidelines.

1.1.6 Borrow Pits along the Roads

- The preservation of topsoil will be carried out in stockpile
- A 15 cm topsoil will be stripped off from the borrow pit and this will be stored in stockpiles in a designated area for height not exceeding 2m and side slopes not steeper than 1:2 (Vertical: Horizontal).
- Borrow pits along the road shall be discouraged.
- If permitted by the Engineer; these shall not be dug continuously.
- Ridges of not less than 8m widths should be left at intervals not exceeding 300m.
- Small drains shall be cut through the ridges of facilitate drainage.
- The depth of the pits shall be so regulated that its bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of bank, the maximum depth of any case being limited to 1.5m.
- Also, no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10m.
- Minimum distance from road/ railway should be 50 metres.

1.1.7 Re-development of Borrow Areas

The objective of the rehabilitation programme is to return the borrow pit sites to a safe and secure area, which the general public should be able to safely enter and enjoy. Securing borrow pits in a stable condition is fundamental requirement of the rehabilitation process. This could be achieved by filling the borrow pit approximately to the road level.

Re-development plan will be prepared by the Contractor before the start of work in line with the owner’s will and to the satisfaction of owner.

<u>The Borrow Areas will be rehabilitated as follows</u>

- Borrow pits will be backfilled with rejected construction wastes (unserviceable materials) compacted and will be given a turfing or vegetative cover on the surface. If this is not possible, then excavation slope should be smoothened and depression is filled in such a way that it looks more or less like the original ground surface.
- Borrow areas might be used for aquaculture in case landowner wants such development. In that case, such borrow area will be photographed after their post-use restoration and Environment Expert of Supervision Consultant will certify the post-use redevelopment.
- The Contractor will keep record of photographs of various stages i.e. before using materials form the location (pre-project), for the period borrowing activities (Construction Phase) and after rehabilitation (post development), to ascertain the pre and post borrowing status of the area.