INLAND WATERWAYS AUTHORITY OF INDIA

Ministry of Shipping, Government of India

"CAPACITY AUGMENTATION OF NATIONAL WATERWAY -1"

(Jal Marg Vikas Project)

ENVIRONMENTAL IMPACT ASSESSMENT REPORTS

VOLUME-3:

CONSOLIDATED ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

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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
DFCCIL	Dedicated Freight Corridor Corporation of India Limited
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
EDFC	Eastern Dedicated FreightCorridor
EHS	Environment, Occupational Health and Safety
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
GRIHA	Green Rating for Integrated Habitat Assessment
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
M	Million
MARPOL	International Convention for the Prevention of Pollution from Ships
meq	Milli equivalent
mg/l	Milligram per litre
mg/l	Milligram per litre
□ il^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
VECs	Valued Environmental Components
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:

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SUMMARY

1.0 INTRODUCTION

Cargo movement through waterway is considered cheapest mode of transportation internationally. However, cargo movement 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. Amongst the five notified waterways, the national waterways on Ganga (NW-1 between Haldia to Allahabad) is the longest waterway 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 and tourist movements. Already good amount of cargo movement is taking place between Haldia and Farakka. 3 million metric tonne of imported coal from Haldia to National Thermal Power Plant (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. The Environmental Impact Assessment study has been carried out for 'Jal Marg Vikas Project'. Additional focused studies have been carried out for planned interventions (terminalsand navigation ship lock), dredging and barge operations. Standalone Environmental Management plan (EMP) has also been prepared for these planned interventions.

2.0 Project Need and Location

Inland waterways transport (IWT) is a competitive alternative to road and rail transport, offering an economical, sustainable and environment friendly mode in terms of energy consumption, noise and greenhouse gas emissions. Infrastructure requirements of IWT in comparison to road and rail transport are also relatively low, although certain investments are essential such as in port/terminal facilities, connecting road/rail infrastructure, navigation aids 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 was 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 (Allahabafd – Haldia) alone, there are9 thermal power plants located along Ganga River stretch within UP & Bihar and 11 more are expected to become operational soon. The total requirement of coal for these power plants alone will be nearly 94.78 million tonnes per year, 21.4 MT of which will have to be imported reflecting the sea connectivity of NW-1. In addition to this, there are 7 fertilizer plants 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 in general and NW-1 in particular would play a very vital role when high quality ports/terminals with waterway connectivity is made available to facilitate the cargo movement in a cost effective and environmental friendly manner catering to the needs of large 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 developments. 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 1** below.

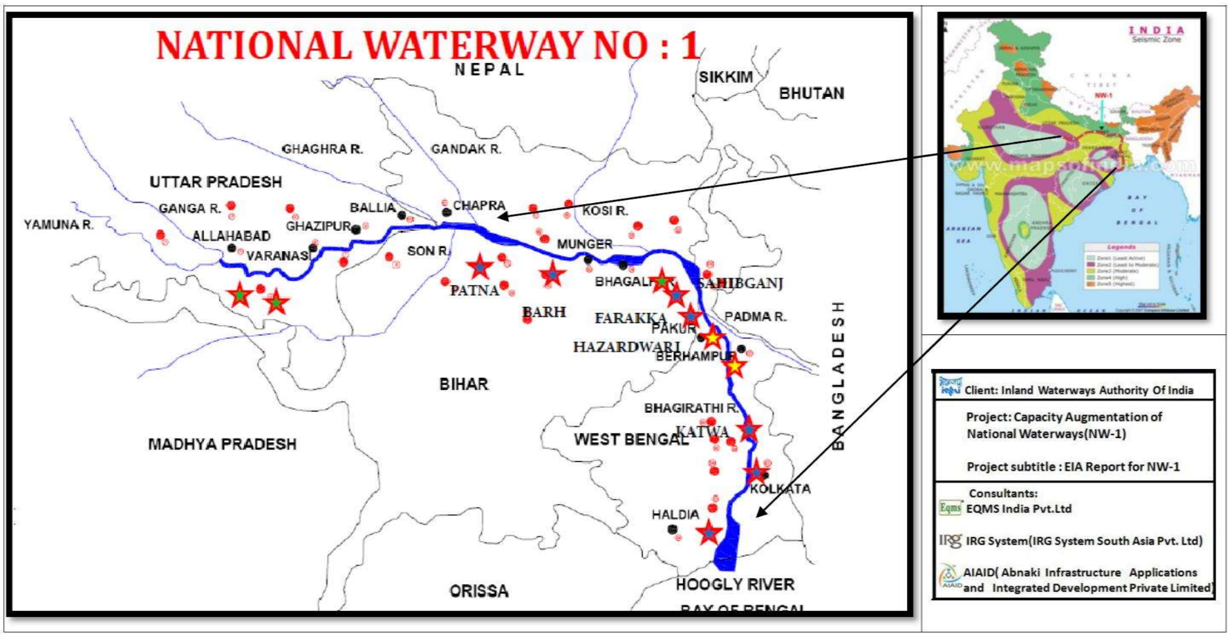


Figure 1: Location Map of NW-1

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)[1]. NW-1 is the Ganga - Bhagirathi - Hooghly river system. NW-1 is being fed by various tributaries at different locations. Major tributaries of river Ganga in 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 the required LAD in this waterway channel and also for various proposed terminal facilities.
- Improved Navigation Infrastructure & Navigation Aids
    - Construction of 5 Ro-Ro crossings & 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 accomplished. Besides 2 more potential sites for development of terminals are also identified at Ghazipur and Kalughatand 1 site, i.e. at Kalyani in Tribeni is under consideration.
    - Construction of one new navigation lock at Farakka, West Bengal.
    - Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment. Development of low draught vessel[2].
    - 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 proposed to be 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 (HSD), lube oil, boulders, pulses, aluminium block, sand, chips, ship blocks, food grains, manganese ore, petroleum products, coke, cooking coal, rock phosphate, timber, peas, slag oil, and non-cooking coal. As per the survey traffic, current traffic transported via rail & road between Haldia & Varanasi is 121426130 tonne. Traffic projection studies are carried out and as per the study, projected traffic for year 2045 is 4,80,11,367 tonne. Under NW-1, 6 nos of terminals are proposed out of whch planning for 3 terminals is completed. As per the planning the cargo handling capacity for base year and year 2045 is given at **Table 1.**

[1] At present IWAI plans to develop it from Haldia to Varansi only.
[2] In American system this is called low draft vessels.

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	3.18MTPA		

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

There are various challenges for Jal Marg Vikas Project development including typical characteristics of alluvial river Ganga and its braiding, meandering characteristics and large water fluctuations between summer and monsoon months with high annual silt loads of 1600 million tonnes. The maintenance dredging requirements including all other planned infrastructures facilities etc. are designed addressing all such challenges besides projected transportation needs under considerations. The salient features of this Jal Marg Vikas Project with the design details of various planned and proposed developments are given at **Table 2.**

Table 2: Salient Features of Jal Marg Vikas Project

<table>
<tr><th>Salient Features</th><th>Capacity/Quantity/Nos.</th></tr>
<tr><td>Facilities Planned</td><td>3 terminal sites (Sahibganj, Varanasi & Haldia)
1 new Navigation lock- Farakka
River bank protection works at planned terminal sites and along Feeder canal</td></tr>
<tr><td>Facilities under Planning Stage</td><td>3 additional terminal sites (at Ghazipur & Kalughat-site finalized and at Tribeni-under consideration)
5 ro-ro crossings
Barge repair and maintenance facilities
River training works
River bank protection works at the proposed civil intervention sites</td></tr>
<tr><td>Designed capacity of Terminals</td><td><table>
<tr><td>Infrastructural Facility</td><td>Projected Cargo-2015 (MTPA)</td><td>Projected Cargo-2030 (MTPA)</td><td>Projected Cargo-2045 (MTPA)</td></tr>
<tr><td>Sahibganj Terminal</td><td>2.24</td><td>4.39</td><td>9.00</td></tr>
<tr><td>Varanasi Terminal (with current land)</td><td>0.54</td><td>1.22</td><td>1.22</td></tr>
<tr><td>Haldia Terminal</td><td colspan="3">3.18 MTPA</td></tr>
</table></td></tr>
<tr><td>Navigation Channel</td><td>Width-45 m
LAD-3 m from Haldia to Barh, 2.5 m from Barh to Ghazipur and 2.2 m from Ghazipur to Varanasi at present</td></tr>
<tr><td>Design Vessel Specifications</td><td>Vessels of maximum length of 110 m, beam of 11.4 m, draught of 2.5 m-2.8 m and air draught of 9 m will be required in NW-1.</td></tr>
<tr><td>Size of Vessels</td><td>1500-2000 dWT</td></tr>
</table>

River Slope	Haldia to Farakka-1 in 11000 Farakka downstream-1 in 18000 Farakka to Allahabad-1 in 17,000
Maintenance Dredging	Within Navigation Channel-14,850,000 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 Government of India (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 6 of the World Bank safeguard policy[3] and requires comprehensive environmental assessment. The detailed environmental impact assessment study has been undertaken for all the proposed components to identify the environmental and social issues associated with the project. The environmental impact assessment was carried out by a consortium led by EQMS India Pvt. Ltd. in line with World Bank Operational Policies,IFC EHS Guidelines for Ports, Harbours and Terminals, IFC General guidelines for EHS, MoEF&CC EIA Guidelines for Ports and Harbours, findings of CIA and Standalone EIA studies carried out for civil interventions.

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 quality (for physico-chemical and contamination characteristics) at different locations in the entire stretch of NW-1 was also carried out. The baseline survey was carried out between: 15thSeptember, 2015 to 28th February 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. Influence area was assessed based on different project activities on different VECs. Being a liner project, the 500m radius on either side of the bank was assessed as

[3]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), Physical Cultural Resources (OP/BP 4.11) and Project on International Waterways (OP/BP 7.5)

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. This has helped to analyse the suggested alternatives with environmental perspective also. Further various design measures were modified during the design stage keeping environmental perspective such as incorporation of mechanical conveyance system at Sahibganj, mandatory green plantation all around the periphery and along the roads, dust suppression system at storage and barge loading areas, provision of storm water management system, separate for buildings and for surface. Further basin level study has helped to identify the NOGO areas which has helped to strikeout the environmental sensitive locations for development of terminals, dredging and other project activities. Bhagalpur was avoided for development of terminal due to presence of Dolphin sanctuary, even though this site has good cargo generation potential and engineering feasibility.

Environment impact assessment process started with basin level critical resource assessment study followed by cumulative impact assessment. Also separate environmental impact assessment was carried out for each terminal / navigational lock, maintenance dredging and barge operations. In line with all these studies, this consolidated report is prepared for the entire NW-1 project. To ensure the public participation as per World Bank Policies, two stage public consultations, both formal &informal were 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.

As per EIA Notification, 2006 as amended at present the project components like development of terminals & jetties does not requires environment clearance. However, environment clearance may be required for the activities like borrowing of earth which should be taken by the respective contractor. Additionally, NOC/Permissions are required to be obtained by IWAI/Contractor for specific activities like setting up Hot Mix Plant, DG Sets, STP from respective agencies as indicated under legal and administrative framework. Each permission will have associated conditions which need to be complied by contractors / IWAI and same will be monitored by the permission granting agencies like State Pollution Control Boards (SPCBs). None of these permissions require detailed environmental impact assessment however, findings of this EIA and proposed mitigation measures would be useful in obtaining these permissions.

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.

As per EIA Notification, 2006 as amended at present the project components like development of terminals & jetties does not requires environment clearance. However, Environmental clearance will need to be obtained for any project component wherever found applicable due to any amendment to the above notification. The environmental clearance under minor mineral category of EIA notification 2006 should 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 should be obtained by the contractor before setting up these facilities from State Pollution Control Boards. The contractors / IWAI will ensure compliance to the conditions of these permissions and should abide by the monitoring requirement to be imposed by the permission granting agencies. 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 should be managed as per Hazardous & Other Waste Management Rules, 2016. Other waste related regulations should 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 KashiTurtle Sanctuary & Vikramshila Gangetic Dolphin Sanctuary located under Wild Life Protection Act, 1972[4]. 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 should 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

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

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 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 opined that the proposed project would contribute to social and economic development of the region. The proposed project would 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 was analysed for practical and scientific basis, and for developing an appropriate mitigation, management and monitoring plan, depending on its importance and practicality.

An executive summary of consolidated EA report is available for public scrutiny 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. A brief table illustrating the key concerns of the informal stakeholders is given below in **Table 3.**

Table 3: Summary of Key Concerns raised by stakeholders and its redressal

S. No.	Key Concerns	Redressal
Social Concerns		
1	Fishing community raised concern regarding effect on fish productivity and demanded support from project for the same.	Such impacts are unlikely from this project. However, mitigation, enhancement measures are proposed under EMP for reduction of impacts if any due to construction & operation of NW-1 and its components. Some of the measures includes: Technical support for enhancing fish productivity by setting up demonstration nurseries and training centre through institute of repute like CIFRI Regulated/slow speed of vessel at select locations and Zero Pollution approach from vessel and terminals Intimation of dredging/piling plan to fishermen community prior to carrying out any activity Provision of sirens and strong search lights in vessels/barges to pre-warn the fishermen
2	Provision should be made for adequate compensation for land acquisition wherever applicable.	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.
3	People desired to have the relocation site for the people likely to be displaced near river Ganga.	Relocation site is proposed to be selected by the concerned authorities responsible for land acquisition in consultation with people concerned.
4	People demanded support for the improvement in and around local immersion Ghat at	Budgetary provision is made under EMP for improvement of Ghats as an enhancement measures.

	Durgachak (near Haldia terminal in West Bengal) to reduce congestion, especially during the local festival.	Additional enhancement measure has been proposed for small enclosed areas dedicated for female bathing in every village along the NW-1 to allow female maintain their privacy while fulfilling their religious belief of bathing in river Ganga.
Environmental Concerns		
1	People raised concern that the terminal development may lead to increased traffic on the connecting roads which are not suitable for such an increased load and needs to be upgraded.	Project design has considered this aspect and adequate provision is made for developing access road to the terminals to avoid any kind of congestion at each terminal sites.
2	Turtleswill be affected due to regular movement of vessels in river in Kashi Turtle Sanctuary	Maximum of 1-2 vessels per hour are expected to move in the sanctuary area. Speed of vessels shall be maintained to 5 kmph/2.7 knots in turtle sanctuary area. Barge movement at this speed generates noise in order of 110-140dB. 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 anticipated to be insignificant. Other measures are also being proposed in the EMP to minimize impact of barge movement on turtle.
3	Dolphins will be affected due to barge movement during the operation phase of the project.	Adequate mitigative measures have been proposed in the project design which includes provision of propeller guards to prevent entangling of dolphins and other mammals, speed restriction in the sanctuary area and a restrictive buffer zone of 100m horizontally and 500m longitudinally either side of the river confluence areas for any dredging activity. Other measures are also proposed in management plan to reduce the impact on

		dolphins and other aquatic fauna.
4	Oil spillage from ships during accident may impact the aquatic flora, fauna, water quality and anti-bacterial properties of river Ganga.	Such situations are remote. Safety measures are proposed in the EMP for vessels as well. No vessels are expected to discharge any of its liquid or oily waste in the river. Emergency response plan would deal with such situations to minimize the impact of emergency situations. It is also proposed that each vessel would have appropriate sewage treatment, treated sewage storage and waste management facilities to prevent water pollution.
5	People raised concerns regarding the likely impact on water quality due to construction and operation of terminal facility and cargo movement.	Environment management plan has incorporated the measures for prevention of water pollution from terminals, and barge operations. Zero discharge approach is proposed for terminals development and barge operations.
6	People raised concern about cutting of large no. of tree at Sahibganj site.	Compensatory tree plantation (1:7 basis) at Sahibganj 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 CO_2.
7	The varying LAD may lead to grounding of vessels.	LAD is proposed to be maintained in the stretch between Haldia to Varanasi during entire lean period
8	Dredging may have significant impact on breeding and spawning season of fishes.	Dredging is proposed to be regulated during breeding and spawning season of the fishes.
9	People have pointed outtheexisting erosion problem in the Farakka feeder canal and voicedthe apprehension that the NW-1 development and barge movement may escalate this problem.	Provision has been made in the project design for bank protection work of 9.438 km; it is proposed to be undertaken on banks of feeder canal to prevent the erosion.

10	People have suggested that appropriate parking facilities be madeinside the proposed terminals for better management of goods carriers and to reduce traffic on existing road due to inappropriate parking on the public roads.	Adequate parking provisions are proposed in each terminal site design.
11	People have proposed adequate provisions forprevention of water logging in and around the terminals, and for firefighting.	Adequate drainage provision is made for channelizing the rain water at each terminal site. Fire-fighting facility is also proposed at each terminal site.

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 and social, design considerations. Based on alternative analysis three terminal sites at Ghazipur, Tribeni (Kalyani), Kalughat near Doraiganjwere considered as preferred sites for these interventions. The other three terminal sites at Barh, Kahalgaon &Baliawere 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 throughout the year 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 Ghazipur and 2.2 m from Ghazipur to Varanasi). Width[5] of 45 m will be maintained throughout the navigation channel with side slope of 1:5. Alternative analysis was carried out for both these options considering environmental (dredge quality, impact on aquatic ecology and water quality), social (cultural and aesthetic

[5] The channel width is proposed to limit to 45m in phase I which will further reduce the maintenance dredging requirements.

value, employment and socio-economic consideration) and technical feasibility (dredge quantity, navigation feasibility, economic aspects, dredgers and other infrastructure 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. Typically, CSDs have least effect on turbidity at the dredging site. Grab dredgers and TSGDs when used with overflow, produce significantly high turbidity throughout the water column near the dredging site than do CSDs. Underwater noise generation in CDSs is comparatively lesser than other dredgers. As per experience of KoPT and IWT also CSD has proven to be the best option and is considered for maintenance dredging planning and environmental impact assessment. Additionally, to further reduce disturbance to the riverbed sediments, water injection dredgers would be used in the project.

8.4 Integration of analysis of Alternatives and Suggested Design Consideration into Project Design

Since studies were being carried out along with the feasibility report preparation, the output of alternative analysis and design consideration was discussed with the design team and incorporated in the project design. Some of the design changes include provision of mechanical material handling system at Sahibganj Terminal, dust suppression system at each terminal, provision of green belt all along the terminal boundary, integration of green building concept in terminal buildings, adoption of zero discharge concept at terminals and barges, rain water harvesting, emergency response planning, exploring feasibility of using low draft vessel and alternative fuels for barge operations. The project description details presented below includes the above considerations.

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 4**. 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 4: Salient Environmental Features along NW-1 Alignment

S. No.	Environmental Features	Within 500 m influence area around NW-1	Within 2km Influence area around NW-1	Within 10km 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 (more frequently sighted) Smooth Coated Otter and Crocodile (very rarely sited in Ganges system)	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

S. No.	Environmental Features	Within 500 m influence area around NW-1	Within 2km Influence area around NW-1	Within 10km influence area around NW-1
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 KardmeshwarMahadevaMandir, 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, SinghiDalan 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 14.85 million cubic meter will be undertaken from Haldia to Varanasi to maintain LAD of 3 m upto Barh, 2.5m upto Ghazipur & 2.2 m upto 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/critical 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/critical 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 influence 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 influence 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[6]. 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.

If dredge material is found contaminated at any particular location, then it should be disposed on land after decontamination. On land disposal of dredged material should be carried out only at approved TSDF site such as approved TSDF site of Haldia Dock Complex at Sagar. The contaminated dredge material shall be collected in the leak proof container for decontamination and disposal to the landfill site. The disposal facilities should be designed with adequate liners to contained the leachate and also should have provision of leachate collection and testing to periodically check the functionality of the disposal site. 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.

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

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 should 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 should be made available to navigators and intimation of navigational hazards in form of cautionary signage should be displayed at required locations to minimize the accidents and spillage of material in river. Oil carrying ships (>5000 dwT) should be double hulled as prevention against oil spills.

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

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^{o}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 emissions but this is far less as compared to road and rail for transportation of same quantity of cargo for the 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. Emission savings in "With project" scenario is given in **Table 5.**

Table 5: Emission Savings Due to Shift of Freight from Road & Rail to IWT Mode

Year	SO_2 emissions (Tonne/Yr.)	NO_x emissions (Tonne/Yr.)	CO emissions (Tonne/Yr.)	HC emissions (Tonne/Yr.)	PM Emissions (Tonne/Yr)

2016	0	0	0	0	0
2025	176.547	1305.17	511.9684	365.981	215.8993
2035	242.8597	1772.377	695.3507	495.2122	292.4799
2045	365.2669	2508.429	986.5775	684.3006	404.4284
Net Savings Estimated (Tonnes) from 2016-2045	5874.205	42201.2	16575.06	11700.31	6901.329

Key Mitigation Measures: Material generating dust should 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) 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

Biological Critical Environmental Resources: 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) fresh water turtle species (frequently sighted), The smooth coated Otter and crocodile (very rarely sighted) 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 IBAs.

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' mammalian fauna present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanistagangeticagangetica*) andthe Smooth Coated Otter (*Lutrogale perspicillata*) which are categorized as endangered species (Schedule-I). Dolphin is found routinely moving between Allahabad to Farakka and post Farakka region of NW-1. However, these mammals are rarely sighted in Allahabad and Varanasiregion. TheSmooth Coated Otter is found throughout the length of the gangetic system but in very poor numbers and it is one of the endangered category animal as per IUCN list. Though it is not sighted during our study period but fishermen at Bhagalpur and Sultanpur only has indicated its sighting. Its number has depleted fast due to one of the most hunted animal because of its precious skin. The reptile fauna found in Gangetic system are variety of fresh water turtle species, water snake(*Xenochrophispistator*), Mugger Crocodile (*Crocodilus Paluspris*), estuarine (East Coast) Crocodile (C. porosus) and Indian Gharial (*Gavilialis Gangeticus*). The Mugger, Crocodile and Indian Gharial are very rarely seen in NW-1 stretch. Its presence is more reported in tributaries (Chambal river) of Ganges. The turtle and water snake are found more commonly in the NW-1. Other than water snake, other reptile faunal species are classified as endangered species. Few researchers have indicated presence of Ganges Shark (Glyphis Gangeticus) in the last part of Ganga (Hoogly river region). However, there is no confirmed news or basis available yet for the presence of this critically endangered species in the gangetic system.

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 Submerged Aquatic Vegetation

(SAV). 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. Noise sensitivity reference are not available for other crocodile and Smooth Coated Otter but these animals are rarely sighted. It is assumed that these animals will also have similar sensitivity range. In any case these animals prefer to stay more on banks or on wet land near banks and are unlikely to be impacts due to dredging which is most likely to undertaken in the deep stream of river. 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; confluence zone of major rivers (100 m horizontally and 500m either side of major river confluence location) 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 appx. 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. As indicated under dredging section above, Smooth Coated Otter and Crocodile are rarely sighted and prefers to rest on wet lands of river banks, noise impacts are anticipated negligible due to its fast attenuation. Accidental impact cannot be rules out however it will of similar nature as to Dolphin and same precautions will apply for these animals as well. 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 should 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 should be undertaken only at 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 culturally 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 may be impacted due to project. However, measures are proposed to minimize such impacts. Several festivals are celebrated on a large scale at the banks of river Ganges at different locations and time period of year along NW-1. These locations and period of celebrations are Kumbh Mela at Allahabad (between Jan-Feb), Ganga Mahotsav at Varanasi (between Oct-Nov), Dhrupad Mela at Tulsi Ghat of Varanasi (between Feb to March), Chatt Pooja at various location all along the river stretch passing through Bihar& Jharkhand state (between Oct-Nov) and Ganga Sagar Mela at Sagar (in January). 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. There are few archeologically protected monuments located along the NW-1. Since regulations restricted 300m area around these monuments as regulated zone,

B. Impacts on Socio-economy and cultural aspects 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 confined to dredging locations only. Dredging activity also pose threat to health & safety of the workers and other waterway users. No construction or interventions are planned within 300m of any of Archeologically protected monument. The Ramnagar fort is one of the protected monument. IWAI has undertaken a study with the help of Indian Institute of Technology (IIT) Roorkee to establish the effect of development of Varanasi terminal and NW-1 development. IIT in its study has establish that these developments will have no impact on this protected monument. No direct impact is anticipated on any such protected monuments or other culturally important structure due to dredging activity.

Key Mitigation Measures: Dredging will be prohibited in biological & social sensitive location and at time of religiously and culturally important festivals, during breeding & spawning season of fishes and during migratory bird season to minimise impact on socio-cultural aspects. A minimum of 100 m buffer zone from the religious Ghats at Varanasi and Patna (the cultural heritagelocations) are proposed to be maintained as prohibited area for dredging for the protection of Ghats. Precautions followed for archeologically protected monument shouldalso be followed for any intervention near any culturally important heritage structures.It is also proposed to report to IWAI and ASI for any chance finding during excavation and construction stage. 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 and Cultural Aspects 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 and accident intensity can be minimised with appropriate preventive 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. Barge operations should be regulated in consultation with local bodies during religious and culturally importantfestivals.

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 should 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

A. 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 common service. 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.

B. 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 should be preserved and used for landscaping purpose and should be given to farmers in nearby areas, if asked by them. Clean up operations should 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 should be proposed. Excavated earth should 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.

C. 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 CO_2 emissions from different mode of transportation for transportation of same quantum of cargo for similar distance. It is estimated that due to project development (model shift) CO_2 emissions will be reduced and net saving of 4.54 million tonnes will be realised over a period of 30 years (till 2045).

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

CIA is one of several tools to consider as part of an overall process of environmental and social risk assessment and management. Scope of the CIA both temporally and spatially is much larger than the EIA studies and other tools for environment and social assessment. CIA not only captures the project induced impacts but also consider the status of the already impacted VECs[7]/CERs, communities and considers the existing, proposed, planned and anticipated developments which may come in the influence (impact) area of the project so as the impacts of not only the project but these other developments can also be assesses cumulatively. CIA study carried out for the project in similar way has captured other developments to be undertaken in the influence area other than the proposed NW-1 project which includes railways, roadways, urban agglomerations, TPPS, Irrigation schemes etc. Difference between the CIA study and the EIA studies is elaborated in the section below which justifies the reason of carrying out multiple studies for the proposed project to assess the environmental and social impacts due to it.

Cumulative Impact Assessment (CIA) of NW-1 from Allahabad to Farakka has been carried out for (a) analysing 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 VECsover 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.

The influence area considered for study of the impact is based on multi dimension criteria and same is used for carrying out the EIA study of the project. 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 VECs. Further, overlay mapping and GIS have been extensive used for identifying the spatial distribution of VECs. Also indicators have been identified which can determine status/conditions of VECs. Baseline study has been conducted to assess the existing condition or status of the identified VECs based on these

[7] VECs are environmental and social attributes that are considered to be important in assessing risks; they may be: • physical features, habitats, wildlife populations (e.g., biodiversity), • ecosystem services, • natural processes (e.g., water and nutrient cycles, microclimate), • social conditions (e.g., health, economics), or • cultural aspects (e.g., traditional spiritual ceremonies).

Critical Environmental Resource (CER) and Valued Environmental Components (VEC) are technically same referring to various key environmental resource or component like natural habitat. Critical Environment Resource word is used for Basin Level study as per terms of reference of these studies. However, for EIA studies VEC word is used.

indicators in the influence area. Further VECs 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.

10.5.1 Cumulative Impact Assessment Vs Environmental Impact Assessment: Difference& Utility

CIA and EIA shares the same basic framework and analytical process for impact assessment but still the perspectives are different. EIA can be termed as project centred and CIA is always VECs centred. The CIA is prepared following preparation of Basin Level Critical Resource Study[6] and takes into account the overall project perspective. The CIA is focused on existing condition of VECs which may be changed due to intervention of project and the other simultaneous developments taking place in the influence area.Theecological and social impacts are determined considering, past, present, and natural drivers that effects the VECs in the influence area. The assessment reflects the geographical and temporal context in which the effectis aggregating and interacting with river landscape, catchment area, town, etc[8]. The CIA provides the strategic consideration for project design and intervention proposed and environmental assessment to be undertaken for the Jal Marg Vikas Project. The influence area consideration for respective intervention is also derived based on CIA outcome.

The focus of EIA has been on impacts assessment of specific intervention or activity on the VECs.The EIA is undertaken following CIA preparation and considering outcome of CIA such as influence area recommendations for EIA studies.In EIA study specific mitigation measures are proposed to avoid, minimize or eliminate them.Environmental Management Plan is also prepared in EIA for each intervention for effective implementation of identified mitigation measures.

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 6 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. Consolidated EIA provides institutional mechanism, budgetary provisions and other systems and plans which are commonly applicable to all intervention and operations of NW-1. The EMPs prepared for dredging and barge operations are commonly applicable to the terminal development and operation and other intervention sites. Consolidated EIA also provide generic EMP for the interventions such as Ro-Ro Jetties, embankment protection. Additionally, standalone EMPs prepared based on

[8] IFC Good Practice Handbook for Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets

site specific terminal developments at Varanasi, Sahibganj and Haldia and Navigational Lock at Farakka. These standalone EMPs are included in additional volumes (4 to 9) to this report.

Environment Health & Safety (EHS) Policy and Management System: An effective environmental health and safety policy is essentially to demonstrate top management commitment for environmental protection and occupational health and safety. The policy should be communicated to all stakeholders including workers and should be freely available to them on demand.

For effective and systematic implementation of the project, it is desirable that IWAI 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. Training and awareness will be an essential component of the EMPand EHS management system. It should include use of posters, bill boards/glow boards around project site and barge NW-1 alignment in Hindi, English & Regional language so as it can be understood by the workforce and community as well. Some of the important days'celebrations 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 and community through campaigning.

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 should evolve its environmental, Occupational health and safety guidelines and performance protocol. Budgetary provision has been made under environmental budget. The same should be developed with the help of reputed institutions and organisation of repute. It should also follow the system of emergency response and suggested emergency response and management plan is included in the report.

Responsible Carrier Programme of IWAI[9]: It is proposed that IWAI develops Indian Waterways Operations Responsible Carrier Programme which should be developed as part of its EHS ManagementSystemsand Emergency Response Plan and

[9] Reference is drawn to the successful similar programme of American Waterways Organisation's Responsible Carrier Programme. http://www.americanwaterways.com/rcp-2016.

Protocols Development. The programme should have the following components as well:

- Protocol for speed control, monitoring, and vessel tracking
- Protocol of waste management for barge operations and terminals management. (including zero discharges and waste disposal to river by barges and terminals. This protocol should also define about waste handling facilities at barges and waste disposal facilities at terminals for maintain zero discharge concept.
- Biodiversity protection including accident reporting with Aquatic mammals (dolphin)
- Oil spills reporting and control and remediation
- Near-miss reporting/lessons learned and corrective actions program
- Risk assessment procedures to assess and manage risks to personnel, vessels and the environment
- Identification of critical or essential equipment/systems
- Authority of the master, crew and shore side personnel
- Addition of document control procedures
- Tracking of number and volume of spills in performance measurement requirements
- Internal and external audit procedures and frequency

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) development of mechanism to ensure implementation of suggestive management plans and to integrate this at policy level so as the measures can be made mandate to be followed during respective project stage (ii) to review, monitor and inspect implementation of the EMP during design, construction and operation stages; (iv) implementation of the environmental capacity building and awareness programme; (v) 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

Environment & Safety Compliance and Monitoring Responsibility: Project design and implementationstage: The respective contractors should be liable for implementation of suggestive EMPs and IWAI will be responsible to monitor the contractor's performance and adequacy of implementation of EMPs directly or through third party (PMC).

Environment & Safety Compliance and Monitoring Responsibility: During Operation Phase and Emergency Situations e: IWAI should be solely responsible for implementation of the EMP and emergency response. IWAI should be liable to ensure that suggestive mitigation measures are taken up by the shippers, dredgers and other stakeholders in time and adequately. IWAI should develop the mechanism so as to ensure the adherence and compliance of the EMP. It is proposed that IWAI will have dedicated department adequately staffed and equipped with speed monitoring, vessel positioning, and emergency response equipment like oil spills control and remediation systems. IWAI may also adopt mechanism of involving Barge operators on the line of Responsible Carrier Programme of Americans Waterways Operators.

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 should 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 EMP budget is proposed for environmental management for each of the proposed activity under the project. The overall budget is INR 49.91 Crore. Summary of environmental budget is given in **Table 6.** Detailed environmental budget component wise for civil interventions is given in the respective EIA reports. Lump sum budget for each of the planned civil intervention area planned is given below in **Table 7** below. For detailed budget of each component the individual EIAs prepared for each of the proposed civil intervention can be referred.

Table 6: Summary of Environmental Budget for NW-1 (Indicative)

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) including after care and monitoring Additional tree plantation for GHG sink (18000) including after care and monitoring	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

S.No.	Description	Amount
	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
	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**
		Or say US$ 7.34 Mn (1US$= INR 68)

Table 7: Environmental Budget of Planned Civil Interventions

Civil Intervention	Amount (Rs in INR)-Crores
Varanasi Terminal	0.10029
Farakka Lock	1.37466

Haldia Terminal	1.20246
Sahibganj Terminal	1.64136

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.

Adequate training should be imparted as proposed under environmental management plan to enhance the capability of concerned EA officials. Awareness programme for contractor and workers should also be organised for effective implementation of EMP.

IWAI should adopt the measures for reduction of dredging. Dredging management plan including compliance to defined restriction for dredging and disposal of dredged material close to cultural and aquatic sensitive locations should be followed.

It should adopt the concept of green building and energy efficient terminals. The GRIHA guidelines should be adopted for terminal design. All terminals should be designed with zero waste discharge concept to prevent pollution to river Ganga. Similarly, all barges should have integration of zero pollution concept. Each barge should be inspected by IWAI for compliance of these requirements before allowing its operation in NW-1. All consequent waste from the vessels should be managed at terminals and barge maintenance facilities. All possible measures should be adopted for GHG emission reduction including exploring the feasibility of fuel switch to LNG operated vessels.

It should take all measures for conservation of aquatic sanctuaries including reduction of impact on aquatic fauna. All possible efforts should be made to minimize the impact considering the findings of CIA, Critical Resource Basin Study, Consolidated EIA Study and proposed conservation studies. IWAI should facilitate development of conservation plan for Dolphin, Turtle and sensitive species in NW-1 with the help of reputed institutions.

IWAI should develop all facilities for handling emergencies as part of emergency response plan. IWAI should develop Indian Waterways Operations Responsible Carrier Programme on the line of American Waterways Operators Responsible Carrier Programme for accident and pollution free waterways operations

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.

CHAPTER 1. INTRODUCTION

1.1. Project Background

Cargo movement through waterway is considered cheapest mode of transportation internationally. However, cargo movement 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 waterway (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**.

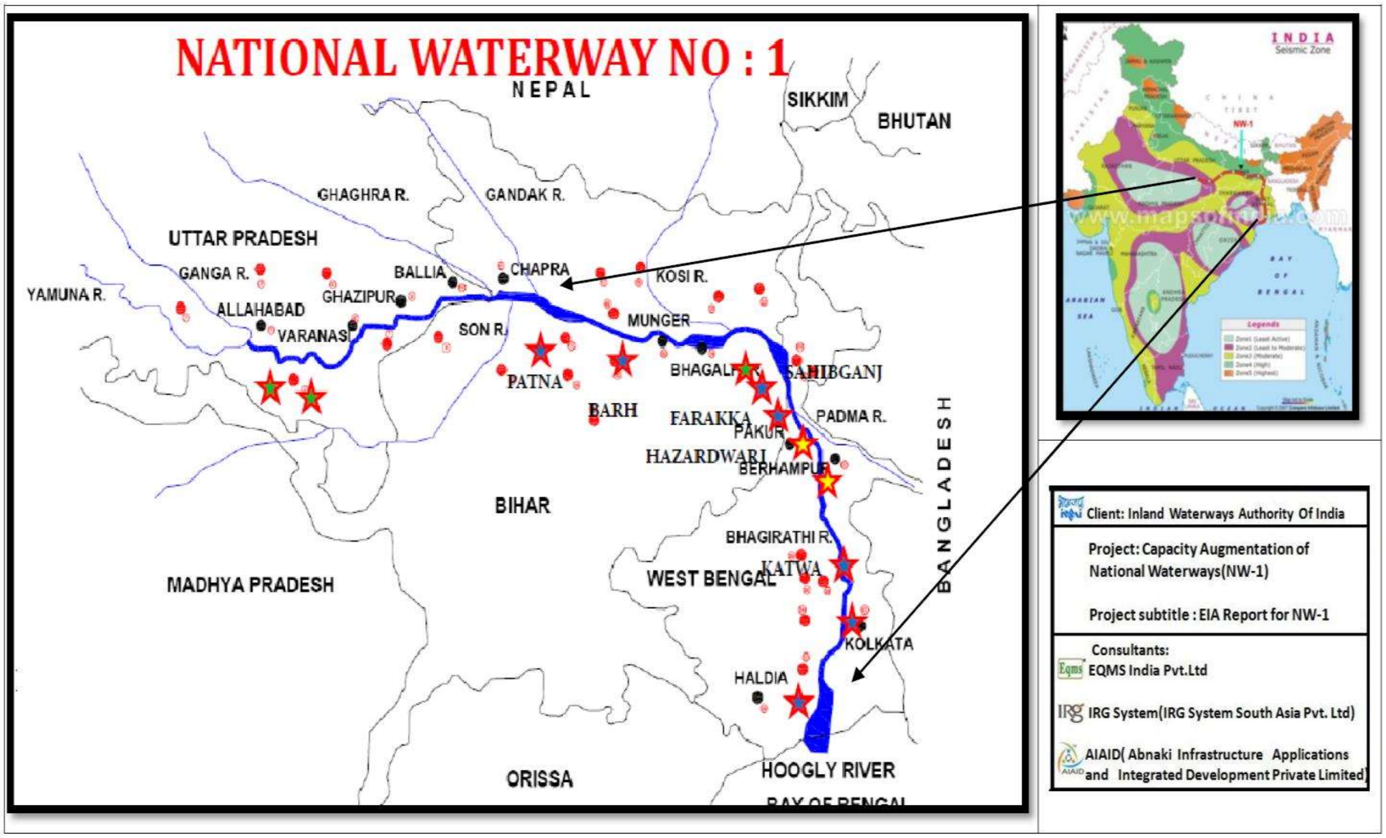


Figure 1.1 : Location Map of NW-1

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

Inland waterways transport (IWT) is a competitive alternative to road and rail transport, offering an economical, sustainable and environment friendly mode in terms of energy consumption, noise and greenhouse gas emissions. Infrastructure requirements of IWT in comparison to road and rail transport are also relatively low, although certain 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 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 was 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, there are 9 thermal power plants located along Ganga River stretch within UP & Bihar and 11 more are expected to become operational soon. The total requirement of coal for these power plants alone will be nearly 94.78 million tonnes per year, 21.4 MT of which will have to be imported reflecting the sea connectivity of NW-1. In addition to this, there are 7 fertilizer plants 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 in general and NW-1 in particular would play a very vital role when high quality ports/terminals with waterway connectivity is made available to facilitate the cargo movement in a cost effective and environmental friendly manner catering to the needs of large 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 15.0% abatement is 70%			
**Service Tax on road Transport is 15.0% 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[10] it is estimated that 1 litre of fuel can move 105 ton-km by inland water transport whereas the

[10] As per *German Federal Waterways and Shipping Administration*, **Error! Hyperlink reference not valid.**

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 (202 Miles) by road and rail transport[11] respectively. The higher energy efficiency of IWT compared to road haulage contributes to less fossil fuel consumption and therefore to less emission of $CO_{2,}$ NOx, 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 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

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

one lock site have already been identified namely terminals at Haldia, Sahibganj& Varanasi and new lock site at Farakka. Kalughat and Ghazipur are identified potential sites for terminal development. One more site is to be finalized for development of terminal, currently Tribeni is under consideration.

- 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 Facilities

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 in accordance with World Bank Operational Policies, IFC Guidelines and related Guidelines published by MOEF&CC. 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.

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[12], primary field investigations / assessment, secondary data collated from different Gov. Departments (centre as well as of four states as UP, Bihar,

[12] 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.

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 different volumes:

- Main Volume: Environmental Assessment
- Sub Volumes: Description of Environment, annexures to Main Volume, EMP Framework for future interventions.
- Additional volumes: EMPs for various activities and already planned interventions

Main Volume on Environmental Assessmenthas 7chapters 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: Anticipated Environmental Impacts and Mitigation Measures: This chapter presents summary environmental baseline condition and linked identification with magnitude of anticipated potential impact for each environmental and cultural resource. For each potential impact the mitigation measures are delineated in order to mitigate the impacts up to the threshold of acceptable residual levels.

Chapter 5: 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 6: 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 7: Conclusions and Recommendations: This chapter provide the summary of findings and concluding remarks.

Sub Volume on Description of Environment (Environmental profile and baseline of the project and influence area): Thisvolume provides background information based on primary and secondary information for physical, biological, social and cultural resources of project and influence areas.

Sub Volumeon Framework for Future Intervention: It provides framework of activities and TOR for different intervention to be undertaken in future.

AdditionalVolumes: EMPs: These volumesprovide EMPs for terminals already planned, navigation lock, dredging, barge operations.

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 6 of the World Bank safeguard policy[13] and requires comprehensive environmental assessment. The detailed environmental impact assessment study has been undertaken for all the proposed components to identify the environmental and social issues associated with the project. The environmental impact assessment was carried out by a consortium led by EQMS India Pvt. Ltd. in line with World Bank Operational Policies, IFC EHS Guidelines for Ports, Harbours and Terminals, IFC General guidelines for EHS, MoEF&CC EIA Guidelines for Ports and Harbours, findings of CIA and Standalone EIA studies carried out for civil interventions.

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 and specially designing baseline monitoring network and preparation of environment management plans.

The EIA study was carried out using recommendations and findings of CIA and individual EIA studies for civil interventions, reconnaissance survey, review of previous studies, field visits, consultation with stakeholders & NGOs, review of existing data and primary data collection. The methodology was evolved in line with the CIA study, considering the defined terms of reference of IWAI for the study and IFC EHS guidelines for general industries and for ports, harbours and terminals. Extensive use of geographic information system is made to analyse the land use, drainage pattern, elevation profile

[13]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), Physical Cultural Resources (OP/BP 4.11) and Project on International Waterways (OP/BP 7.5)

and identify the environmental features of the influence 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 influence area for this study purpose. Influence area considered for this project is 500 m, 2 km and 10 kms in line with the CIA study recommendationsand EIA study carried out for each civil intervention. The influence area was assessed based on different project activities on different VECs. Criteria for demarcation of the influence area is discussed in detail in CIA report and is briefed in Chapter 4 of this report also. Details of the parameters studied in each zone is given below

500 m radius: All the parameters of environmental, socio-economy and cultural importance are studied within this zone.

2 km radius: All the parameters of environmental, socio-economy and cultural importance are studied within this zone also.

10 km radius: 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 each proposed intervention. 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.

As per EIA Notification, 2006 as amended at present, the project components like development of terminals & jetties does not requires environment clearance. However, environment clearance may be required for the activities like borrowing of earth which should be taken by the respective contractor. Additionally, NOC/Permissions are required to be obtained by IWAI/Contractor for specific activities like setting up Hot Mix Plant, DG Sets, STP from respective agencies as indicated under legal and administrative framework. Each permission will have associated conditions which need to be complied by contractors / IWAI and same will be monitored by the permission granting agencies like State Pollution Control Boards (SPCBs). None of these permissions require detailed environmental impact assessment however, findings of this EIA and proposed mitigation measures would be useful in obtaining these permissions.

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 influence 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 influence area to get representative water quality information. River bed samples were also tested to assess the contamination level of river bed 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 6.

1.10. Cumulative Impact Assessment

CIA is one of several tools to consider as part of an overall process of environmental and social risk assessment and management. Scope of the CIA both temporally and spatially is much larger than the EIA studies and other tools for environment and social assessment. CIA not only captures the project induced impacts but also consider the status of the already impacted CERs or VECs[14], communities and considers the existing, proposed, planned and anticipated developments which may come in the influence (impact) area of the project so as the impacts of not only the project but these other developments can also be assesses cumulatively. CIA study carried out for the project in similar way. Difference between the CIA study and the EIA studies is elaborated in the separate section below. Cumulative Impact Assessment (CIA) of NW-1 from Allahabad to Farakka has been carried out for (a) analysing 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 Valued Environmental Components (VECs) 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 on both sides of the NW-1.

The influence area considered for study of the impact is based on multi dimension criteria and same is used for carrying out the EIA study of the project. 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 level critical resources study of the proposed project has been carried out to identify the VECs. Further, overlay mapping and GIS have been extensive used for identifying the spatial distribution of VECs. Also indicators have been identified which can determine conditions of VECs. Baseline study has been conducted to assess the existing condition or status of the identified VECs based on these indicators in the influence area. Further VECs 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. Some of the mitigation measures proposed under the CIA includes additional tree plantation particularly to the area prone to erosion in the catchment area of the river, control of noise and vibration for the development of the railways (EDFC), promotion of bio-pesticides and organic manure to reduce the use of chemical pesticides and resultant reduction in river pollution from the run off from the agriculture field, promotion of electric crematorium to prevent pollution from the wood burning in the crematoriums located on the river banks. The agency involved includes urban local bodies, DFCCIL, industrial development agencies, water resource departments and irrigation department. It is also proposed for IWAI to take initiative for creating awareness and bringing these departments on board for promotion of these measures through established administrative process.

1.10.1. *Cumulative Impact Assessment Vs Environmental Impact Assessment: difference and utility*

[14] Critical Environmental Resource (CER) and Valued Environmental Components (VEC) are technically same reffering to various key environmental resourceor component like natural habitat. Critiacl Environment Resouce word is used for Basin Level study as per terms of reference of these studies. However, for EIA studies VEC word is used.

CIA and EIA shares the same basic framework and analytical process for impact assessment but still the perspectives are different. EIA can be termed as project centred and CIA is always VECs centred.

The CIA is prepared following preparation of Basin level Critical Resource Study and takes into account the overall project perspective. The CIA is focused on existing condition of VECs which may be changed due to intervention of project and the other simultaneous developments taking place in the influence area.Theecological and social impacts are determined considering, past, present, and natural drivers that effects the VECs in the influence area. The assessment reflects the geographical and temporal context in which the effectis aggregating and interacting with river landscape, catchment area, town, etc[15]. The CIA provides the strategic consideration for project design and intervention proposed and environmental assessment to be undertaken for the Jal Marg Vikas Project. The influence area consideration for respective intervention is also derived based on CIA outcome.

The focus of EIA has been on impacts assessment of specific intervention or activity on the VECs. The EIA is undertaken following CIA preparation and considering outcome of CIA such as influence area recommendations for EIA studies.In EIA study specific mitigation measures are proposed to avoid, minimize or eliminate them.Environmental Management Plan is also prepared in EIA for each intervention for effective implementation of identified mitigation measures.

1.11. 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	Wetland information

[15] IFC Good Practice Handbook for Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets

Source organisation	Report/source Name	Type of data
	Space Applications Centre (ISRO), Ahmedabad and Institute of Environmental Studies & Wetland Management (IESWM), Kolkata)	
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 Conservation of Nature) 1980	Gland, Switzerland: International Union for Conservation of Nature. IUCN (International Union for Conservation of Nature) 1980.*World Conservation Strategy: Regional strategies for international river basins and seas*.	RET species
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	Status of fish and fisheries in Ganga	Fish

Source organisation	Report/source Name	Type of data
(Indian Institutes of Technology)	River (Ganga River Basin Management Plan) By Consortium of India's IIT Institutes	
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
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 *Platanistaindia*nd *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*	Dolphin toxicology

Source organisation	Report/source Name	Type of data
	Environmental Chemistry.	
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 *Clupisomagarua*in 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
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

Source organisation	Report/source Name	Type of data
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) • 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	
IFC, World Bank Group	• General Environment Health & Safety Guidelines • Environment Health and Safety Guidelines for Ports, Harbours and terminals	
NMCG & WWF	• Recommendations of the Workshop on Operationalization of Dolphin Action Plan 2010 – 2020	
IFC & EBRD	• Workers' accommodation: processes and standards A guidance note by IFC and the EBRD	

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/critical 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 by IWAI and Ministry of Shipping, GoI are given in **Table 2.2.**

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 should also be responsible for EMP implementation and compliance to environmental clearance conditions. Contractor/EPC contractor for EC for borrowing of earth.

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
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 (CTE) &Consent to Operate (CTO)	SPCB	contractor, should obtain CTE & comply its conditions for setting up each facility, batching plant, hot-mix plant, DG set as prior to its establishment from SPCB CTO should 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 should also obtain CTE/CTO for each proposed facility under the project before its handover. Contractor and IWAI should be responsible to comply with the conditions as mentioned in CTO
Water Prevention	An act to prevent and	Applicable. It is applicable for the	Consent to Establish	State Pollution	CTE should be taken by

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
and Control of Pollution) Act, 1974, 1988	control water pollution.	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 Operate	Control Boards	contractor for disposal of sewage and construction of septic tank/soak pit prior to start of construction from SPCB. Compliance to the conditions mentioned in the CTE should be done by EPC Contractor CTE/CTO for each proposed facility under the project should also be obtained by EPC contractor along with CTE / CTO under Air Act. IWAI should ensure the conditions specified in CTO are complied with
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	Protection to general public against improper handling storage and	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 should obtain authorization for handling, storage and disposal of hazardous waste

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Movement) Rules, 2016	disposal of hazardous waste. The rules prescribe the management requirement of hazardous wastes from its generation to final disposal.				(Waste Oil) along with CTE/CTO for air and water act. Also compliance to the conditions mentioned in authorization should be ensured by contractor and IWAI
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 should 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 requirements should have to be complied if storage quantity exceeds the regulated threshold limit	Chief Controller of Explosives, MoEF&CC and DC	EPC contractor and IWAI. Compliance to the rules should be ensured
The Bio	To control	Applicable	No specific	Disposal	EPC contractor

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Medical Waste Management Rules, 2016	storage, transportation and disposal of Bio Medical Waste.	Applicable for the disposal of bio-medical waste from first aid centres and dispensaries	permit is required. Just comply with the handling and disposal requirements of the rule	through authorized disposal agency	and IWAI. Compliance to the rules should be ensured
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. Compliance to the rules should be ensured
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

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
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. Compliance to the rules should be ensured
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. Compliance to the rules should be ensured
Coastal Zone Management Act 2011 as amended	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). Conditions mentioned in the clearance should be complied by the contractor and IWAI during both construction and operation phase of the project
Forest Conservation and Wildlife Protection Legislation					
The Forest (Conservation) Act, 1980 and	To protect forest by restricting conversion	Not Applicable. No forest land is being diverted. However large no. of tree cutting is	Forest Clearance / Permission for tree cutting.	Forest Department, MoEF&CC	NOC should be obtained from forest department prior

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
amendments The Forest (conservation) Rules 1981 and amendments till date	of forested areas into non-forested areas and deforestation	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).			tree cutting. Compensatory plantation should be carried out as per state forest policy. 1:8 is recommended for thus project. NOC should be obtained by contractor. All the conditions mentioned in Forest NOC should be complied with
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	Not Applicable as no development is being undertaken within the buffer zone of the eco-sensitive zone notified	Wild life clearance	Chief Conservator Wildlife, Wildlife Wing, Forest	Necessary permission should be obtained for virgin movement

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	Parks and Sanctuaries and buffer areas around these zones	under this act. Necessary permission should be obtained for virgin movement of vessel through these zone (Kashi Turtle Sanctuary andVikramshila Dolphin sanctuary). Permission should 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 under this Act.		Department, MoEF&CC	of vessel through these zone (Kashi Turtle Sanctuary and Vikramshila Dolphin sanctuary). Permission should 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 sanctuaries have already been started) Compliance to the conditions mentioned in permits should be complied by the IWAI
Safety and Other Related Legislations					
Chemical Accidents (Emergency Planning, Preparedness and Response)	Requirement of preparation of on-site and off-site Disaster Manageme	Not Applicable. The project does not involve handling of any hazardous chemical during both construction and operation phase which may lead to	No permits issued under this act	Central, State & District Crisis Group	Not Applicable

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Rules, 1996	nt Plans for accident-prone areas.	continuous, intermittent or repeated exposure to death, or injury.			
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 should 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) should 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 project purpose	License to store petroleum beyond prescribed quantity.	Chief Controller of Explosives/DC	EPC Contractor / IWAI. Compliance to the rules should be ensured
Central Motor Vehicle Act 1988 and	To minimize the road	Applicable, for all the vehicles at site during construction & operation	No permit issued under	Motor Vehicle Department	EPC Contractor to follow Rules for all the

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
amendment Central Motor Vehicle Rules, 1989 and amendments till date	accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise pollution.	phase	this Act	(Licensing authority, registration authority &State Transport Authorities)	construction vehicles being used at site during construction purpose. IWAI should follow the rules for all its vehicles at site during operation phase and should also monitor that loading & unloading vehicles also complied these rules Compliance to the rules should be ensured
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. Compliance to the rules should be ensured
Ancient Monuments and Archaeologic	Conservation of cultural and historical remains	Applicable only if any intervention is planned within 300 m of archaeological protected	No objection certificate	Archaeological Dept. GoI, Indian Heritage	Not applicable as yet as no intervention planned within

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
al Sites and Remains Act, 1958	found in India. According to this Act, area within the radii of 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	sites falling along the NW-1		Society and Indian National Trust for Art and Culture Heritage (INTACH).	300m of these sites. However, it should be applicable if any such intervention is planned in future within 300 m of such resource.

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
	permission of the Archaeological Survey of India (ASI).				
Merchant Shipping Act, 1958	To prevent marine pollution from ships beyond 5 km of the coastline and to make the transportation safe.	Considered Applicable as these cargos are also required to register in India under this act.	Registration Certificate	National Shipping Board	IWAI should ensure that all the barges plying in the waterways 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	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 should obtain NOC from CGWA/CGWB prior digging any bore well during construction & operation phase. Compliance to the rules should be ensured by IWAI and contractor

Name	Key Requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
areas, 2012					

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 navigation on the NW-1 and for the matters connected therewith or incidental thereto	Applicable for all the vessel plying in National Waterway	IWAI
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**. Other than the operational policies of World Bank, Guidelines of IFC (World Bank Group) are also considered for carrying out EIA study and are listed in **Table 2.3.**

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

Name	Key Requirement	Applicability	Remarks	Management Plans
Operational Policies				
OP 4.01 Environmental	Ensures sustainability and environmental	Triggers	Project classified as	Environment Management Plans

Name	Key Requirement	Applicability	Remarks	Management Plans
Assessment	feasibility of the project. Projects are classified into A, B & C category depending on the nature and extent of the impact.		Category A considering nature of activities and impacts	including guidelines and management plans for tree plantation, waste management, Borrow area management, Emergency response and budgetaryprovisionfor development of EHS management system and Responsible carrier Programme.
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	Triggers	Triggered for Sahibganj & Varanasi Terminal Projects. No other project is in close vicinity of such endangered or protected environment	Environment management plan and Tree Plantation Management Plan
OP 4.36 Forests	Ensures that project activities do not 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.	--do -
OP 4.12 Involuntary Resettlement	Ensures minimal involuntary resettlement by considering feasible alternatives project design, assisting	Triggers	Applicable for facilities which involves land acquisition	RAP and Social management plan

Name	Key Requirement	Applicability	Remarks	Management Plans
	displaced people to improve their former living standard.		like Sahibganj terminal, Varanasi terminal etc.	
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	Environment management plan and Social Management Plan
OP 7.50 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,	Triggers	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	No specific plan is required for this.

Name	Key Requirement	Applicability	Remarks	Management Plans
	sufficiently far in advance to allow them to review the plans and raise any concerns or objections		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	
IFC Guidelines				
IFC Guidelines- Environment, Health& Safety Guidelines (General)	Technical reference document for guidance of general health & safety measures to be taken for general industries, construction and other such activities	Followed	Applicable for all the construction and operational activities of the project	Environment management plans and emergency response plan
IFC Guidelines- Environment, Health and Safety Guidelines for Ports, Harbors and Terminals	Act as reference document which provides guidance for incorporation of RHS measures during EIA study of the Ports, Harbours& Terminals	Followed	Applicable for the terminals proposed at Sahibganj, Varanasi & Haldia and will be considered for other 3 proposed terminals also	Environment management plans and emergency response plan

The OP 4.09: Pest management, OP 4.37: Safety of Dam, OP 7.60: Project in Disputed Areas and OP 4.10: Indigenous People are not triggered for this project. Incase of Sahibganj terminal few Schedule Tribe are located in 10km radius of this terminal but are not affected from this project.

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*

A. 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 should 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 **Annexure2.1** (Volume 3C)**.** 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.

List of Safety Related Regulations: All the legislations and regulations as per IMO applicable for vessel movements and cargo transportations through waterways is listed in Annexure 2.1. However, few are listed below, which should specifically be referred to ensure the safety of the personnel

- Initial Assessment of Environmental Effects of Navigation and Infrastructure Projects (WG 143 -2014)
- Sustainable Waterways Within the Context of Navigation and Flood Management (WG 107 -2009)
- Climate Change and Navigation (TG3 -2008)
- International Labour Organization (ILO) Code of Practice for Safety and Health in Ports (2005);
- General Conference of the International ILO Convention concerning Occupational Safety and Health in Dock Work, C-152, (1979)
- General Conference of the ILO Recommendation concerning Occupational Safety and Health in Dock Work, R-160
- IMO Code of Practice for Solid Bulk Cargo (BC Code)
- International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code)
- International Code for the Safe Carriage of Grain in Bulk (International Grain Code)
- Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code)
- International Maritime Dangerous Goods Code (IMDG Code)

B. 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

C. 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 should 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 is listed below and given in detail at **Annexure 2.2(Volume 3C).**

- 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.

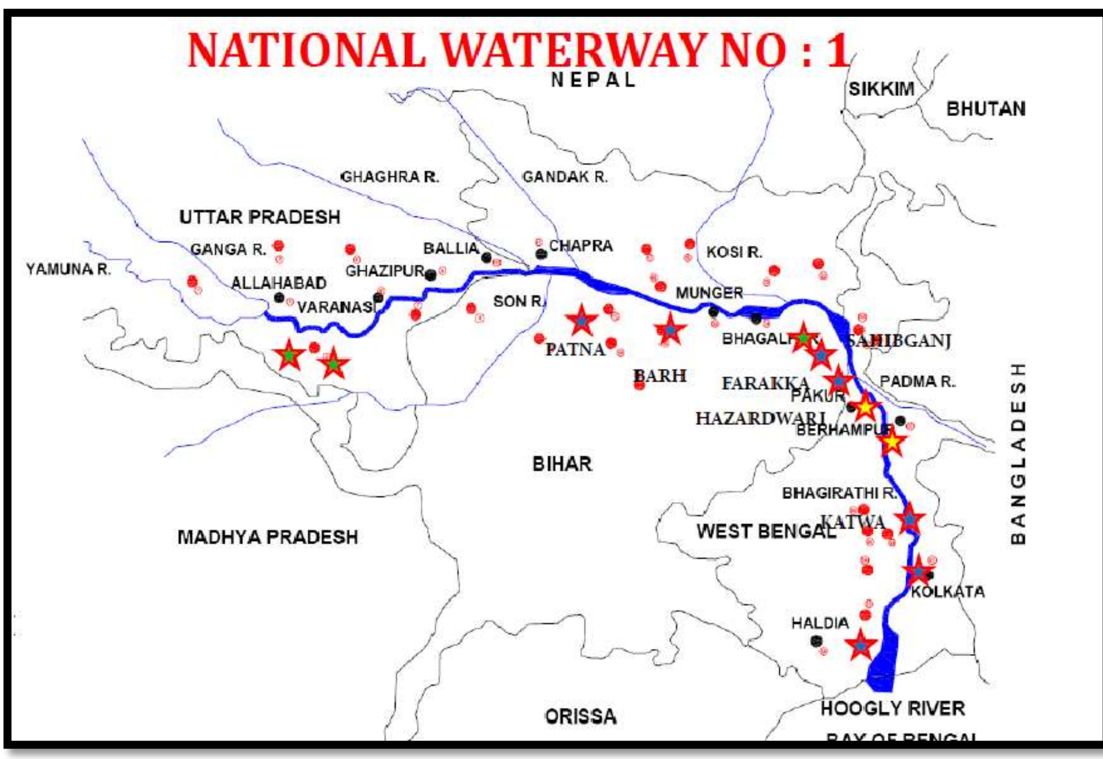


Figure 3.1 : Alignment of NW-1

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**.

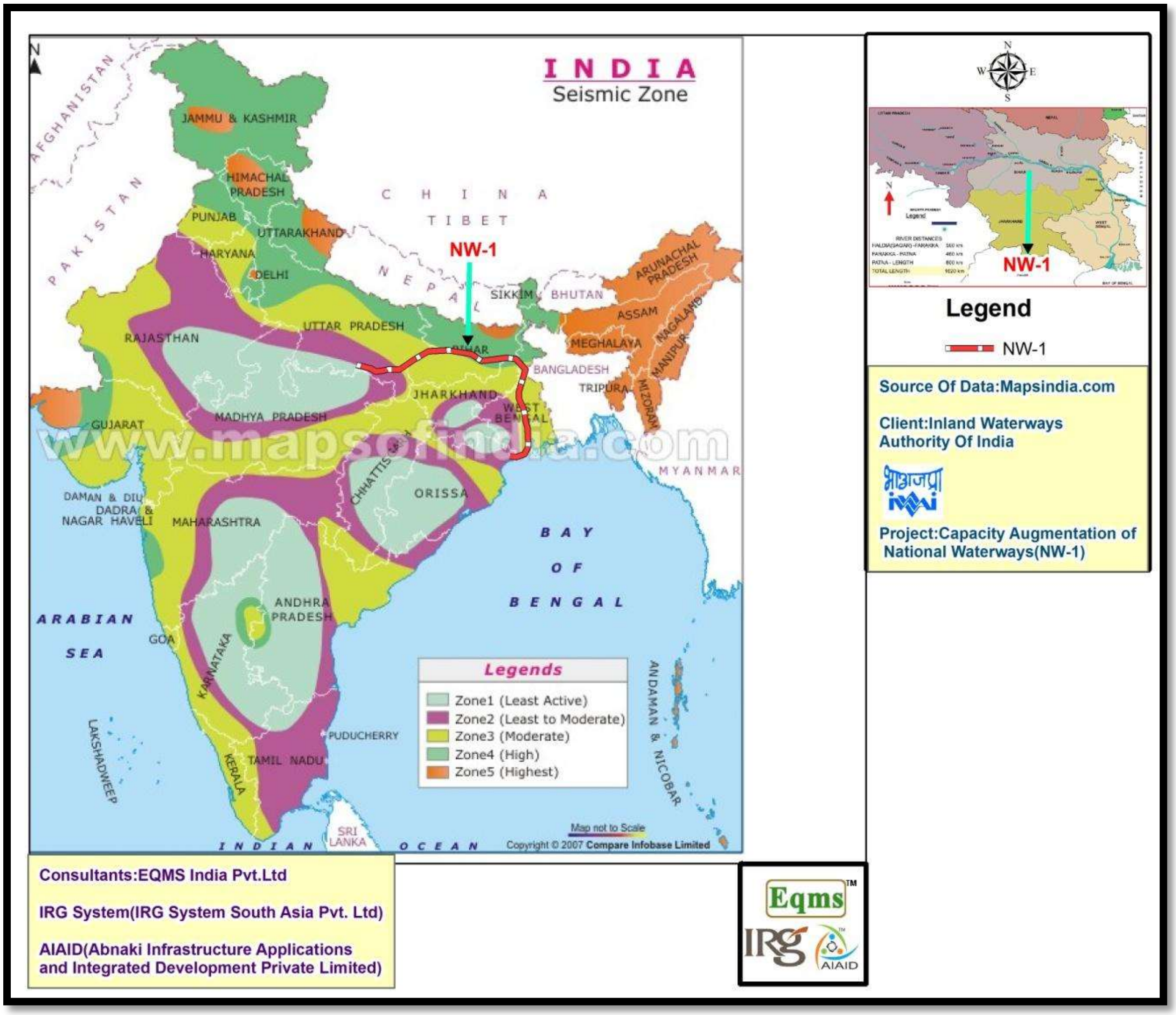


Figure 3.2 : Location Map of NW-1

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 required LAD in waterway/channel and at the proposed terminal facilities
- Improved Navigation Infrastructure& Navigation Aids
  - Construction of 5 Nos. of Ro-Ro crossings & 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 accomplished. Besides 2 more potential sites for development of terminals are identified at Ghazipur and Kalughat. These two sites are at initial stage of planning. One more terminal site

is to be identified along NW-1 and the likely site is at Kalyani in Tribeni, West Bengal.

- Construction of Navigation Locks (New navigation lock at Farakka)
- Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment and development of low draught vessels
- 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 Barh, 2.5 m until Ghazipur 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 es expected to be different for different stretches, the separate traffic projections is made for Haldia-Varanasi, Haldia-Patna & Patna-Varanasi. The traffic projection for these stretches as per medium case augmentation is given at 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	0	18,72,123	27,83,131	48,68,543	63,44,978

	cargo					
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	1,62,487	63,63,580	79,20,893	1,04,42,930	1,19,90,623

	&Foodstuff					
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	3.18 MTPA		

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 Ghazipur and 2.2 m from Ghazipur to Varanasi at present[16].

[16] ***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).***

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 maintain the channel width[17] of 45 m and side slopes of 1:5 from section Haldia to Varanasi.[18]

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[19]. 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

[17] ***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.***

[18] ***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).***

[19] ***(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)***

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
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)

12. 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.
13. 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 JangipurLock 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[20]. 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

[20] ***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).***

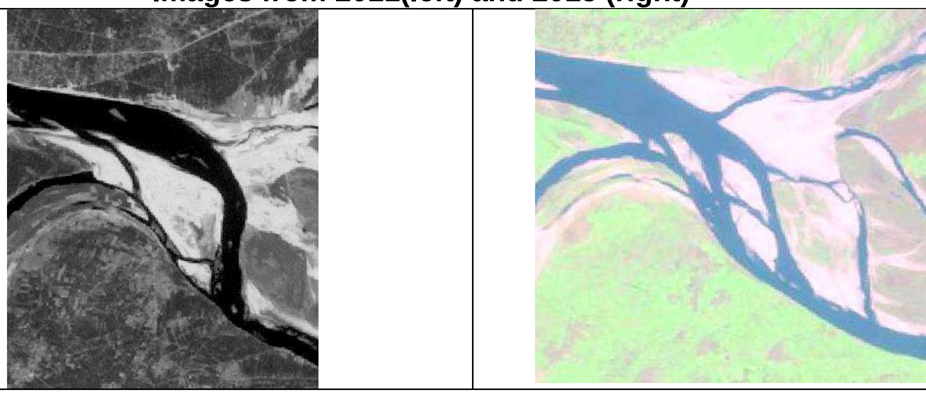
S. No.	Reach/Stretch	Chainage	Morphology
			bars at the near the inner bank of bends
9.	Nabadweep-Patuli	(280-322)	Tortuous meandering channel with chutes atbends and several split channels. Oxbow lakes and cut-offs visible
10.	Patuli-Katwa	(322-345)	Tortuous meandering channel with localised bars and 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

S. No.	Reach/Stretch	Chainage	Morphology
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 ofanabranching
31.	Doriganj-Ballia	(1000-1063)	Meandering single channel, wider at bends with some chutes and several subparallel anabranches
32.	Ballia-Buxar	(1063-1124)	Sinuous single channel, wider at

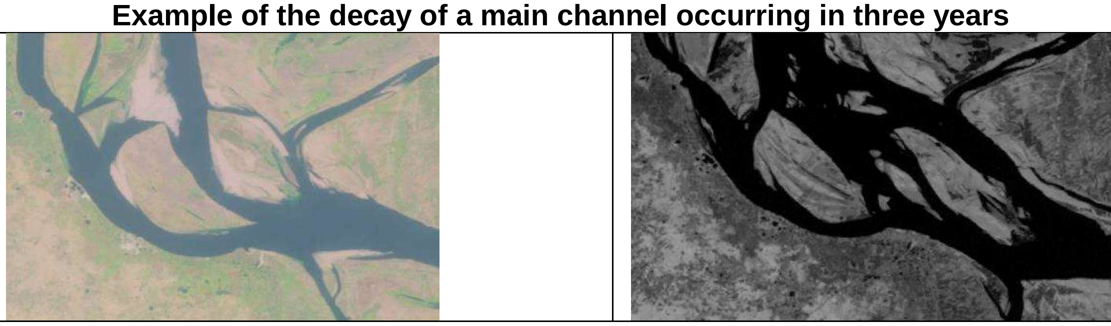
S. No.	Reach/Stretch	Chainage	Morphology
			bends with some chutes and a sinuous side channel and certain degree of braiding
33.	Buxar-Ghazipur	(1124-1178)	Sinuous single channel, wider at bends with some chutes and a sinuous side channel
34.	Ghazipur-Saidpur	(1178-1254)	Sinuous channel that shows some degree of braiding in a stretch of around 10 kilometres
35.	Saidpur-Varanasi	(1254-1311)	Meandering single channel, wider at bends with some chutes and a side channel
36.	Varanasi-Chunar	(1311-1344)	Meandering single channel, wider at bends with some chutes and a side channel
37.	Chunar-Mirzapur	(1344-1398)	Meandering single channel, wider at bends with 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 bends with 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)

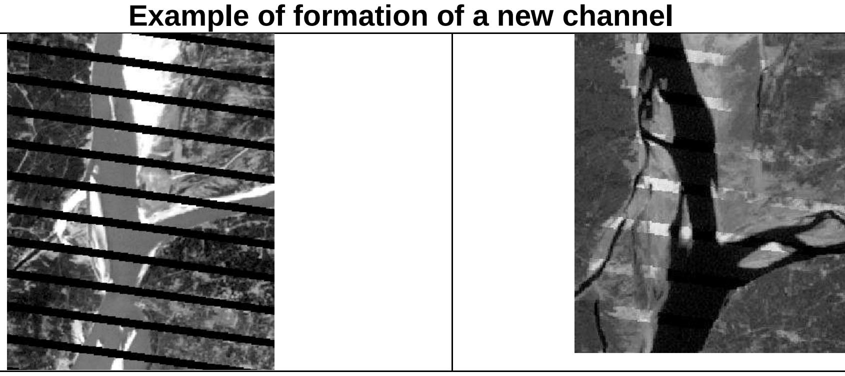
Formation of a big island with two main channels upstream of Farakka Barrage. Images from 2011(left) and 2015 (right)



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



Example of formation of a new channel



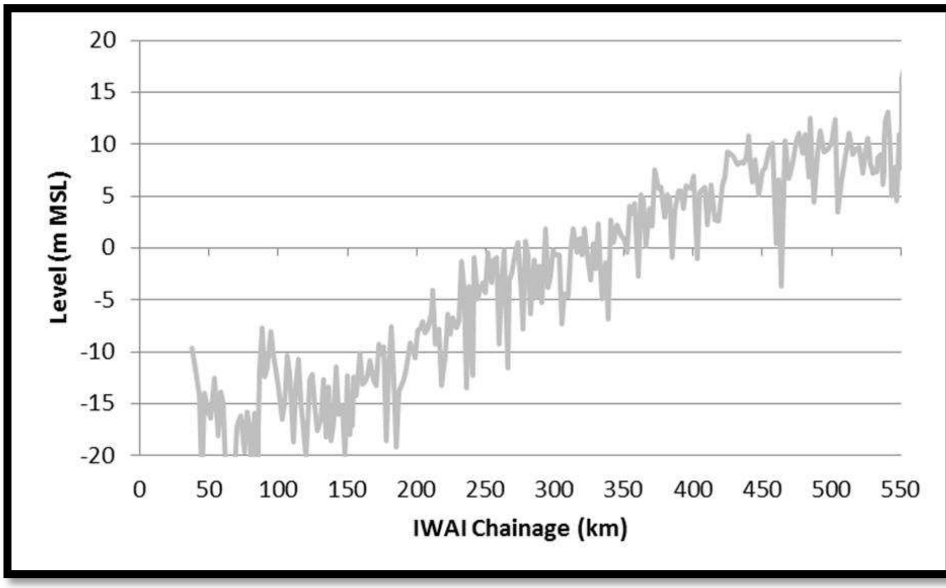
Example of lateral migration of main channel

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

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

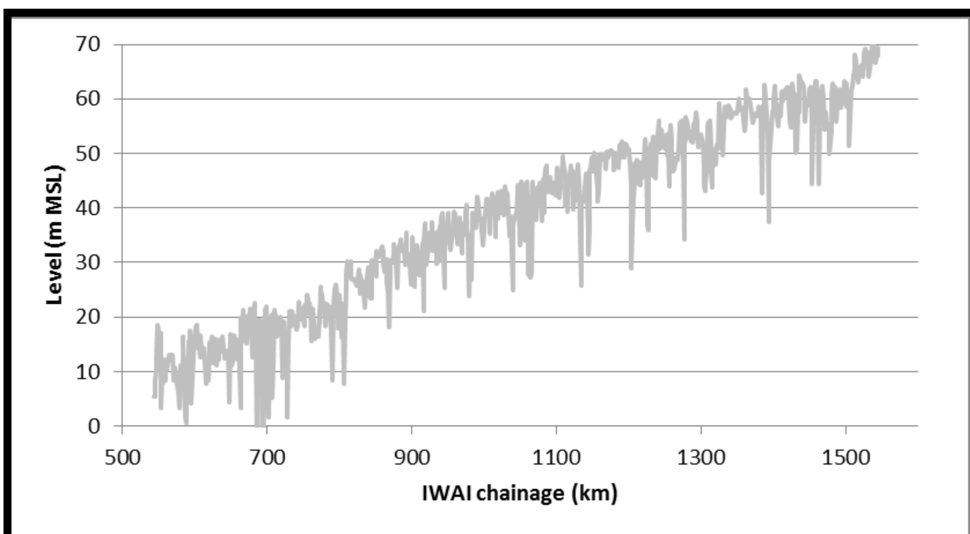
3.7. Bathymetry of NW-1 & River Slope

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.

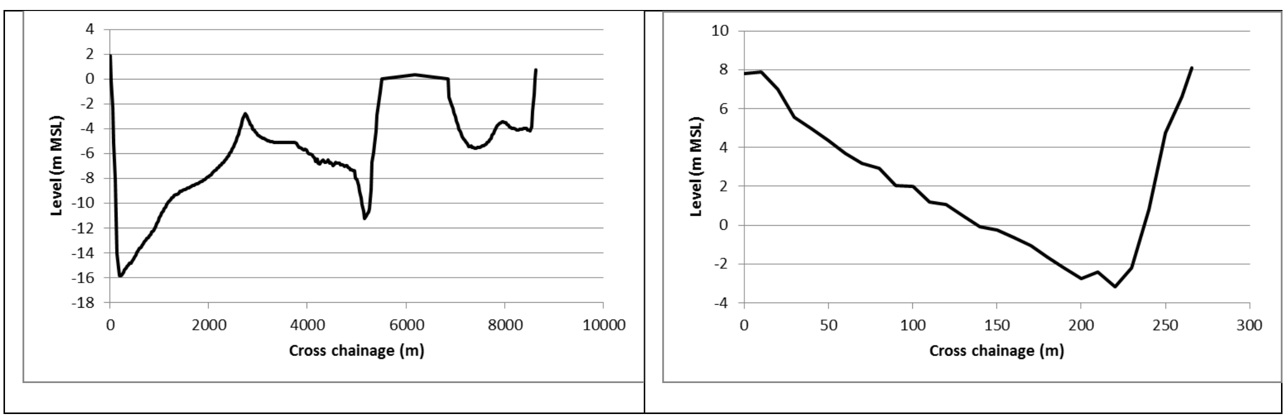
River slope from Farakka to Allahabad is 1 in 17,000. Longitudinal profile of river slope from Farakka to Allahabad is given in **Table 3.10** below.

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	

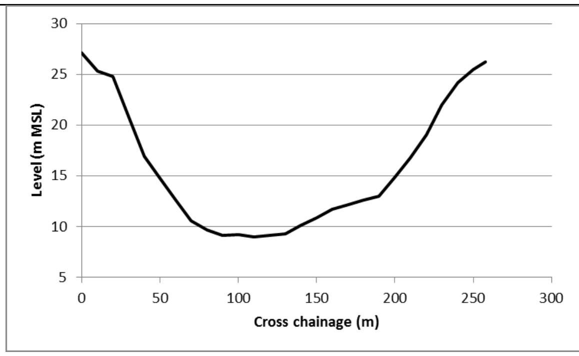
Source: IWAI &HOWE ENGINEERING PROJECTS (INDIA) PVT. LTD. (DESIGN CONSULTANT)

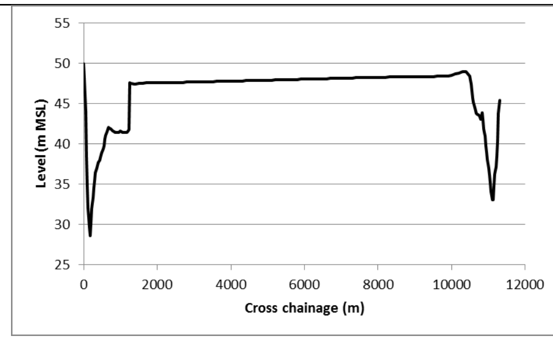
Cross section profile of the NW-1 at various location has also been studied by design consultant at various locations like Haldia, d/s Farakka lock, around island near Patna, Ghazipur, Varanasi, Allahabad & at meandering bend. Cross section profile of river is given at **Figure 3.6.**



Cross section of river at Haldia

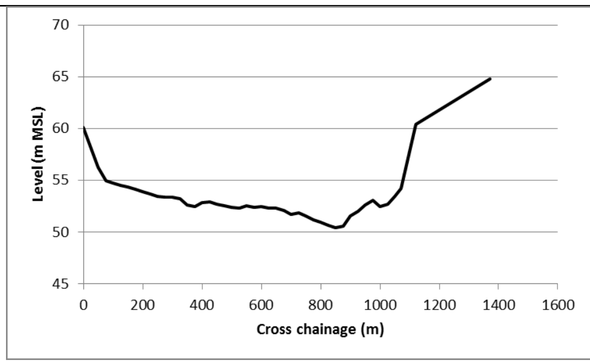
Cross section of river at meandering bed (ch-0326)

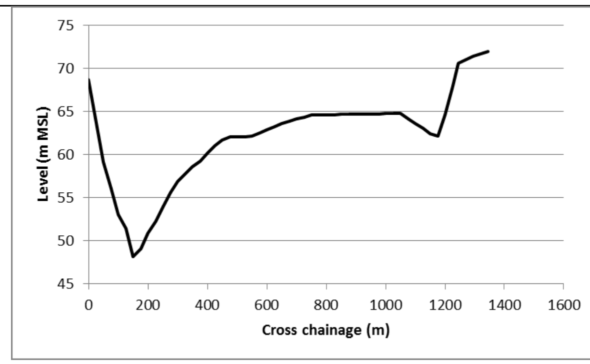




Cross section of canal d/s Farakka lock

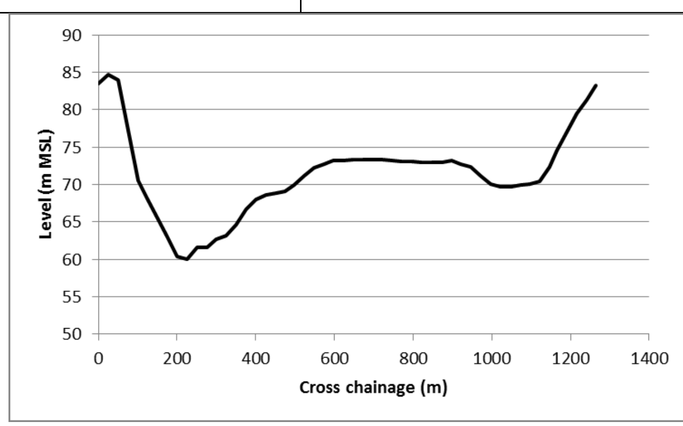
Cross section of river near large island at Patna





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

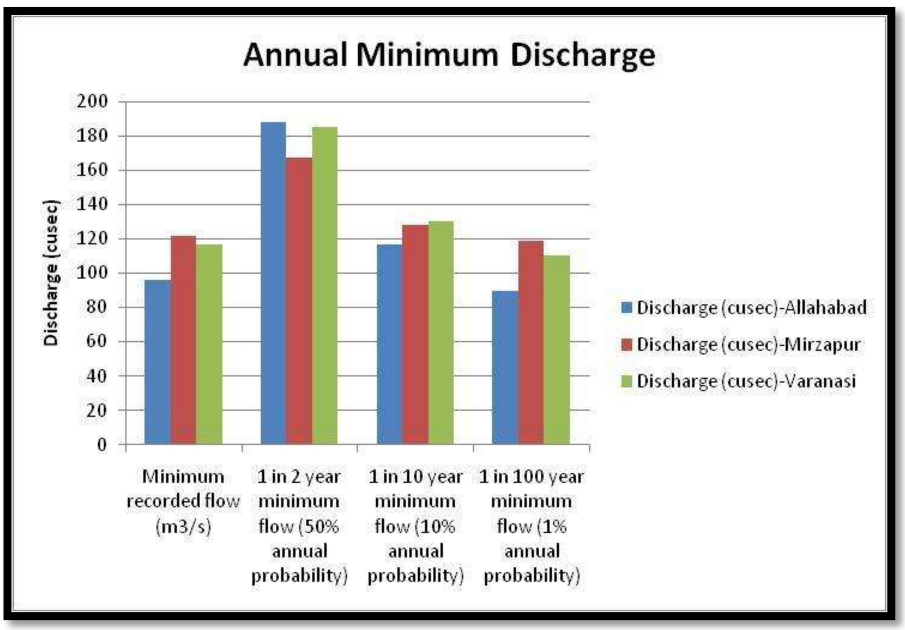
3.8. Available Flow in NW-1

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

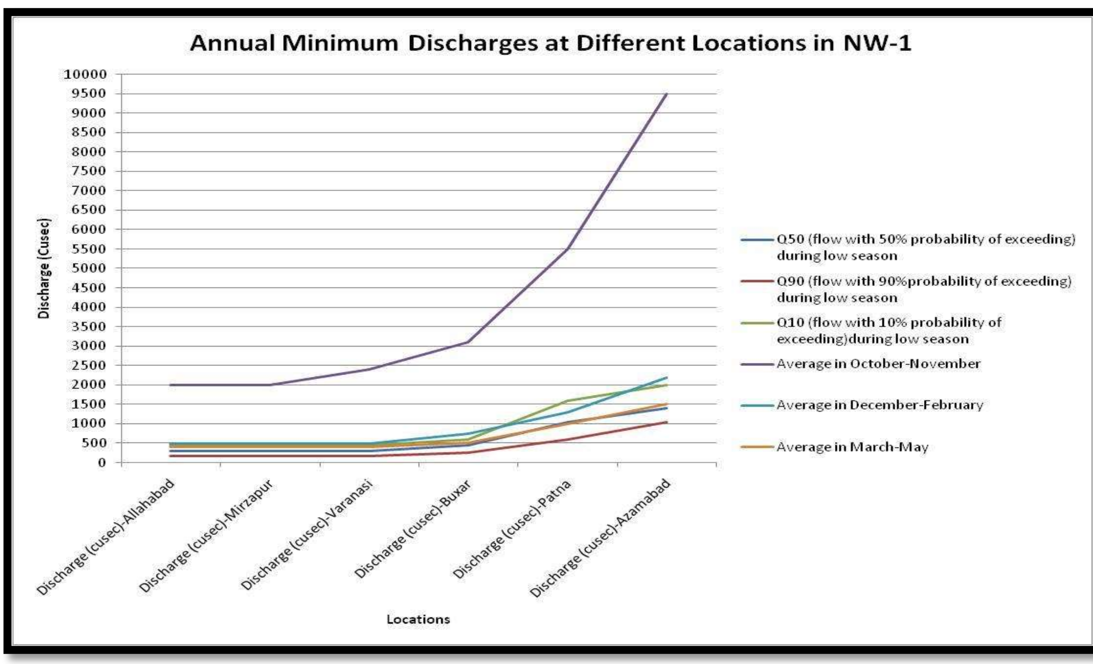
As per data available with IWAI, lowest flow recorded at Buxar was 225 cusec and lowest available flow at Patna 689 cusec. These flows are considerably lower than the average dry season flows. The design discharge for the feeder channel at Farakka is around 1,100 m^3/s.

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)

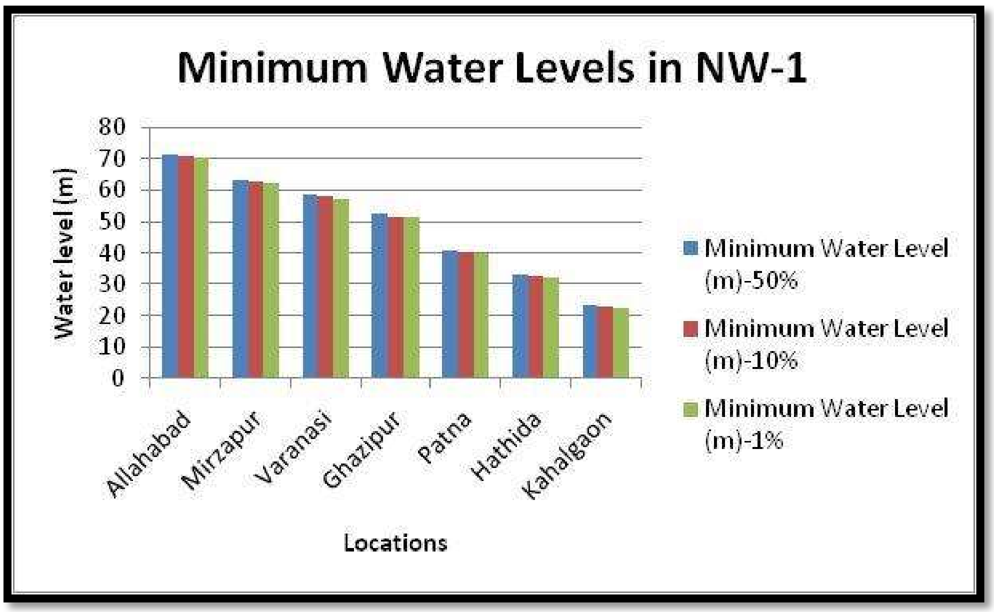


Figure 3.9 : Minimum Water Levels for a Range of Annual Probabilities

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)

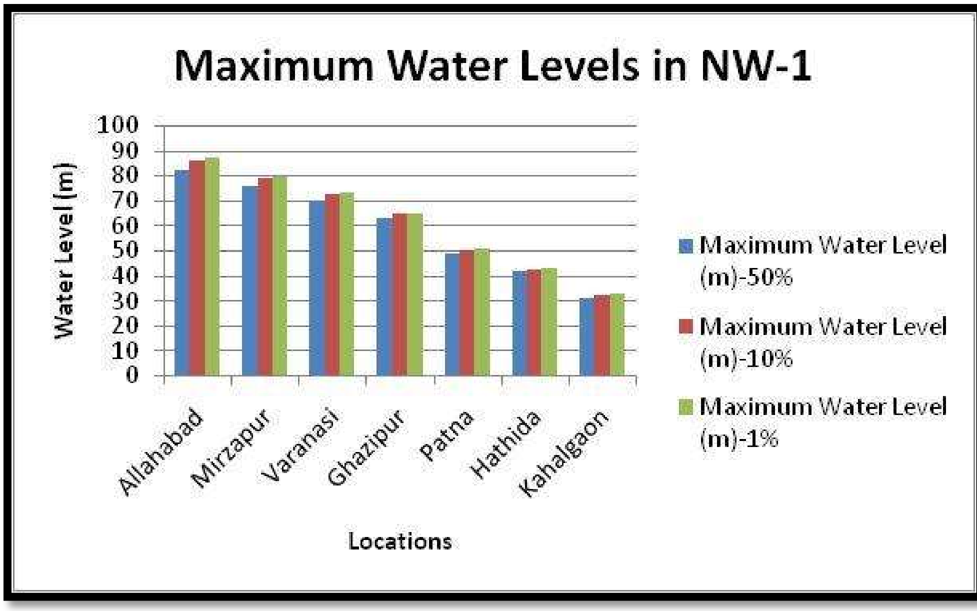


Figure 3.10 : Maximum Water Levels for a Range of Annual Probabilities

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[21] 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.

[21] 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

B: ALTERNATIVE ANALYSIS

3.12. Analysis of Alternatives

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 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[22]	IR is oversaturated[23] 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	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.

[22] 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 in time 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

[23] 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 through 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%)

Environment	Without Project	With Project
	expansion & improvement of IR & road network.	
Physical Environment	**GHG Emissions:** In this scenario GHG emissions associated with freight transportation through rail/road mode will continue to generate GHG (under as usual scenario), there by continuous increase in the CO2 emissions take place. GHG Emissions associated for movement of cargo (based on maximum terminal capacity as planned in phase I) through rail & road modes (without NW1 as business as usual scenario) are 84 billion & 277 billion g/yr respectively. **Ambien Air Quality:** There are three aspects: one is the continuation of increase in air pollutants(calculated for maximum terminal capacity as planned in phase I) through rail & road modes 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. The second is the additional increase traffic on roads or rail network because of additional rise in cargo transport. Such additional rise is going to create congestion in the roots used and thereby causing more emission per km travel. Third is need for additional infrastructure to cater the new higher transport demand by road and/or rail modes which will costly and require additional land as compared to IWT as well as higher pollution**.** Besides, the impact on terrestrial biology due to cutting of trees required for expansion of road/railway network will further deteriorate the air quality.	**GHG Emissions:** Their will be overall reduction in GHG emissions in case the cargo transport mode is changed to IWT as this mode is energy efficient (detailed GHG emission estimates have been made for LCA analysis) As per analysis carried out, it is estimated that CO_2 (potential GHG) emissions associated with IWT for freight transportation (calculated for maximum cargo upto maximum terminal capacity as planned in phase I) from Haldia to Varanasi is 4.54 million tonnes/yr. **Air Quality: As IWT is more energy efficient the exhaust related emissions are going to reduce proportionally.** As per these estimates that the NOx; SOx; CO; PM & HC emissions associated with the model shift in transport to 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, the truck exhaust related air pollutant emissions in immediate vicinity of the terminals are likely to increase due to rise in vehicular activity of trucks and other vehicles due to requisite pre and post haulage from cargo terminals. The impacts of such in ambient air quality can be mitigated or reduced by adopting the proposed EMP which includes even measures like site planning, adopting fuel shift or vessel/barge design, requisite operational norms of IWT vessels/barges etc., Besides there are number of impacts during construction as well as operational phase of different interventions envisaged for IWT mode warranting compromise EMP

Environment	Without Project	With Project
		to mitigate the respective impacts. .
	Water Quality: Due to construction of more roads for rise in road traffic demand will result in more paved surfaces, there by rising the surface run-off (which may also be contaminated with oil and grease-accidental or used oil/grease) causing pollution of water bodies land environmental impacts.	**Water Quality:** Similarly, there are number of activities (as detailed in respective reports) during construction as well operational phase of IWT implementation however, these impacts have been assessed and mitigated to the extent that residual impacts are minimal and not significant. The examples of such activities include increased contaminated run-off from construction site, pilling and dredging activities, plying of vessels/barges, usage of antifouling paints, accidental release of spillage of oil cargo etc.
	Loss of agricultural land and top soil: The continual expansion of railway and road network to meet the additional freight & passenger transportation requirement of the country, warrant additional acquisition of agricultural land and loss of top soil (more probable). Also construction soil is to be sourced to burrow pits which is often located in 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 IWT interventions required.	**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 networks essential for these transport modes
Terrestrial & Aquatic ecology	**Terrestrial Ecology:** Terrestrial ecology will not be directly	**Terrestrial Ecology:** Impact on terrestrial flora is

Environment	Without Project	With Project
	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 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	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. **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.	**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.

Environment	Without Project	With Project
	Employment Opportunities: Employment generation involved only for construction of new road/railway alignment and maintenance of road/rail networks	**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 is anticipated on water and aquatic ecology in "With Project" scenario for which mitigation and management plans are prepared to minimize the impact.

3.12.2. *Planning Consideration*

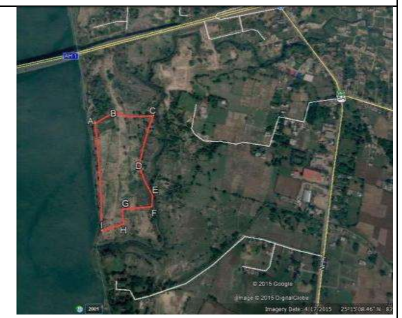
This involves the consideration of options involved in planning stage, i.e. location of the proposed interventions, suitability of site, design of the project layout and dredging extent. This enables to select the option having best planning/design with minimal implication on physical, biological & socio-economic environment. Since the EIA is carried out in tandem with the detailed engineering study, thus this facilitated to undertake the analysis of proposed alternatives with environmental point of view and planning is done on the basis of suggestive outcome of the environmental alternative analysis study. Detailed planning alternative analysis carried out with environmental perspective is discussed in sections below

a. 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	

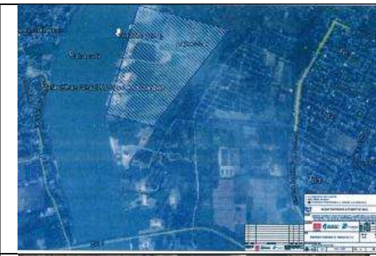
3.	Terminal site at Sahibganj, Jharkhand	**Environment Considerations:** • Location of stone quarries in nearby areas thus locally available material to be transported • Site is not part of or close to any eco-sensitive location **Social Considerations:** • Sahibganj is one of major centre of the Jharkhand 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, approach road is required to be constructed **Design Considerations:** • River banks and bed are required to be protected from erosion & scouring	Selected	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 Selected	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.

b. 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	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
			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-	**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	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
		97 has large volume of traffic which can be diverted here				
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:**	**Environment Considerations:** • Requires tree cutting **Social Considerations:** • Involves land acquisition	Not Selected	Involves tree cutting and acquisition of agricultural land	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
		• River channel is stable • No shoal formation and availability of LAD • Availability of sufficient cargo for transportation				
2b	Terminal at Kalughat, 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:**	**Social Considerations:** • Involves acquisition of land	Selected	Site has no environmental, design & social issues associated	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
		• Availability of sufficient LAD • River section suitable for navigation				
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 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	**Environment Considerations:** • Site is low lying area and requires filling **Social Considerations:** • Involves land acquisition and R & 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	Selected	Availability of sufficient cargo, no major environmental issues, stable river channel with manageable river bank protection works makes site suitable for terminal development	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
		or close to any eco-sensitive location	terminal			
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 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	**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 agricultural soil etc. **Social Considerations:** • Site is located in thickly populated area • Traffic pressure on internal city road will increase significantly after development of	Not Selected	Disadvantages cannot be overcome through mitigation and management measures	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
			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			

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
			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 requirement of 0.5 lakhs cum in	**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	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
		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	Not Selected	No major environment or engineering issues associated but parallel site is better in all respect to this site	

S. No.	Development, Site & Location	Advantages	Disadvantages	Selection Status	Remarks	Site Map
			requirement of 1.5 lakhs cum in U/s approach 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.

c. Design Planning

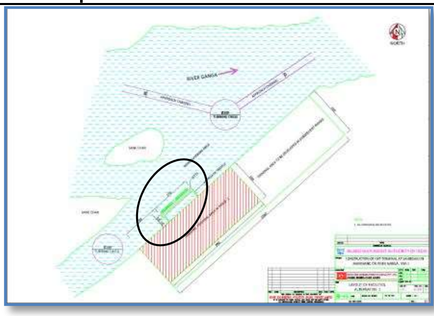
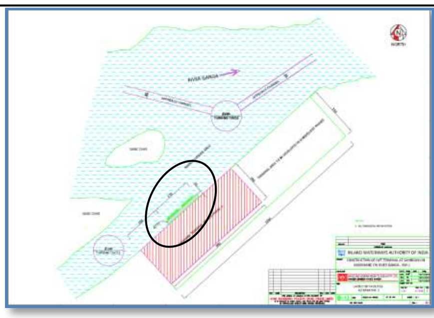
After selection of site for development of the terminals, alternatives are selected for layout design and alignment of proposed roads and railways for connecting the site. Design planning helps to optimize the project cost during construction as well as during operation phase. Such alternatives are considered 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

i. Alternative layout Designs at Sahibganj Site

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		

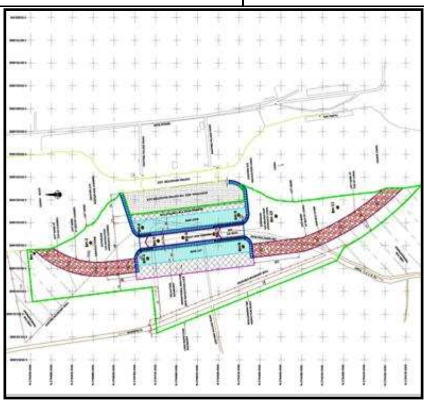
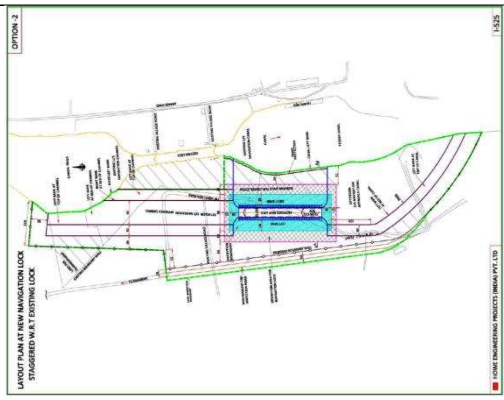
Based on multi criteria matrix presented above, both the alternative layouts have certain advantages as well as disadvantages. It could be observed that in terms of available required depth round the year without need of dredging and marginal cost difference between two alternatives, and environmental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

ii. **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	0.05	0.15	Quantity of excavation in Option-II is

	water depth of the channel as 3-m, approximate quantity of dredging in excavation for U/S Approach Channel (million mm^3)			almost three times than that in Option-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.

iii. **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 app. 1 km. Brownfield alignment and involves improvement of rural road.	Length of this alignment is app. 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.

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

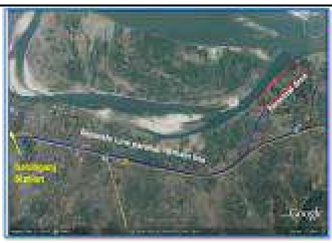
It is proposed to develop railway connectivity for terminal site with existing Railway Line. Three options are considered for giving the connectivity to the terminal site and are given below.

- 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 analysed 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.

d. 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 Ghazipur and 2.2 m from Ghazipur 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 Ghazipur and 2.2 m from Ghazipur to Varanasi) In CUM**	**Remarks**
Dredging Quantity in Dry Season	31,079,576	1,48,50,000	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)	12 (if dredgers work for 10 hours in month of 25 days in double shift for 8 months)	Requirement of dredgers and dredging infrastructure is more than 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.

a. Selection of Material Conveying System Within Terminal Site

Initially it was planned to transport the material from Railway siding to stockyards to barges and vice versa through the barges/dumpers at Sahibganj Terminal as per feasibility report. But looking into the environmental impacts including the dust emissions during loading and unloading, vehicular emissions, oil spillages from transportation vehicle movement and repair, alternative system for material transportation within the terminal called as mechanical conveying system was analysed and considered as best option as it can drastically reduce the dust emissions. It was found more suitable also due to presence of residential areas (villages) closet Sahibganj terminal. This has been adopted in the plan of Sahibganj terminal.

b. 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

Type of Dreger	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	-	+	-/0	+	+	+	+

Type of Dreger	Safety	Accuracy	Turbidity	Mixing	Spill	Dilution	Noise
Dredger							
Grab Dredger	-	-	-/0	0	+	+	+

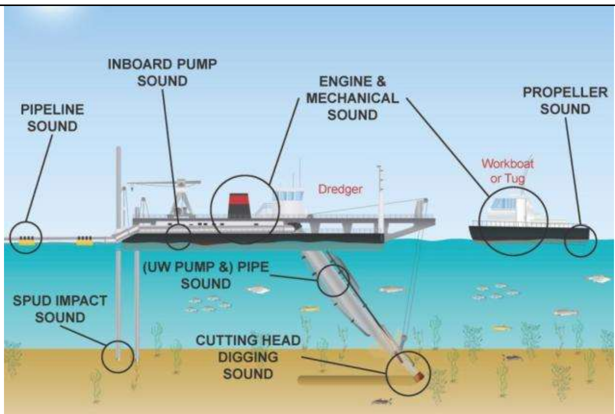
+ is better than average, 0 is average and – is below average

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

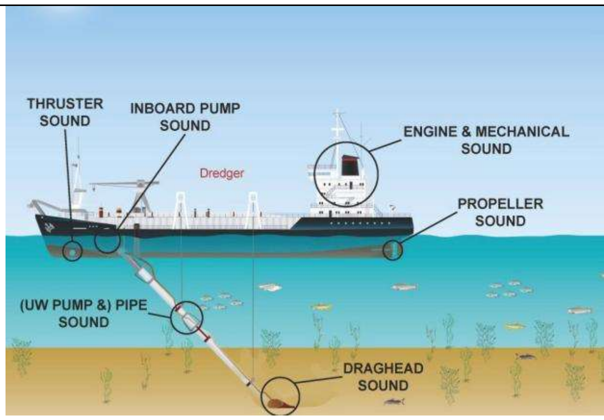
Attributes	CSD	Hopper Dredgers	Grab/Bucket Dredger	Back hoe Dredger
Type	Hydraulic	Hydraulic	Mechanical	Mechanical
Strata	All type-soil, sandy, silty and rocky	Silty and gravel	Silty, gravel, mud and soft rock	Clay & Gravel
Usage	Inland waters	Coastal areas	Coastal waters and inland waters	Shallow waters 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)[24]- Annexure 3.1(Volume 3C)	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)[25]- Annexure 3.1(Volume 3C)	Ordinary 4,000 PS1/- 1.2 – 1.4 Ordinary 2,000 PS-NA	12-203	NA	--
Schematic diagram showing noise sources	**Figure 3.11**			

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

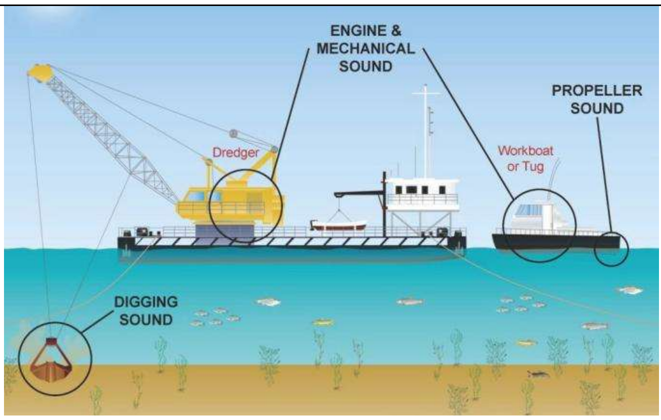
[25] *Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992*



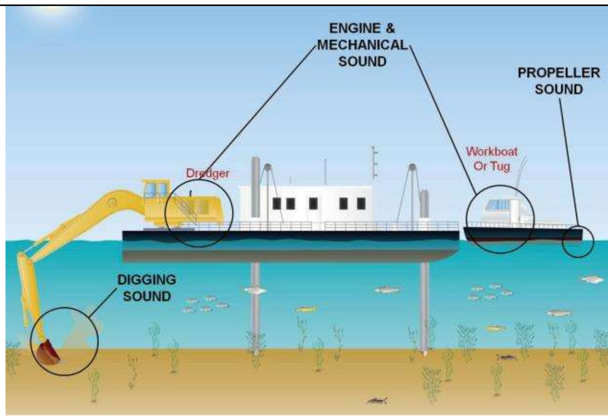
Cutter Section Dredger



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[26] 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(Volume 3C).**

3.12.4. *Integration of Analysis of alternatives and Design Input in project Design:*

Since studies were being carried out along with the feasibility report preparation, the output of alternative analysis and design consideration was discussed with the design team and incorporated in the project design. Some of the design changes include provision of mechanical material handling system at Sahibganj Terminal, dust suppression system at each terminal, provision of green belt all along the terminal boundary, integration of green building concept in terminal buildings, adoption of zero discharge concept at terminals and barges, rain water harvesting, emergency response planning, exploring feasibility of using

[26] 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.

low draft vessel and alternative fuels for barge operations. The project description details presented below includes the above considerations.

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 navigation in NW-1 through dredging and bandalling. Depths[27] 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

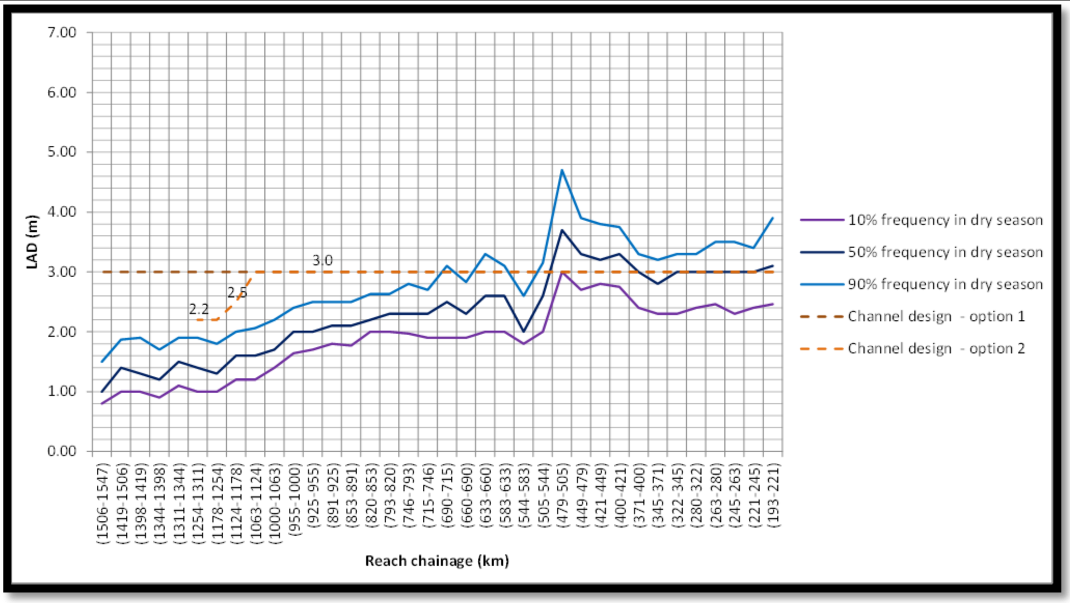
However, “Jal Vikas Marg” Project aims at maintenance of LAD to 3 m in entire NW-1. But to optimize the cost, deployment of dredgers, manage man-power and minimize environmental impacts, IWAI is focussing on different depths in different stretches at present.

- Haldia to Tribeni : 3 m (naturally available LAD)
- Tribeni to Farakka : 3 m (including Farakka Lock)
- Farakka to Barh : 3 m
- Barh to Ghazipur : 2.5 m
- Ghazipur to Varanasi : 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**.

[27] 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



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

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 yearly 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 Ghazipur, 2.2 m from Ghazipur 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 45 m, and 1:5 side slope. Estimated dredging quantity will be as low as 50% in average flow conditions in option 2 compared to option1. Detail of dredging in different stretches is given in **Table 3.26.** 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 : Dredging Volumes in different Stretches for Maintaining LAD in Navigation Channels and at terminal

Stretch	LAD (m) to be maintained as per option 2	Average Annual Dredge Volume (cum)		
		Present Day 2013-2014	**Option 1**	**Option 2**
Haldia to Tribeni ***including Haldia (2.4M cum) and Kalyani terminal (0.1 M cum)***	3 m	--	2,400,000	2,400,000
Tribeni to Farakka ***including Farakka navigation lock***	3 m	--	1,220,000	1,220,000
Farakka to	3 m	3,70,000	1,570,000	1,570,000

Kahalgaon ***including Sahibganj terminal(0.1 M cum)***				
Kahalgaon to Barh	3 m		2,390,000	2,390,000
Barh to Patna	2.5 m	3,30,000	3,189,534	1,600,000
Patna to Buxar Including Kalughat terminal ***(0.5 M cum)***	2.5 m	--	4,999,253	2,770,000
Buxar to Ghazipur ***including Ghazipur terminal at Nawapura (0.1 M cum)***	2.5 m	--	5,793,355	1,060,000
Ghazipur to Varanasi ***including Varanasi terminal (0.1 M cum)***	2.2 m	--		1,840,000
Varanasi to Allahabad	Natural depth	--	9,816,710	Nil
Total		7,00,000	31,079,576	14,850,000

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

a. 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 14,850,000 cum/year thus it would require 50 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 40. If dredger works for 10 hrs in a day for 8 months, then dredgers required will be 24 nos. only. If dredgers work this way in 2 shifts, then no. of dredgers required will be 12 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.

b. 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 45 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.

c. 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*

a. 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.

b. 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*

a. 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 3.27**. 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 3.27 : 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	KachchaRasta (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 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)

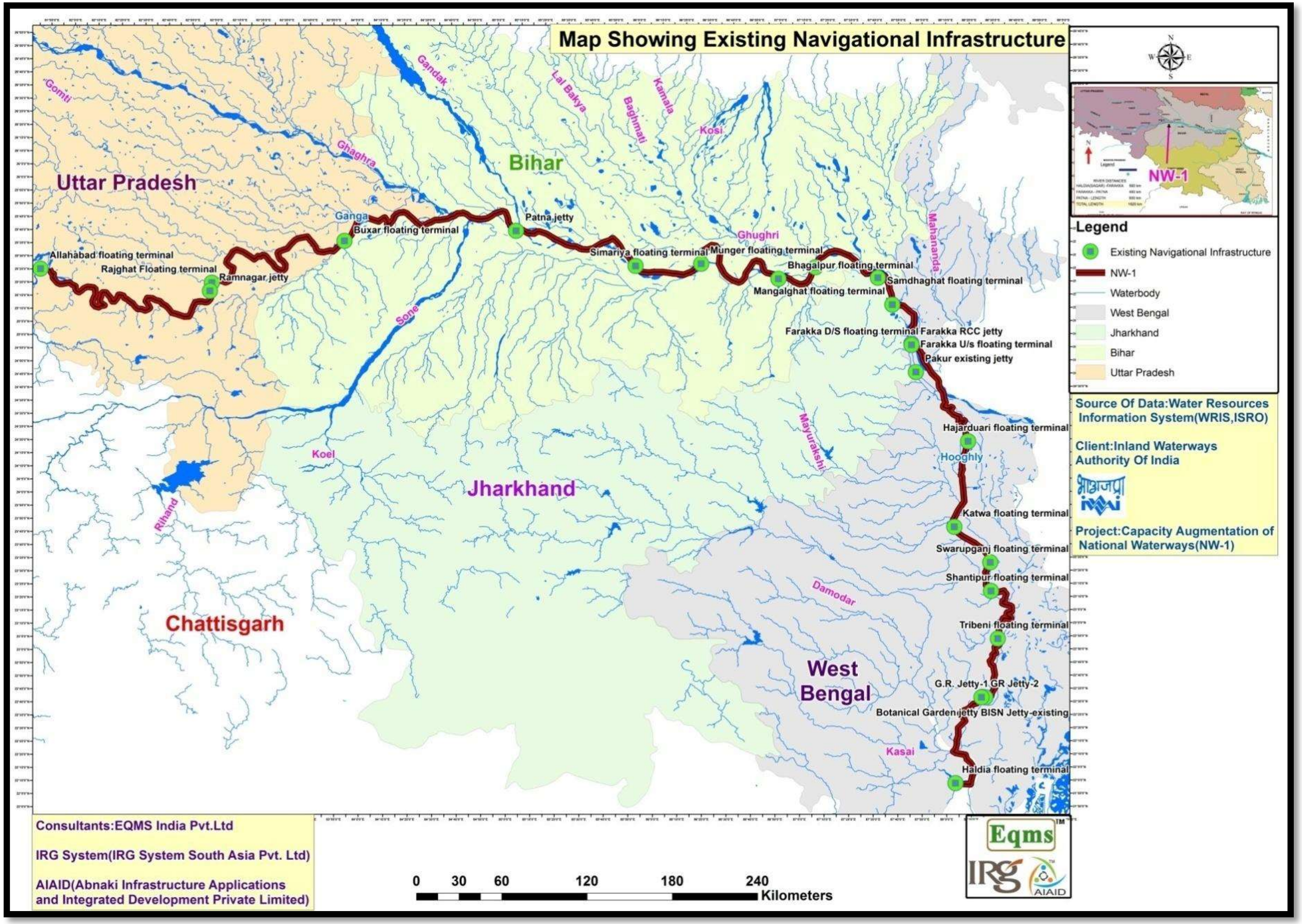


Figure 3.13 : Existing Navigation Infrastructure Facilities in NW-1

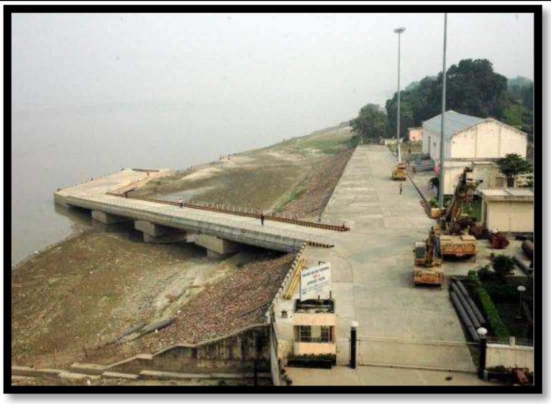
	
Mangal Haat, Jhakhand	Pakur Jetty
	
Farakka Lock	Existing Patna Terminal

Figure 3.14 : Photographs of Existing Infrastructure along NW-1

b. 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

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

Infrastructure Facilities at Initial Planning Stage

i. Terminals at Ghazipur and Kalughat

Facilities yet to be planned

i. One similar terminal site (Kalyani at Tribeni)
ii. 5 Nos. Ro-Ro Crossings and Passenger Ferry Jetties
iii. Development of low draught vessel
iv. River Training Works at Critical Locations like bends and civil interventions under planning

v. Bank/slope & scour protection works
vi. Equipment of tow barges, inland vessels, survey vessels including rescue boats and survey equipment
vii. 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.**

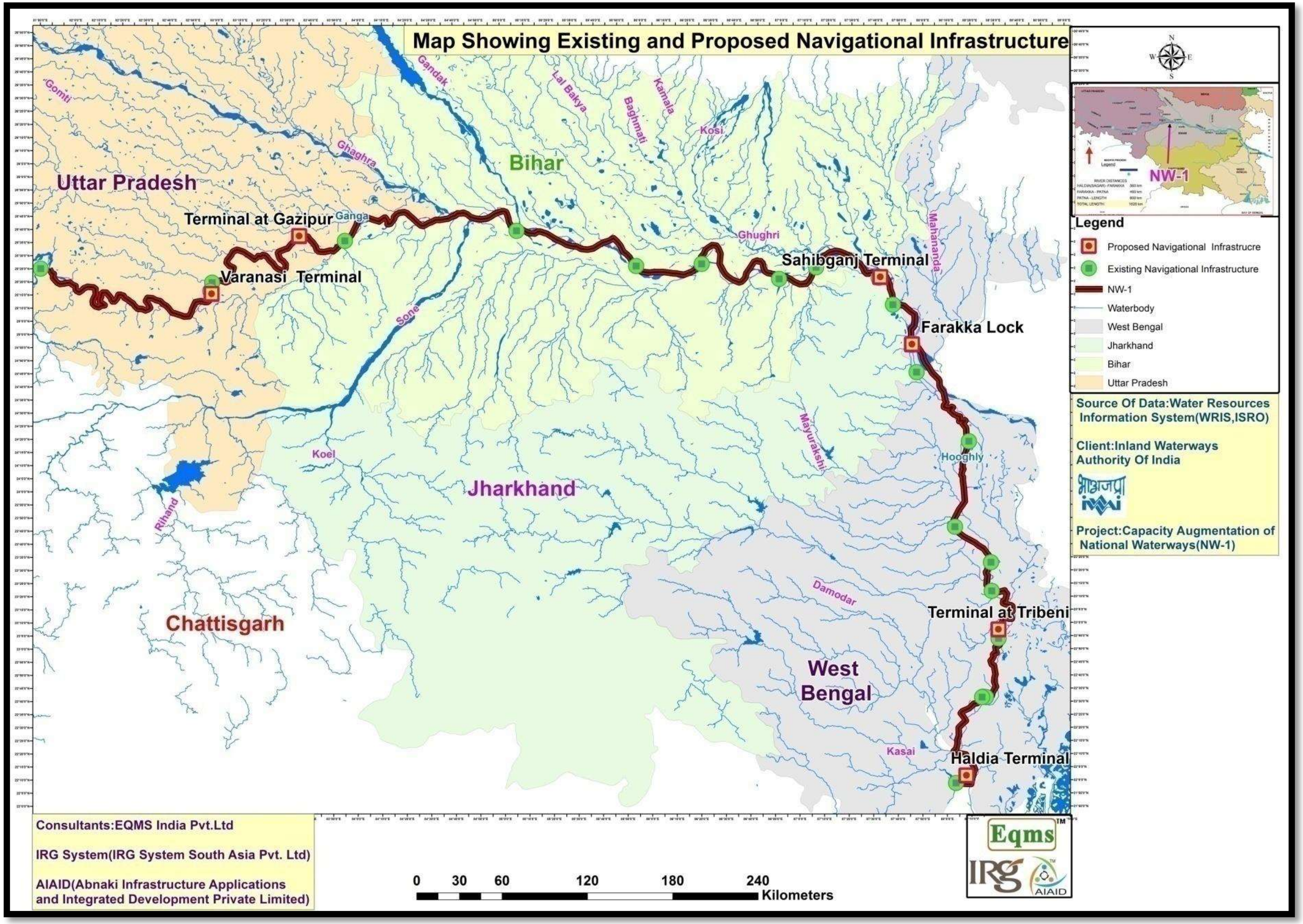


Figure 3.15 : Planned Navigation Infrastructure Facilities in NW-1 Under Jal Marg Vikas project

3.15.3. ***Description of Planned and Proposed Infrstructure***

a. 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 & JagatChak 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

24.68 ha of land in the Haldia Dock Complex has been leased and transferred by the Kolkata Port Trust to IWAI on 30-year lease on June, 2015 for development of terminal. 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

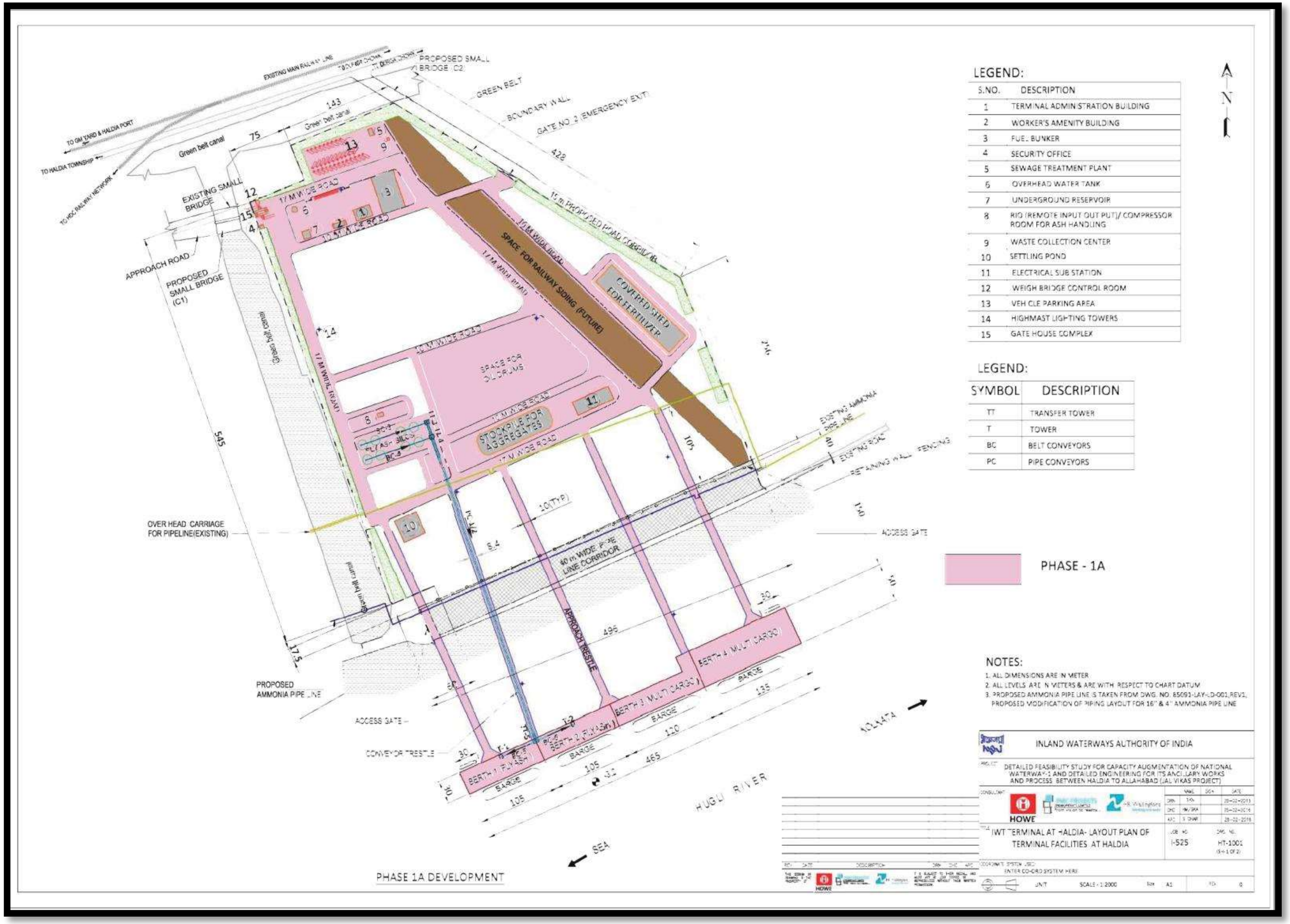
Terminal facility is designed to handle 3.18 MTPA of cargo. Cargo to be transported is fly ash, fertilizer, stone aggregate, edible oil & POL. It is proposed to develop administrative building, worker's amenity building, fuel bunkers, security office, overhead water tank, STP, underground water reservoir, 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 3.28** and layout plan of the terminal site at Haldia is given in **Figure 3.18.**

Table 3.28 : 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	3.18 MTPA
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 (4 Nos.) • 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 structure (berth + Length of approach trestle inside river Length of Berth Width of Berth

			approach trestle) inside the 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
		* 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. Fly ash 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	2.3lakhs 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

b. 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.**

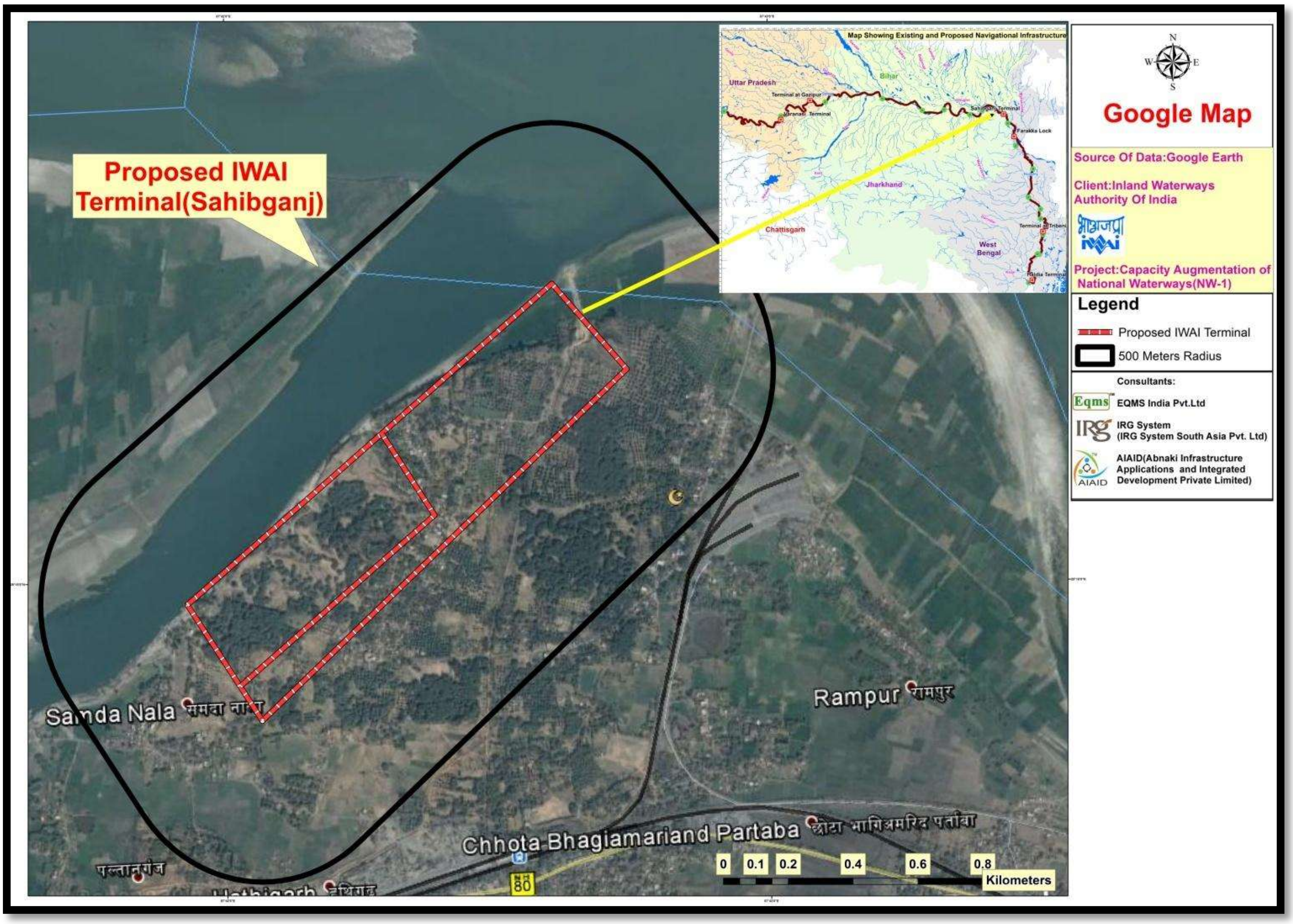


Figure 3.19 : Location Map of Sahibganj Terminal Site

The requirement of land for construction of the terminal with road and rail connectivity has been estimated at 78.91 ha. The facility will be developed in two Phases. Approximately 23.98 ha of will be required for Phase- I to build the terminal. 54.93 ha will be required for the expansion of the terminal and for providing road connectivity, which is proposed to be taken up in Phase- I (B). However, the District Administration, Sahibganj has initiated acquisition proceedings for 45.20 ha of private land for the terminal under RFCTLARR 2013. In addition to this, 2.89 ha of government land will also be transferred to IWAI.

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 3.29** and layout plan of the terminal site at Sahibganj for phase I is given in **Figure 3.21**below.

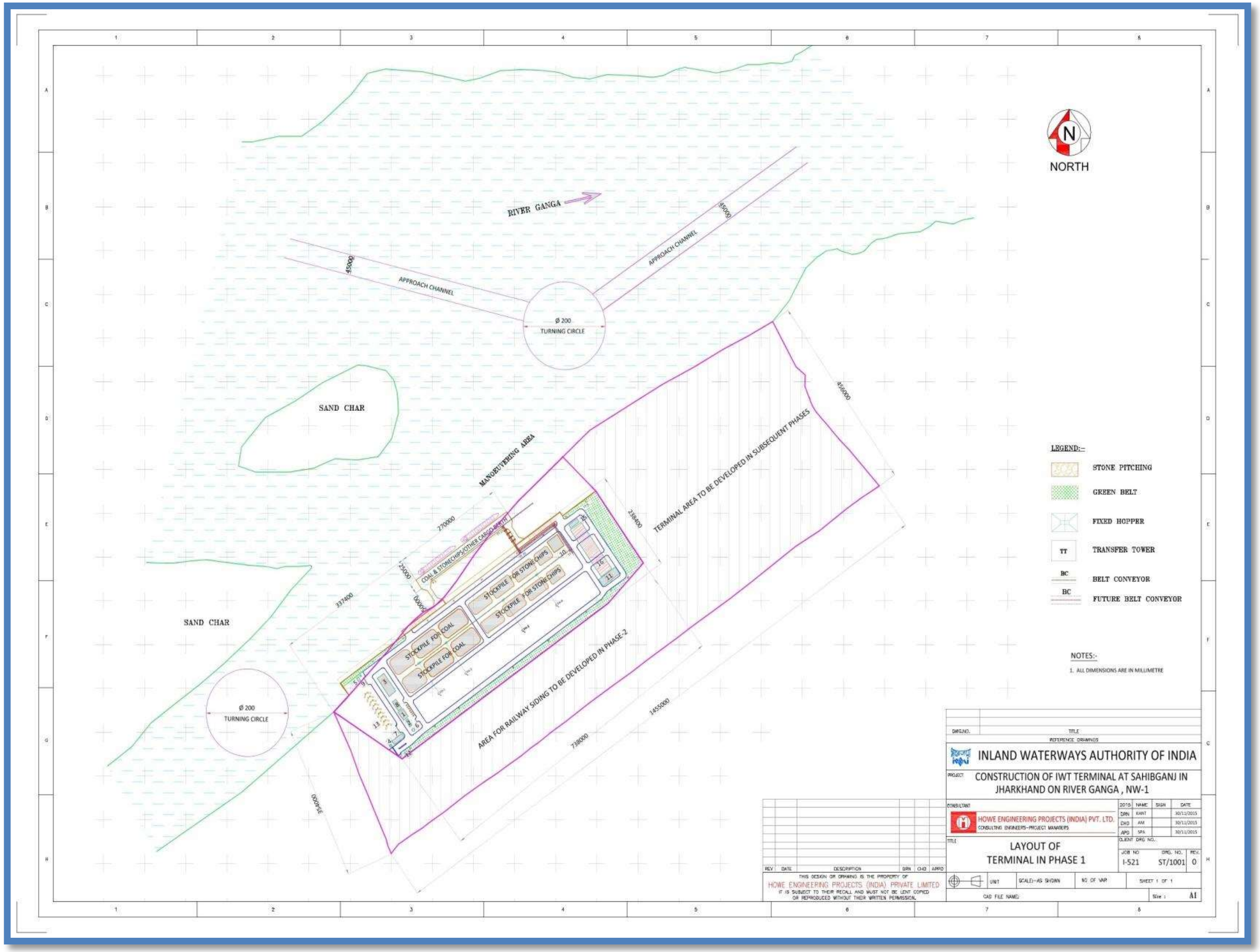
Table 3.29 Salient Features of the Sahibganj Terminal

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	Coal, stone chips, food grains, cement, fertilizers &sugar

	to be handled	
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 & Berth (1 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.	Off-shore facilities in Phase II & III (Master Phase)	Phase II-3 nos. of berths (1 each for coal-270 m, stone chips-270 m&other cargo-160 m) Phase III-3 nos. od berths (1 each for coal-400 m, stone chips-400 m &other cargo-160 m)
11.	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.
12.	LAD	1-2.5 m near shoreline 7-11 m at distance of 50 m
13.	Water level fluctuation of River near Terminal Site	10 m
14.	HFL of Site	30.91 m amsl
15.	Finished Level of Site	37 m amsl
16.	Top level of Berth & Jetty	33.5 m
17.	Earthwork Phase	Cut: 14.25 lakhs cum

	I	Fill: 2.15 lakhs cum Muck for disposal: 12.1 lakhs cum
18.	Dredging During Construction Phase	1.5 lakhs cum
19.	Material Transportation System	In Phase-1 of terminal, it is proposed to provide hopper at the coal and stone chips stockyard and the cargo should be carried through conveyor system to the berth where it should be discharged to the vessels through barge loader
20.	Maintenance Dredging during operation phase	0.1 M cum in lean season
21.	River Water Requirement for dust suppression and horticulture	Phase 1: 162 KLD Phase II: 210 KLD Phase III: 350 KLD
22.	Municipal supply water for domestic purpose (staff & vessels)	Phase 1: 46.5 KLD Phase II: 65 KLD Phase III: 90 KLD
23.	Power Requirement	Phase 1: 588 KW Phase II: 2535 KW Phase III: 1897 KW
24.	Storm Water System	Storm water drain of length 3.05 km Stock yard, parking area & roads –dump pond Buildings- Rain water storage sump
25.	Sewage Generation & STP	Phase 1: 30 KLD Phase II: 36 KLD Phase III: 40 KLD STP: 40 KLD capacity
26.	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.
27.	Vehicle Parking Area	App. 1 ha
28.	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 should 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
29.	Equipment	• Mobile Harbour Crane, • Barge Loader, Front End Loader, • Conveyor System with Fixed Hopper, • Navigation Aids, • Dust Suppression System Road over Bridge, • Fire Fighting System, • Communication and IT System,

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

c. 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**

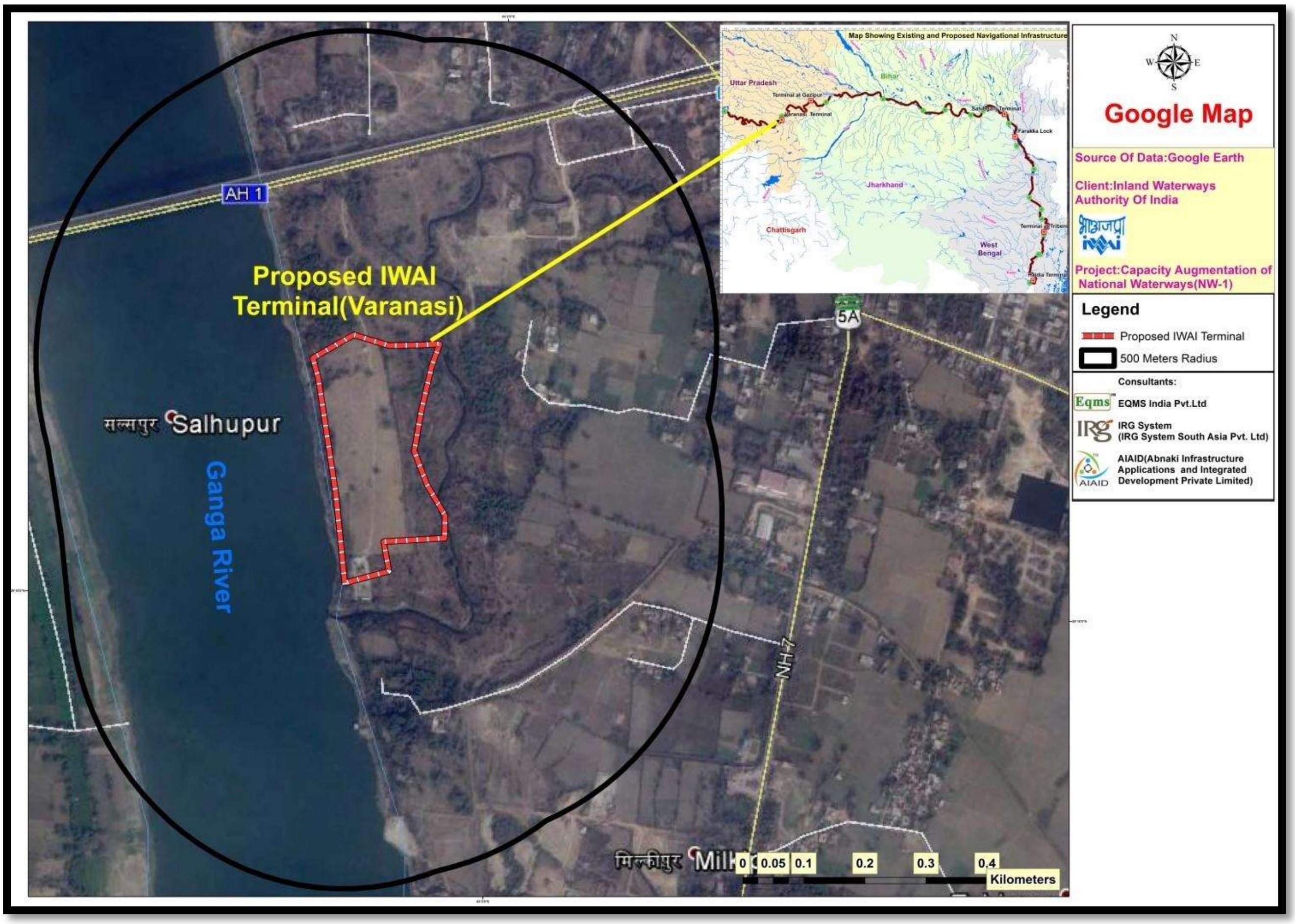


Figure 3.22 : Location of Varanasi Terminal Site

Area of 5.586 ha has been acquired for development of the terminal by IWAI and is in possession fo 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.** In addition to this land, area of 1.415 is to be acquired for construction of access rod to connect terminal with NH-7. Total land requirement will be thus 7.001 ha.

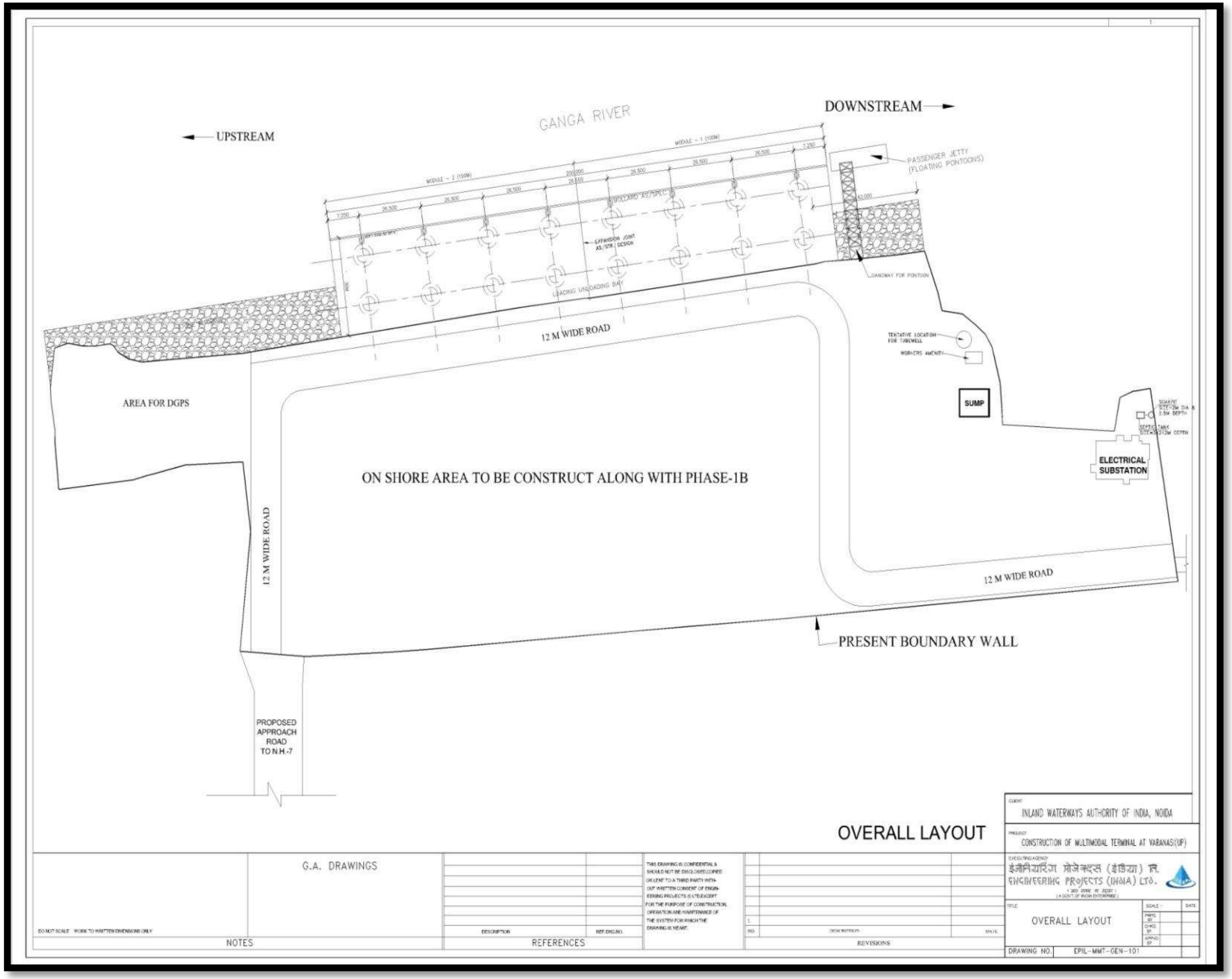
Figure 3.23 : Photographs of Varanasi Terminal Site

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 3.30** and layout plan of the terminal site at Varanasi for phase I is given in **Figure 3.24**below.

Table 3.30 : 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 • Storm water drainage system • Earthing & lighting protection system for all conducting materials • Lighting system • Green area
8.	**Cargo to be handled**	Coal (imported & domestic), cement, fertilizers, wheat & crude edible oil
9.	**Plying vessel**	**Multimodal jetty** | **DWT** | **LOA (m)** | **Beam (m)** | **Loaded Draft (m)**

<table>
<tr><th>S. No.</th><th>Salient Feature</th><th>Capacity/Quantity/Nos.</th></tr>
<tr><td></td><td></td><td><table><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>Maintenance Dredging</td><td>0.1 M cum</td></tr>
<tr><td>12.</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>13.</td><td>Water Supply System</td><td>Municipal Corporation, Varanasi</td></tr>
<tr><td>14.</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

d. 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**

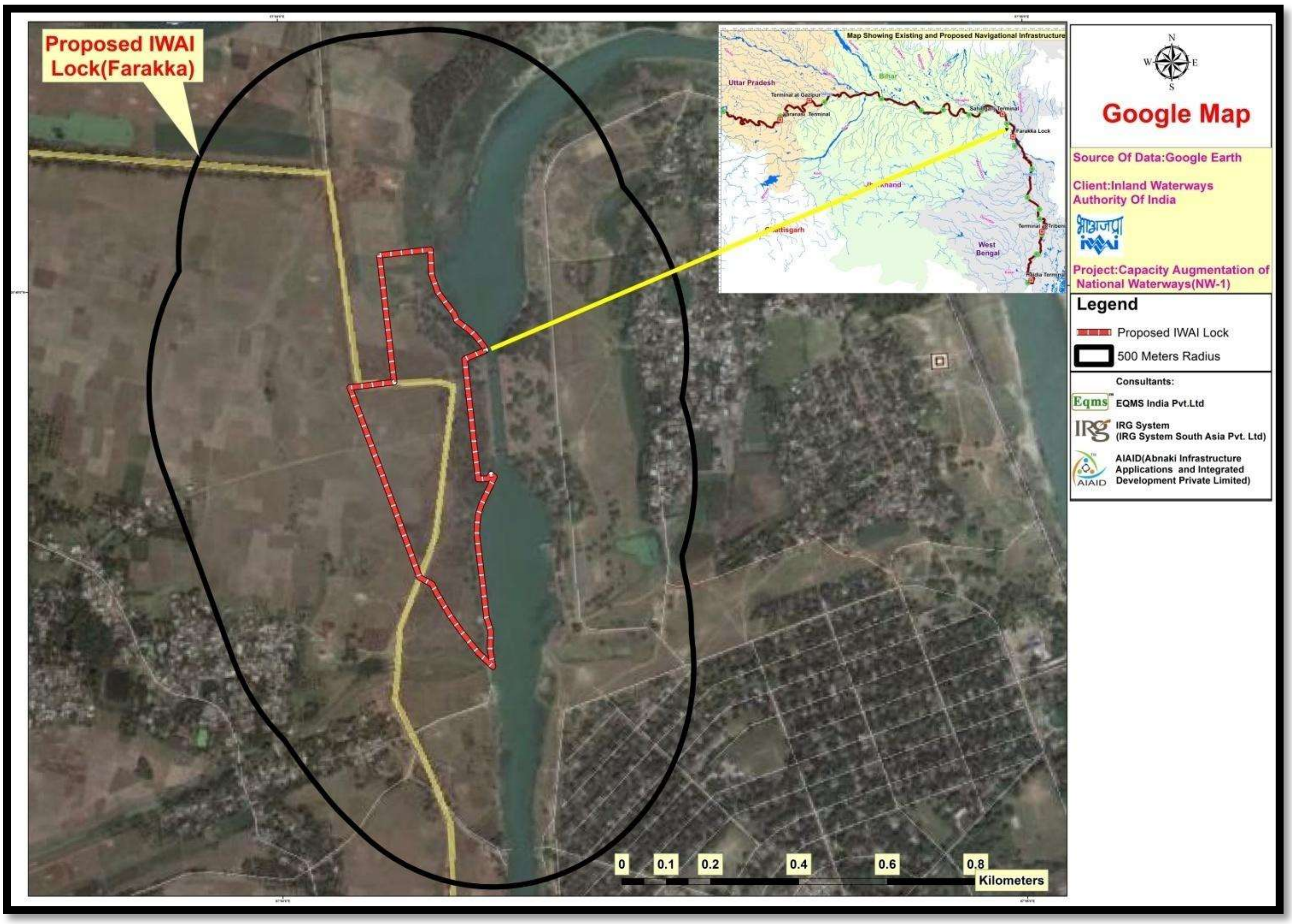


Figure 3.25 : Location Map of Farakka Lock

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 3.31** and layout plan of the lock site at Farakka for phase I is given in **Figure 3.27.**

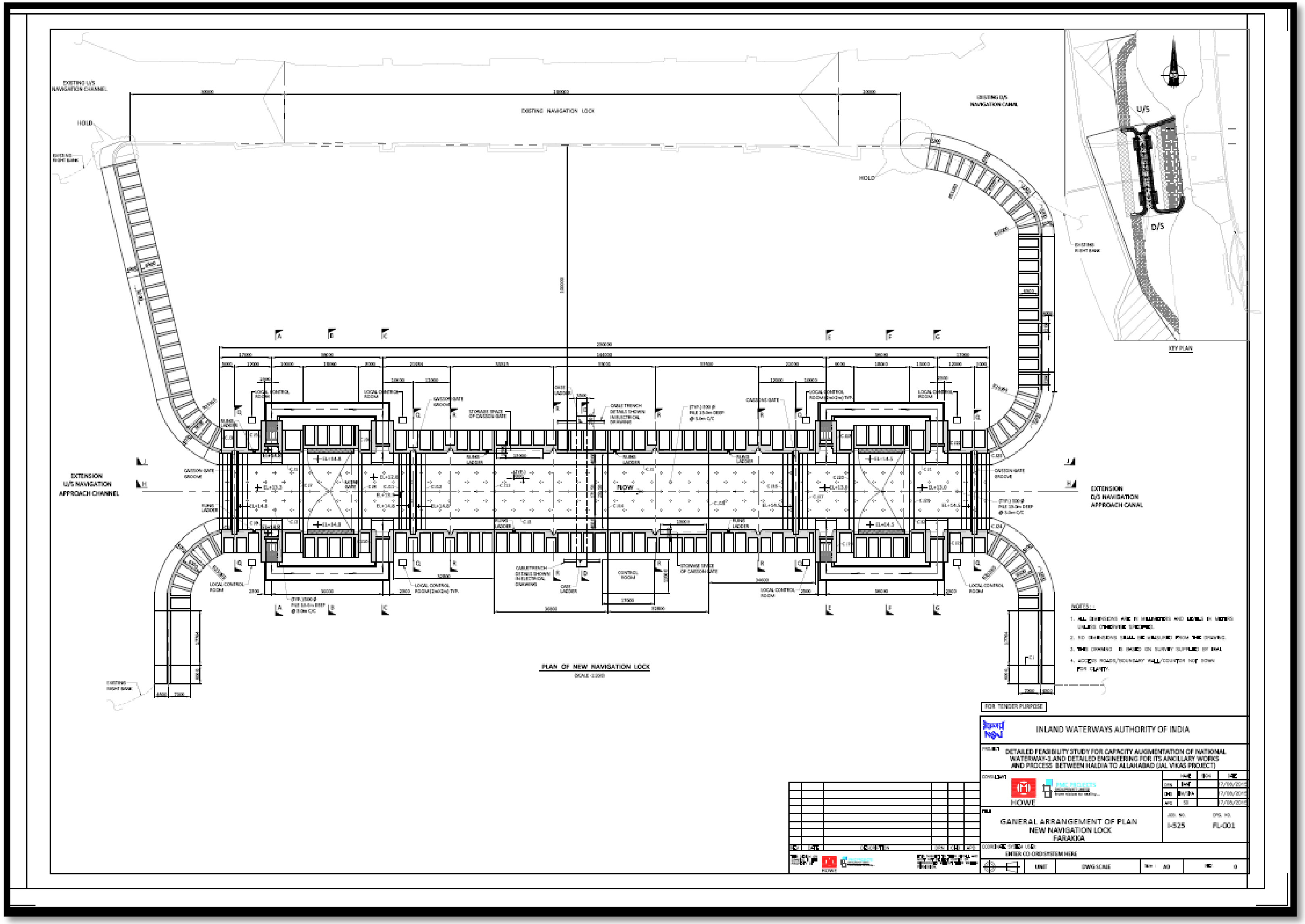
Table 3.31 : Salient Features of New Lock

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

S. No.	Parameters	Value
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) • Bollards - 8 nos. floating type (4 nos. each bank), • 14 nos. fixed type (7 nos. on each bank) Caisson Gates/Stop logs - 2 Nos. (Used for U/S or D/S) • Bulkhead Gates – 8 nos. (4 nos. for U/S and D/S) • Control Room for remote control operation
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

S. No.	Parameters	Value
	Green Area	10000 m^2 (1000 m X 10 m). 900 trees to be planted
27	Total time per operation	38 minutes for average water vessel. If movement of a vessel is followed by movement of another vessel in the reverse direction, the operating time is 23 minutes.

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

e. 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 of total 48.168 kms in the areas where erosion is observed and where civil interventions are planned to be carried out and details of the same are given at **Table 3.32**. Bank protection additionally also be carried out at other interventions yet to be finalised.

Table 3.32 : 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	9.438
6.	Farakka to Tribeni	27.43
7.	Barge Repair and maintenance facility	2
8.	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.

f. Terminal at Ghazipur (Nawapura)

It is planned to develop terminal at Ghazipur, U.P. Planning is at initial stage for this terminal. Site finalization has been carried out. Two sites were identified and considered for development of project. Out of the two sites, preferable site is located at Village Chaukiya, Ghazipur near Nawapura. 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 3.28.**

Figure 3.28 : Google Map Showing Proposed Terminal Site at Ghazipur at Nawapura

g. Terminal at Kalughat

A terminal site is planned to be constructed at Kalughat. Two options were considered for construction of terminal, i.e. at Kalughat and Doraiganj. By seeing the environmental, social and technical feasibility, Kalughat is considered to be suitable site for development of terminal

Kalughat site is located in Parmanandpur village of Sonepur block in Saran District, Bihar. River width in the area is app. 60-100 m with water depth availability of 3.3 m in lean season.

NH-19 connecting Patna in Bihar and Ghazipur in Uttar Pradesh is adjoining the terminal. It is a 2 lane bituminous road of 7 m width. The nearest railway station is at Paramanandpur, which is about 1.5 km from the terminal. Since the terminal is proposed to handle only container cargo meant for Nepal, rail connectivity may not be required. Google map showing the site considered for development of terminal at Ghazipur is given in **Figure 3.29.**

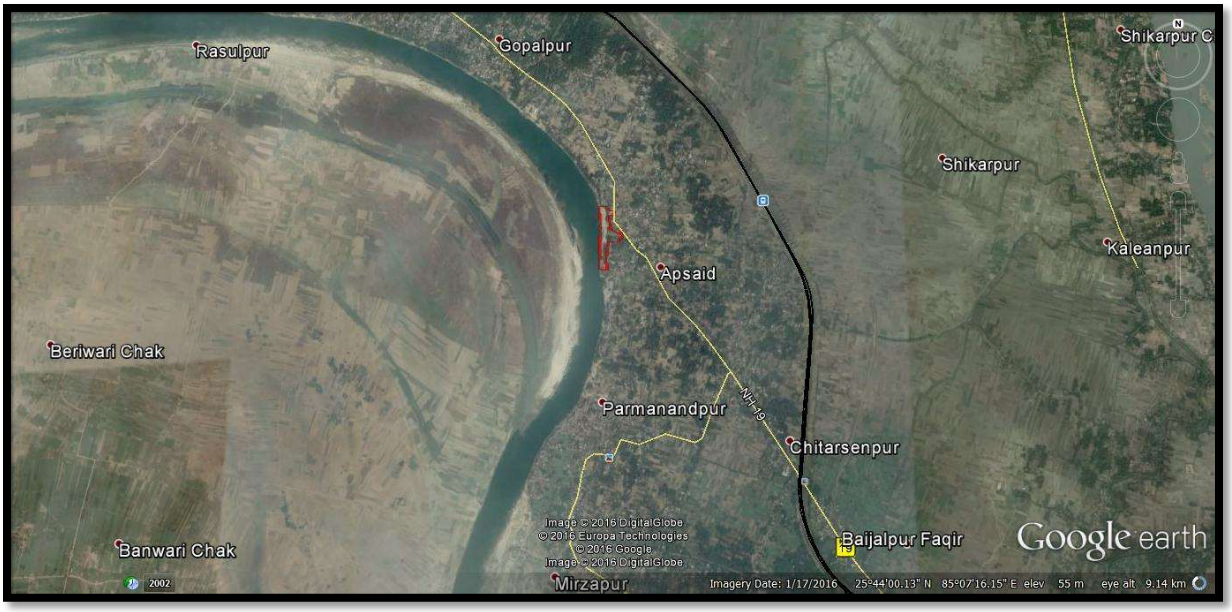


Figure 3.29 : Google Map Showing Proposed Terminal Site at Kalughat

h. 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 3.30.**

Figure 3.30 : Google Map Showing Proposed Terminal Site at Tribeni

i. 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 main 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.

j. Details pf Planned /Proposed Infrastructure : Waste Management at Maintenance & Repair Facility

Since at this facility, vessel repair, maintenance and waste management will be carried out, proper waste management facility is required for these facilities. These facilities should be designed on Zero discharge basis and should have Effluent treatment plant so as the oil water, vessel washing water, floor washing water can be treated here. Further STP are required at these sites to treat sewage generated at facility and sewage generated from vessels. These facilities should have a proper waste management plan which should detail about segregation of different type of waste which may generate at this site or can be received from the vessels, e.g. municipal waste, recyclable waste, bio-medical waste, packaging waste, sweeping waste, plastic waste etc. For each type of waste, a specific waste management plan should be prepared. Waste treatment facility to the extent possible should be proposed within the maintenance and repair facility. For the waste which cannot be treated in-house, should be sent for treatment and disposal to authorized vendors only. List of those authorized vendors for each type of waste should be available in the plan.

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 3.33** below.

Table 3.33 : 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 should be undertaken at the proposed intervention sites. Site will be identified for development of workshops/maintenance hubs. Adequate waste management system should 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 should 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 3.34** below.

Table 3.34 : 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 3.35** below. Cost considered for the terminals include land cost, development and cost of R & R (as applicable)

Table 3.35 : 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 inmid-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 3.36** below.

Table 3.36 : 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. ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1. 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 on the physical, biological and social environment. 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[28] under NW-1 and for all three broad aspects of environment namely physical, biological and socio-economic aspects.

4.2. Valued Environmental Components

Valued or critical environmental components[29] (VECs) are defined as fundamental elements of the physical, biological or socio-economic environment, including physical features, habitats, wildlife populations (e.g., biodiversity), ecosystem services, natural processes (e.g., water and nutrient cycles, microclimate), social conditions (e.g., health, economics), or cultural aspects (e.g., traditional spiritual ceremonies) air, water, soil, terrain, vegetation, wildlife, fish, birds and land use that may be affected by a proposed project. VECs are environmental and social attributes that are considered to be important in assessing risks..

Critical Environmental Resource (CER) and Valued Environmental Components (VEC) are technically same referring to various key environmental resource or component like natural habitat. Critical Environment Resource word is used for Basin Level study as per terms of reference of these studies. However, for EIA studies VEC word is used.

Key VECsidentified for this project requiring greater attention in reference to CIA study are climate, micro climate, aquatic ecology, impact on sensitive species namely Dolphins and Turtles, Water quality, Terrestrial flora (cutting of trees at intervention sites), Avifauna, ambient noise levels and air quality pollution from barge movement, dredging and terminal operations, land use, soil quality & ground water due to dredge (dredging)

[28] 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.

[29] As per TOR of theCritical Environmental Resources (CER) was used for preparation of basin level study. The CER and VEC is same otherwise.

and muck disposal(development of terminal sites), water resources and socio-economy aspects.

4.3. Environmental Profile of NW-1

By the virtue of nature of the activities involved in the development of the project, it is evident that the project will have interface with various identified VECs at different stage of development, implementation and operation. A brief environmental profile of the NW-1 is presented in the **Table 4.1** below, indicating the environmental sensitivities associated with the alignment and the influence area considered for the EIA purpose.

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 Reserves, Tiger reserve etc.	None	None	None
B	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
C	Reserved /Protected Forests	None	None	Yes
D	Wetland of state and national interest	None	None	Yes (Udhwa Bird sanctuary)
E	Migratory route for wild terrestrial animals	None	None	None
F	Presence of Schedule-I Terrestrial Fauna/AviFauna	None	Yes Migratory birds near Farakka Barrage and surrounding	Yes Migratory birds at important birds' areas
G	Presence of Schedule-I Aquatic Fauna	Yes Dolphin, and Turtle (more frequently sighted) Smooth Coated Otter and Crocodile (very	None	None

		rarely sited in Ganges system)		
H	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
I	Seismicity	NW-1 falls in Zone-III (moderate risk) and zone IV (high damage risk zone) as per Seismic Zone Map of India		
B.	**Social Environment**			
J	Physical Setting	Rural, Industrial and Urban		
K	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.		
L	Physical Sensitive Receptors	Yes Ghats at Varanasi, Patna, Temples, Schools, College and Hospital. Details are provided at section 4.7		
M	Archaeological Monuments within 300 m of the river bank (NW-1)	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.		

4.4. Influence Area Considered for Environment Impact Assessment

Influence zone for study of impact assessment considered are 500 m, 2 kms and 10 kms as per outcome and recommendation of CIA. The basis of this classification is also presented at **Table4.2** below.

Table 4.2 Criteria for Demarcation of Influence Zone

S. No.	Impacts on VECs	VECs's Area of Influence	Concluded Influence area
1.	Cultural activities, fest and festivals	Largely located adjacent to river and within **200-500 m** of the river, e.g. holy dips, holy poojas, idol immersions, fares, cremations and cremation grounds, bathing ghats etc. Some of the examples along NW-1 are chatt Pooja, Ganga Mahotsav, Magh mela, kumbh etc.	500 m
2.	Sensitive area for archaeological monuments as per Indian Regulations	**300 m** radius of the notified archaeological sites. Many archaeological sites are present along the river stretch including Ramnagar fort, Jama Masjid, Singhi Dalan, Hazardwari Palace etc.	500 m
3.	Existence of major cities (major impact on river water resources & quality)	Major cities like Varanasi, Allahabad, Haldia town, Patna are developed on the bank of river. Lateral stretch of the city from river is largely within 0 to 7 **km** distance from NW-1	10 km
4.	Air pollution dispersion due to barges and dredgers	Max. air draught of the barges is 9 m for planned NW-1 thus height of discharge source (funnel) is considered as 9 m. Generally, GLC is achieved at distance 15 times the height of the source, i.e. 15 X 9 = 135 m. Also it is considered that GLC will dilute significantly within distance twice the distance at which GLC is achieved, i.e. 270 m.	500 m
5.	Increased ambient noise levels due to dredging	Dredging operations can generate noise levels of 90 dB(A), thereby increasing the ambient noise levels. Through noise modelling study it is estimated that this noise reduces to 56 dB(A) which is in accordance to current noise level in the area at distance of **500 m** from source.	500 m
6.	Important Bird Areas	Bird habitats along NW-1 within stretch between Allahabad to Haldia lies within 2 km of the main channel. Total 6 IBAs are identified out of which 5 are on bank of NW-1 and Danapur Cantonment area is at 2 km from the main channel.	2 km
7.	National Parks, Wildlife Sanctuaries,	Indian guidelines define that 10 km radius area around the national parks/sanctuary is to be considered as maximum buffer zone which though	10 km

	Wetlands	vary depending on nature and location of Sanctuary. VGDS and Kashi Turtle Sanctuary is located within NW-1. Udhwa bird Sanctuary is located at 9 Km from the NW-1. Considering presence of these sanctuaries and Indianguidelines10 Km radius is considered as influence zone.	
8.	Flood Plains	Flood plains of the Ganga River extends to kms and varies with the stretch. The length of flood plain varies from no flood plain on one side of bank to few kms. As per study carried out by IIT Consortium "Active floodplain mapping: Defining the "River space"", it is mentioned that flood plains of river vary in different stretch. From Kanpur to Buxar, it varies from 1 km to 7.5 km but downstream of Buxar to Farakka, flood plain widens upto 42 km. Thus consideration to flood plains cannot be undertaken directly. However, as per NMCG and book "Large Rivers: Geomorphology and Management", width of River Ganga and its active flood plains varies in range of0.5-3 kms. Active flood plain is as an area on either side of a stream/river which is regularly flooded on a periodic basis which is designated on the basis of hydrogeological criteria set for this reach, i.e. 2.33 year return period of the flood.	3 kms
9.	General Practise in India for carrying out EIA studies	As per the EIA guidance/technical manual prepared by MoEF&CC for various sectors, the EIA study area is desired as 10km radius around the project site.	10 km

4.5. Impact Identification

Impacts are highly specific and depends on the nature of the activities to be undertaken at different stages viz. design/pre-construction, construction & operation phase.

The three major activities involved in the project development which may have impacts on environment at different stages are construction and operation of civil interventions, maintenance dredging and operation of barges. These activities may impact different environmental components at different stages of project life cycle. But this is always possible that all these three activities may not impact the same VECs, one activity may have more impact on one identified VECS and none on another. Thus to identify the VECs which will be impacted by each of these three activity, an interaction matrix has been developed and is presented in **Table 4.3.**

Table 4.3 Interaction Matrix of Major Project Activities and VECs

Project Activity / VECs	Maintenance Dredging	Barge Operations	Civil Interventions	
			Pre-Construction/ Construction	**Operations**
Climate	No	Yes	No	No
Micro-climate	Yes	Yes	Yes	Yes
Aquatic Ecology	Yes	Yes	Yes	Yes
Dolphins & Turtles	No * Not to be carried out in sanctuary areas	Yes	No	No
Water Flow	Yes	Yes	No	Yes
Water Quality	Yes	Yes	Yes	Yes
Terrestrial Flora/Cutting of Trees	No	No	Yes	Yes
Avifauna	Yes	No	Yes	Yes
Ambient Noise Levels	Yes	No	Yes	No
Air Quality	Yes	Yes	Yes	Yes
Land use	No	No	Yes	No
Water resources	No	No	Yes	Yes
Socio-economy	Yes	Yes	Yes	Yes

From the above matrix, it can be seen which activity is anticipated to affect which VECS. It is apparent that barge movement and maintenance dredging are operational part of the project but civil interventions involve all design, construction & operation stages. Thus all the associated activities with different stages of development of civil interventions are identified and a matrix is developed phase wise to identify the impact of all the identified activities (activities in different stages of development of civil interventions, barge movement and maintenance dredging operations).

The section below identifies the impacts which these three activities will have on the identified VECs. Identified incremental impacts due to NW1 activities are superimposed to assess the significance of identified impacts on these critical environmental resources. Thereafter, cost-effective but appropriate mitigation measures are proposed to mitigate impacts and bring the residual impacts within acceptable thresholds. An EMP has been designed to ensure the effective implementation of proposed mitigation measures (refer chapter 6).

4.6. 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 CIA study and EIAs prepared for finalised components are used as reference input for carrying out impact assessment of all components. Impact assessment has been carried out for all design, construction and operation stages of the project implementation. Impacts have been assessed for all the project activities in entire project life cycle for all the physical, biological and social environmental components. Brief on the various components of the NW-1 on which EIA study has been undertaken is presented below

4.6.1. *Maintenance Dredging for Maintaining Minimum LAD*

NW-1 aims to maintain navigation channel width of 45m and side slope of 1:5 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 Tribeni : 3 m (naturally available LAD)
- Tribeni to Farakka : 3 m (including Farakka Lock)
- Farakka to Barh : 3 m
- Barh to Ghazipur : 2.5 m
- Ghazipur to Varanasi : 2.2 m

The above LAD rationalisation and selection of appropriate site will reduce dredging requirement from 31.08 million cubic meter at 3m LAD to 14.85 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%.

Table 4.4 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. Detailed assessment of impacts of maintenance dredging has been carried out and is given in the sections below. Impact identification matrix for maintenance dredging is given below in **Table 4.5.**

Table 4.4 Environmental Sensitivity Vs. ImpactIdentification Matrix for Maintenance Dredging

Stretch (Stretch length in KM)	**Likley 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 Tribeni Tribeni to Farakka (544 km)	2,400,000 1,220,000	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.
Farakka to Kahalgaon Kahalgaon to Barh (347 km)	1,570,000 2,390,000	Vikramshila Gangetic Dolphin Sanctuary (VGDS) of River Ganga (Within NW-1 bout 60 Km long stretch)	Udhwa Lake Bird Sanctuary (9 km, W) Bird Area - Vikramshila Gangetic Dolphin Sanctuary (within river stretch)	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 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

Stretch (Stretch length in KM)	Likley 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
			Mokama Taal -Barah Wetlands (Along NW-1) Kurseala River Course and Diyara Flood Plains (along river)			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

Stretch **(Stretch length in KM)**	**Likley 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**
						and water quality.
Barh to Patna (64 km)	1,600,000	None	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 km)	2,770,000	None	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.

Stretch **(Stretch length in KM)**	**Likley 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**
						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 Ghazipur Ghazipur to Varanasi (187)	1,060,000 1,840,000	None	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

Stretch **(Stretch length in KM)**	**Likley 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**
						sensitivity analysis reported by Canadian guidelines30. Its disposal in river is likely to have some impact on aquatic ecology and water quality.
Varanasi to Allahabad (236 km)	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.

[30] 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.

Stretch (Stretch length in KM)	**Likley 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**
Total Dredge Quantity for Maintaining LAD in Channel (1547 km)	14,850,000 (option 2)	--	--	--	--	-
Total Dredge Quantity (if LAD is maintained 3 M through the stretch)	3,10,79,576 (option1)	-	-	-	-	-

Table 4.5 Projection of Likely Significance of Environmental Impacts Due to Maintenance 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 and overfilling of dredger	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		√	L	Yes		√	√			√		√

Activity	Potential Impacts	Direction		Significance	Mitigative	Duration		Location		Magnitude		Extent	
		+ve	-ve			LT	ST	Direct	Indirect	Large	Small	Wide	Local
	movement												
Operation of dredgers	Increased ambient noise level		√	L	Yes		√	√			√		√
Leakage of sediments during transportation	Increased turbidity over sensitive inshore habitats		√	M	Yes		√		√		√		√

4.6.2. *Operational Activity-Barge Movement & Maintenance*

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 and are discussed in sections below. Impact identification matrix for barge movement and maintenance on is presented in **Table 4.6** below.

Table 4.6 Identification of Environmental Impacts Due to Barge Movement & Maintenance

Activity	Potential Impacts	Direction		Significance	Mitigative	Duration		Location		Magnitude		Extent	
		+ve	-ve			LT	ST	Direct	Indirect	Large	Small	Wide	Local
Barge Movement	Air emission	√		M	Yes	√		√	√		√	√	
	Underwater Noise generation and impact on aquatic organisms		√	M	Yes	√		√		√			√
	Disposal of waste/sewage		√	M	Yes	√		√		√			√
	Water Quality degradation		√	M	Yes	√			√	√			√
	Collision with aquatic organism		√	L	Yes	√		√			√		√
	Bank erosion/scouring		√	L	Yes	√		√			√		√

Activity	Potential Impacts	Direction		Significance	Mitigative	Duration		Location		Magnitude		Extent	
		+ve	-ve			LT	ST	Direct	Indirect	Large	Small	Wide	Local
	Impact on socio-cultural practises/ rituals		√	L	Yes	√		√			√		√
	Oil spillages/ leakage		√	L	Yes	√		√			√		√
	Improved Freight Transportation System	√		M	Yes	√		√		√		√	
	Reduction in GHG emission	√		M	Yes	√		√		√		√	

4.6.3. *Design, Construction, Operation and Maintenance of the Civil Interventions*

Civil interventions proposed under the project includes terminals, locks, Ro-Ro jetties, passenger jetties, river training works, bed & scour protection works, bend correction works, and barge maintenance facility. 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 may have associated impacts which may affect the environment potentially if not addressed and mitigation measures are not taken. Most of the impact are common in nature for all the 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 to conduct the environment impact assessment study of the entire project. This

EIA study defines the overall impact of the all civil interventions but it is suggested to conduct separate EIA study for the any new civil interventions yet to be planned to study site specific impacts. Impacts during different phases of interventions' construction and operation on physical, biological and socio-economic environment are presented in the sections below for all the environmental attributes. Impact identification matrix for civil interventions is presented below in **Table 4.7** below.

Table 4.7 Identification of Environmental Impacts Due to Design, Construction and Operation of Civil Interventions

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	√		√				--	The air pollution and GHG

		microclimatic status caused due to tree cutting								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 Topography	√	√					Filling of site is required at Haldia,	Natural drainage pattern to be maintained by provision of adequate drainage
ii	Acquisition of Land	Displacement 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	Should 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 should be preserved and used for land escaping and green belt development at site or other locations	The top soil should be preserved and used for landscaping purpose and should 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 should be reutilized to the extent possible in the construction activity and balance will be used for road	Clean-up operations should be taken up immediately after spillage. Debris and excavated earth should be disposed as per defined plan.

									construction or disposed for designated places like mines in case of Sahibganj.	
		Surface water contamina tion	√		√				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 to be taken to minimize noise levels by DG sets & other machinery/equipment

									Measures are proposed for noise reduction.	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 should 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	Berthing of Vessels/ Barges, loading and unloading activity,	Climate (GHG emissions) &Microclimate		√		√		√	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	Overall GHG emissions will be reduced due to shift of freight from road/rail to waterways and thus improving the microclimatic conditions as

	storage of material, transportation of material via road &railway, and Maintenance Dredging Operations at terminals								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)	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 should be made for rain water and collection and reuse. Provision should 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	Provision should be made for thick green plantations at terminal sites as

									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	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	Ground water may get polluted if the dredged material is disposed or stored on land

									proposed. Extraction should be as per CGWB guidelines. Ground water recharge should be done as per CGWB guidelines.	
		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 should 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 should 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.	--

4.7. Impact on Climate Change& Mitigation Measures

4.7.1. *Meteorology of the NW-1 and the influence area*

A. 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 was mostly ranges between 1.9 km/hour at Patna IMD and maximum of 8.7 km/hour at Kolkatta 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 Kolkatta. 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 Kolkatta.

B. Visibility:

Visibility is of key concern for safe navigation all along NW1. There are occasions with reduced visibility (characterised by the average number of days affected by fog) in NW-1 stretch. 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. During such conditions, the performance of vessel-mounted navigation aids, such as radar, may also be affected.

4.7.2. *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 g CO_2/ton-km to 70 g 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 g 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).

4.7.3. *Impact of Shift of Freight Movement to IWT Mode 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. However, it is already established that when we talk about bulk cargo transportation, IWT consumes the minimal fuel thus have associated minimal emissions and minimal transportation cost

A detailed analysis of GHG emission to be emitted during cargo transportation in "with and without project" scenario for all the three modes has been carried out to find out the net GHG savings due to the project implementation in CIA report. It is estimated that in IWT mode emissions will be generated during construction of the proposed infrastructure due to material transportation, due to material transportation by IWT mode (barges) & trucks within terminals during operation phase and due to dredging during operation phase. These emissions were computed and were compared with emissions to be generated vide road and rail mode. Comparison of emission generation due to freight transportation vide rail, road & IWT mode and the savings of GHG emission for "With project" scenario is given in **Table 4.8.** Emissions expected to be generated due to material transportation during construction of the planned navigation infrastructure is given in **Table 4.9.**

On comparison it was found that emissions generation in IWT mode is least and savings in emission is 4875601.76 tonnes. From these savings emissions to be generated during construction of the proposed infrastructure due to material transportation, due to material transportation by trucks within terminals during operation phase and due to dredging during operation phase were deducted and the net GHG savings are computed. Net GHG emissions is estimated to be 4544037.4 tonnes. Net GHG savings due to project, i.e. in "With project" scenario is given in **Table 4.10.**

Table 4.8 : GHG Emissions Generation Due to Material transportation Vide Rail, Road & Barges During With project & Without project Scenario and GHG Savings Estimations

Year	GHG Emissions Without Project (tonnes)			GHG Emissions With Project (tonnes)			GHG Savings (tonnes) (Without Project-With Project)			
	Road	Rail	IWT	Road	Rail	IWT	Road	Rail	IWT	Total
2015	710,611	25,593	91,434	710,611	25,593	91,434	0.00	0.00	0.00	0.00
2016	760,353	26,105	91,434	813,578	26,627	91,434	-53224.73	-522.09	0.00	-53746.82
2017	813,578	26,627	91,434	870,528	27,159	91,434	-56950.46	-532.53	0.00	-57483.00
2018	870,528	27,159	91,434	931,465	27,702	91,434	-60936.99	-543.18	0.00	-61480.18
2019	931,465	27,702	91,434	996,668	28,256	91,434	-65202.58	-554.05	0.00	-65756.63
2020	996,668	28,256	91,434	889,526	25,939	95,092	107141.82	2317.03	-3657.38	105801.47
2021	1,046,501	28,822	95,092	934,003	26,458	98,896	112498.91	2363.37	-3803.67	111058.61
2022	1,098,827	29,398	97,945	980,703	26,987	103,821	118123.85	2410.64	-5876.68	114657.82
2023	1,153,768	29,986	100,883	1,029,738	27,527	107,945	124030.05	2458.85	-7061.81	119427.09
2024	1,211,456	30,586	103,909	1,081,225	29,729	112,222	130231.55	856.40	-8312.75	122775.20
2025	1,272,029	33,033	107,027	1,113,661	31,513	115,589	158367.62	1519.50	-8562.14	151324.98
2026	1,310,190	35,015	109,167	1,147,071	33,404	117,901	163118.65	1610.67	-8733.38	155995.94
2027	1,349,496	37,115	111,351	1,181,483	35,408	120,259	168012.21	1707.31	-8908.05	160811.47
2028	1,389,981	39,342	113,578	1,216,928	37,533	122,664	173052.58	1809.75	-9086.21	165776.12
2029	1,431,680	41,703	115,849	1,253,436	39,785	125,117	178244.15	1918.33	-9267.93	170894.55
2030	1,474,630	44,205	118,166	1,291,039	42,172	127,619	183591.48	2033.43	-9453.29	176171.62
2031	1,518,869	46,857	120,529	1,329,770	44,702	130,172	189099.22	2155.44	-9642.36	181612.30
2032	1,564,435	49,669	122,940	1,369,663	47,384	132,775	194772.20	2284.76	-9835.20	187221.76
2033	1,611,368	52,649	125,399	1,410,753	50,227	135,431	200615.37	2421.85	-10031.91	193005.31
2034	1,659,709	55,808	127,907	1,453,076	53,241	138,139	206633.83	2567.16	-10232.55	198968.44
2035	1,709,501	59,156	130,465	1,496,668	56,435	140,902	212832.84	2721.19	-10437.20	205116.83
2036	1,760,786	62,706	133,074	1,526,601	58,693	143,720	234184.51	4013.16	-10645.94	227551.73
2037	1,796,001	65,214	134,405	1,557,133	61,040	145,157	238868.20	4173.69	-10752.40	232289.49
2038	1,831,922	67,822	135,749	1,588,276	63,482	135,749	243645.56	4340.64	0.00	247986.20
2039	1,868,560	70,535	137,107	1,620,041	66,021	137,107	248518.47	4514.26	0.00	253032.73
2040	1,905,931	73,357	138,478	1,652,442	68,662	138,478	253488.84	4694.83	0.00	258183.67
2041	1,944,050	76,291	139,862	1,685,491	71,408	139,862	258558.62	4882.63	0.00	263441.24
2042	1,982,931	79,343	141,261	1,719,201	74,265	141,261	263729.79	5077.93	0.00	268807.72
2043	2,022,589	82,516	142,674	1,753,585	77,235	142,674	269004.39	5281.05	0.00	274285.43
2044	2,063,041	85,817	144,100	1,788,657	80,325	144,100	274384.47	5492.29	0.00	279876.76
2045	2,104,302	89,250	145,541	1,824,430	81,128	145,541	279872.16	8121.73	0.00	287993.89
Total GHG Savings (Tonnes)										**4875601.76 ~4.9 million tonnes**

Table 4.9 Emissions estimated to be generated due to construction material transportation for 6 terminals and locks

Facility	Emissions (Tonnes)	Year
Varanasi terminal	650	2016
Sahibganj terminal	58	2016
Haldia Terminal	2982	2016
Other three Terminals	3600	2017
Farakka Lock	2132	2017

Table 4.10 Net GHG savings due to Projcet (2016-2045)

S. No.	Year	GHG Savings (Tonnes) (Without project-Withproject) A Tonnes	GHG Emissions Within terminal B Tonnes	GHG Emissions Due to dredging C Tonnes	GHG Emissions Due to Empty barge Movement D Tonnes	GHG Emission in construction of terminals and locks E Tonnes	Net GHG savings A-B-C-D-E Tonnes
1.	2016	-53746.82	641.5	3730.3	6,857.58	3600	-68274.4
2.	2017	-57483.00	641.5	3730.3	6,720.43	5732	-74005.4
3.	2018	-61480.18	641.5	3730.3	6,583.28	0	-72133.5
4.	2019	-65756.63	641.5	3730.3	6,446.13	0	-76272.8
5.	2020	105801.47	667.1	3730.3	6,308.98	0	95408.9
6.	2021	111058.61	693.8	3730.3	6,418.70	0	100542.2
7.	2022	114657.82	728.4	3730.3	6,527.10	0	104014.7
8.	2023	119427.09	757.3	3730.3	6,696.47	0	108599.3
9.	2024	122775.20	787.3	3730.3	6,800.52	0	108227.5
10.	2025	151324.98	810.9	3730.3	6,901.66	0	134531.6
11.	2026	155995.94	827.2	3730.3	6,935.33	0	144892.3
12.	2027	160811.47	843.7	3730.3	6,897.19	0	149737.2
13.	2028	165776.12	860.6	3730.3	6,854.74	0	154735.4
14.	2029	170894.55	877.8	3730.3	6,807.84	0	159891.6
15.	2030	176171.62	895.3	3730.3	6,756.32	0	165210.9
16.	2031	181612.30	913.2	3730.3	6,700.02	0	170698.4
17.	2032	187221.76	931.5	3730.3	6,638.76	0	176359.4
18.	2033	193005.31	950.1	3730.3	6,572.37	0	182199.5
19.	2034	198968.44	969.1	3730.3	6,500.68	0	188224.2
20.	2035	205116.83	988.5	3730.3	6,423.48	0	194439.6
21.	2036	227551.73	1008.3	3730.3	6,340.60	0	216946.9
22.	2037	232289.49	1018.4	3730.3	6,251.83	0	221768.1
23.	2038	247986.20	952.4	3730.3	6,096.61	0	237655.0
24.	2039	253032.73	961.9	3730.3	5,497.84	0	243295.2
25.	2040	258183.67	971.5	3730.3	5,347.16	0	248591.7
26.	2041	263441.24	981.2	3730.3	5,192.91	0	253998.4
27.	2042	268807.72	991.0	3730.3	5,035.05	0	259517.6
28.	2043	274285.43	1001.0	3730.3	4,873.50	0	265151.6
29.	2044	279876.76	1011.0	3730.3	4,708.23	0	270902.9

S. No.	Year	GHG Savings (Tonnes) (Without project-Withproject) A Tonnes	GHG Emissions Within terminal B Tonnes	GHG Emissions Due to dredging C Tonnes	GHG Emissions Due to Empty barge Movement D Tonnes	GHG Emission in construction of terminals and locks E Tonnes	Net GHG savings A-B-C-D-E Tonnes
30.	2045	287993.89	1021.1	3730.3	4,539.16	0	279183.7
	Total	**4875602**	**25986**	**111909**	**187230.5**	**9332**	**4544037.4**

Net GHG savings from Proposed Jal Marg Vikas Project is estimated to be 4544037.4 tonnes. These emissions can be further reduced by design and operational measures.

Measures for Avoidance and Mitigation of Impacts

- 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.

4.7.4. *Impact on Micro Climate of NW1 due to Civil Interventions:*

A. 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.

Measures for Avoidance and Mitigation of Impacts

- 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 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.

- In terms of Carbon value, trees of high Organic Carbon contents[31] need to be planted more for faster recovery of C loss.
- 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.
- All terminal buildings should have energy efficient design. It should follow GRIHA guidelines and aim for highest ratings under GRIHA.
- Minimizing the resource requirement and waste generation through best management practices like re-use, reduce, recycle and recover.

B. 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.

Measures for Avoidance and Mitigation of Impacts

- 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%.

[31] 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

- Adoption of clean energy options like solar energy, designing building to obtain green building rating of Platinum level etc.

4.7.5. *Conclusion (Climate Change)*

From the above discussion, it can be concluded that overall GHG emissions will reduce after operationalization of the NW-1 due to shift of freight from road/rail to NW-1. However, the GHG emissions near the civil interventions may increase due to enhanced traffic movement in nearby areas and within terminal areas. The emission may also increase due to tree cutting which may be required for development of these terminals/locks. Tree cutting reduces the carbon sequestration potential of that area thereby leading to persistence of CO_2 (potential GHG) in atmosphere for longer time. But with the various mitigation measures like compensatory plantation, maintenance of thick green belt around the site boundary & along the road, usage of mechanical conveying system for material transportation inside the terminal can reduce the GHG emissions significantly.

4.8. Impact Due to Natural Disasters & Mitigation Measures

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 should 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.

Measures for Avoidance and Mitigation of Impacts:

- 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.

4.9. Impact Due to Shifting of Existing Utilities& Mitigation Measures

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 For Avoidance of Impacts:

- 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 should 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.

4.10. Impact on Land Environment& Mitigation Measures

4.10.1. *Status of land environment along NW-1 and influence area*

A. Land Use:

Land use within the 10 km Radius 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.

B. 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.

C. Soil Quality:

Most of the NW-1 stretch is dominated by alluvial soil type. The entire alluvial formation is endowed with rich soil nutrients. Soil texture along the NW-1 can be described as Sandy Clay, Sandy Loam and Clay Loam type. Soils along the NW-1 are generally neutral to slightly alkaline nature. 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.

D. River Bed Sediments 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.

E. Existing Waste Management Facilities along NW-1:

The municipal and bio-medical waste management facility is available at select cities like Allahabad, Varanasi, Patna, Kolkatta and Haldia in the entire stretch of NW-1. Common Hazardous waste facility is available only at Haldia in NW-1 area.

4.10.2. *Impacts on Land Environment due to Maintenance Dredging for maintaining minimum LAD in navigation channel*

Impact due to maintenance dredging on land environment is anticipated only due to dredge disposal. On land/on shore disposal is proposed only in case the river bed sediments are contaminated or in case of Haldia terminal dredging. On land or on shore disposal of river bed sediment has the potential to impact soil quality and as the excess water in sediments leaches down to ground can also affect the ground water quality. If sediments contain heavy metals or any toxins, then the soil quality of the area may get affected and these pollutants may travel along with the seeping leachant.

If the dredged material is disposed on land near the water body in form of slurry, excess water drains back to the water body thereby polluting it. This excess water may contain significant sediment load and constituent of land surface which may pollute the water quality and 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.

Measures for Avoidance and Mitigation of Impacts

Mitigation measures are proposed considering for the action required at design and operation stage of the project.

- Standards should be developed by concerned authorities for onshore and off-shore dredged material disposal and development of the process to ensure its compliance
- Dredged material should be checked for toxicity and contamination prior its disposal for prevention of contamination of water and its impacts on aquatic life. International standards for judging onshore & off-shore disposal of dredged material are given in **Annexure 4.1 (Volume 3C).**
- If any stage onland disposal of dredge material is planned, then dewatering of the dredged sediments should be carried out prior to onland disposal.
- If dredge material is found contaminated at any particular location then it should be disposed on land after decontamination. Onland disposal of dredged material should be carried out only at approved TSDF site such as approved TSDF site of Haldia Dock Complex at Sagar. The contaminated dredge material should be collected in the leak proof container for decontamination and disposal to the landfill site.
- The disposal facilities should be designed with adequate liners to contained the leachate and also should have provision of leachate collection and testing to periodically check the functionality of the disposal site.
- Dredge material should not be disposed in river banks;Disposal should be in line with the dredging sensitivity analysis defined at **Table 4.4.**
- 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.

4.10.3. *Impact on Land Environment Due to Operations- Barge Movement*

Barge movement generates the ripples and waves which have potential to affect the river banks and the structures at river banks if proper mitigation measures are not taken. Waves generated due to vessel movement are of varied intensity and depends 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 due to vessel movement is anticipated to be minimal along NW-1 except at Farakka feeder canal which has smaller width and has eroding banks and at bends or at narrow stretches of river. Erosion can be prevented by taking avoidance and mitigation measures as given below.

Waste generated from barges if disposed off at the terminal facilities or nearby areas may impact the soil quality. Thus control measures should be taken to prevent any unaurhorized waste/sewage dumping so as impact can be avoided.

Measures for Avoidance and Mitigation of Impacts

- Restricting the ship speed in the stretches where river is narrow and in feeder canal to prevent impact on the river banks.
- Entire stretch of NW-1 should be studied and speed regulations should be made for the different sections in the NW-1 as per sensitivity to erosion
- 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.
- All barges should have zero discharge facility they should have sewage treatment systemon board along with treated sewage storage facility. It should also have facility to store for the storage of other domestic and maintenance and material handling waste.
- Each barges should dispose these wastes at barge maintenance facilities. In absence of these facilities such waste should be disposed of at terminals. Each terminal should have the facility for suction and treatment of treated sewage from the barges and facility to handle all kind of wastes generated at the barges. These services can be provided to the barge operators on chargeable basis.

4.10.4. *Impacts on Land Environment Due to Physical Interventions*

A. Pre-Construction/Design and Construction Stage

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& Loss of agricultural land and/or fertile agricultural soil
- Land acquisition
- Change in topography
- Soil quality deterioration due to spillage of fuel/paint, disposal of muck or soil contamination with other construction material

i. <u>Impact on Land Use& Land Acquistion</u>

Development of terminals/jetty or other proposed structures under NW-1 can be in general classified under industrial/transportation infrastructure category. Development of these intervention will cause changes from pristine land use class. Varanasi site (5.685 ha) is already under possession of IWAI. However additional land of 1.415 ha is required to be acquired to provide connectivity to terminal site with NH-7 which is agricultural land. For development of Sahibganj terminal, total 78.91 ha of land will be required including road & rail connectivity. For phase I, 23.98 ha of land will be required and remaining 54.93 ha will be required for phase II. Acquistion of 45.20 ha has been initiated by IWAI. Thus change in land use is associated at Varanasi & Sahibganj sites. Land at Farakka is Government land and has been transferred to Ministry of Shipping, with IWAI the custodian. Haldia site currently lie within industrial zone of Haldia Dock Complex (HDC) and no changes in land use is anticipated at this site. Land of 24.68 ha has been leased out by HDC to IWAI for 30 years.

ii. Impact on Topography

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 economic gains of the region.

iii. Impact on Soil Quality

Construction waste (debris, unused iron bars or damaged support structures, quarry dustetc.) if discarded or duped in river in an uncontrolled manner may affect soil of the site or river water quality. Fuel oil/lubricants/chemicalsmay be stored at site thus the occurrence of accidental fuel spillage or leakage cannot be ruled out which eventually can contaminate the adjoining soil strata. Such soil contamination can be severe in case of voluminous leakage. Thus the mitigation measures are required to be taken to prevent the spillages & leakages so as the impacts arising due to oily spillages can be minimized.

Movement of construction vehicles and equipment may lead to soil compaction on haulage roads as well as nearby areas. Soil may also be contaminated due to inappropriate disposal of used oil, lubricating oil, fuel, waste oil, effluent from vehicle/equipment washing area and oily solid waste (fuel filters, oily rags) which are 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 and toilets at site. Such contamination can be prevented by taking appropriate measures for mitigation of impacts. Also these impacts are short term confining to construction period only and will not be of high significance.

Apart from this 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 0.7 million cum river sediments. The river dredge material is not found contaminated (refer Table 4.59 for dredge material quality) and should 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 which can be prevented by implementing dredging management plan which is provided as standalone EMP in Volume 9. The dredged sediments can also be used as fillers (for cut and fill tasks for land levelling) where ever required.

Measures for Avoidance and Mitigation of Impacts

- 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 should be undertaken by controlled sprinkling the water to minimize the surface runoff and erosion.
- Agricultural land should 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 should be stripped off prior to excavation and should 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 should be used for filling purpose and left over should 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 should be identified in advance in consultation with PWD which is likely to construct the approach road.
- Dredge soil should also be either utilised for construction activity or disposed along with excavated soil to the identified debris disposal site
- Fuel should 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 should 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 should be made if required and technically safe to minimise cutting of the tree for rail & railway construction. Separate provision should be made for compensatory tree plantation if any tree cutting is carried out for construction of road & railway link[32].
- Hazardous waste like used oil from DG sets should be stored in HDPE containers and should be stored on paved surfaces in isolated location to prevent its spillage and contamination of soil. Used oil should be disposed through authorized vendors only.
- Movement of construction vehicles should 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 should be provided with storm water drain to arrest the sediments and these sediments should be removed and stored with remaining excavated soil
- Provision of cross drainage structure like culverts should be made in the access road if required to maintain the natural drainage pattern and prevent soil erosion.
- Provision of side drain should 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 should be undertaken
- Bio-turfing of embankments should be made enhance the slop stabilization
- Wash-off from concrete mixing tanks and wash from washing area should not be allowed to enter the soil. This wash should be collected through drains into tanks and concrete should be settled, collected, dried and re-used in the site again.

B. Operation Stage

Solid waste to be generated during the operation phase includes waste generated at terminal sites and waste generated in vessels which is to be received at terminal sites till the time vessel maintenance and repair facility is developed. The waste may include food waste, plastic, metal tins, papers, dredged sediments, STP sludge, e-waste and used oil from DG sets at terminal site and. These impacts could be significant and may persist for long periods if left unadressed and unless mitigated. Hence, appropriate mitigation measures are warranted to minimize the impacts.

[32] 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

Measures for Avoidance and Mitigation of Impacts

- Fuel should 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 should be provided at all the required locations at the site for collection of recyclable and non-recyclable waste. Recyclable waste should be sold to authorized vendors and non-recyclable waste should be disposed through authorized agencies and should not be dumped in open.
- Used oil from DG sets and other equipment should be stored in HDPE containers in isolated location on paved surfaces and should be disposed through authorized vendors only and should not be dumped in open.
- Room should be provided for storage of E-waste at site and this waste should be sold to authorized vendors periodically and should not be dumped in open.
- Bio- medical waste likely to be generated at first aid centre should be disposed of following the bio medical waste disposal rules.
- Municipal waste generated at terminal should either be sent for landfilling through authorized agencies or should be composted within the terminal site and manure should be used for maintaining the green area within the site
- Vessel waste reception facility should be available at the terminal site incase maintenance facility is not in place. The waste should be received from the vessel in proper segregated and packed form.. This waste should be treated and disposed within the terminal site only but in case it is not feasible, tie ups with Government and authorized private agencies can be made for handling, treatment, storage and disposal of this waste. Also fee can be imposed on the vessel operator for letting them dispose their waste at terminal/maintenance facilities.

4.10.5. *Conclusion (Land Environment)*

From the above discussion, it can be concluded that the land use &soil quality of the influence area may be impacted majorly due to development of civil interventions if proper mitigation measures are not taken. To mitigate the impact, efforts are done to identify non-agricultural lands for development of these facilities. However, at some sites, this cannot be avoided due to unavailability of non-agricultural land along the river, e.g. Sahibganj.

Soil quality can be impacted, if sewage and waste from civil intervention sites and from vessels is not managed properly and disposed of in soil. Thus, it is essential to develop waste reception and management facility so as to prevent degradation of the soil quality near banks. Another threat to soil quality can be due to disposal of contaminated river bed sediments in soil. Thus disposal should preferably be carried out within water or in the designated TSDF sites only,to prevent soil contamination. Impacts are avoidable and mitigable and thus will not affect the sland environment significantly if all the proposed mitigation measures are implemented.

4.11. Impact on Air Environment& Mitigation Measures

4.11.1. *Status of air quality along NW-1 and influence area*

Ambient air quality monitoring was carried within the respective critical impact zones as per CPCB guidelines. $PM_{2.5}$, PM_{10}, SO_2, NO_2 and carbon monoxide were monitored at different locations in the influence area. 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 except at Varanasi, Patna and Howrah location. $PM_{2.5}$ levels were found ranging from 16 to 58 µg/m^3. All value of $PM_{2.5}$ is within the specified limit of 60 µg/m^3 except Varanasi, Patna and Howrah locations. Background level of SO_2 ranged from 4.4 to 35.6µg/m^3. The NO_x levels were found ranges between 9.0 to 48µg/m^3. The observed SO_2 and NO_x 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. 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 PM (particulate matter) level in Varanasi, Patna and Howrah is slightly above the national ambient air quality standard (NAAQS) that is because of heavy traffic movement and presence of industries in these cities.

4.11.2. *Impacts on Air environment due to Maintenance Dredging for maintaining minimum LAD in navigation channel*

Dredging does not significantly affect the air quality, but operation of dredgers involves generation of emissions which may have effect on the air quality. However, the impact anticipated are localized and short term as it will be confined for the duration for which dredger will be operated and to the area where the dredger will be operated. Measures are proposed so as to minimize the emissions from dredger and the anticipated impacts.

Measures for Avoidance and Mitigation of Impacts

- Development of emission standards by concerned authorities for regulating the dredgers emissions and development of process to ensure its compliance
- Usage of low sulphur content fuel
- Adoption of electrically operated dredgers
- Optimizing the dredging requirement
- Provision of stack of adequate height for dispersion of pollutants
- Adoption of catalytic reduction/convertor technology for dredgers also so as to minimize the emissions
- Adoption of the dredgers with most modern design which may have low fuel requirement, more efficient pumps, low resistance hull design and optimal jet system.

4.11.3. *Impact on Air Environment Due to Operations- Barge Movement*

Exhaust gases from moving vessel are source of air pollution and GHG gases. However, vessels emit least air emissions compared to the 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 year for base year and projected traffic till year 2045 vide all the modes, i.e. rail, railway & IWT during CIA study for both "with & Without" Project scenario. On comparing both the scenarios it is found that the associated emissions are minimal in case of the "With Project" scenario. Emission factors considered fo calculating the emissions are given in **Table 4.11** and the net emissions savings is given in **Table 4.12.**

Table 4.11 : Emission Factors Considered for Gaseous Pollutants

Mode of Transportation	Emission Factor for NOx (g/tonne km)	Emission Factor for PM (g/tonne km)	Emission Factor for SO2 (g/tonne km)	Emission Factor for HC (g/tonne km)	Emission Factor for CO (g/tonne km)
Railway (Diesel Engines)[33,34]	0.0000004	0.00000007	0.00000018	0.00000007	0.00000015
Road [35]	0.00000137	0.00000022	0.00000018	0.00000038	0.00000054
IWT (For inland vessels)[36]	0.00000026	0.00000002	0.00000004	0.00000005	0.00000011

Source : HPC

Table 4.12 Pollutant Emission Savings in "With" Project Scenario

Year	SO_2emissions (Tonne/Yr.)	NO_x emissions (Tonne/Yr.)	CO emissions (Tonne/Yr.)	HCemissions (Tonne/Yr.)	PM Emissions (Tonne/Yr)
2016	0	0	0	0	0
2017	0	0	0	0	0
2018	0	0	0	0	0
2019	0	0	0	0	0

[33] 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

[34] 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.

[35] 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

[36] 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

Year	SO_2emissions (Tonne/Yr.)	NO_x emissions (Tonne/Yr.)	CO emissions (Tonne/Yr.)	HCemissions (Tonne/Yr.)	PM Emissions (Tonne/Yr)
2020	130.1969	918.6861	360.6105	254.1557	150.5532
2021	136.3225	963.9684	378.4112	266.7546	157.9367
2022	140.2691	995.3974	390.2841	276.8844	164.4477
2023	145.6836	1036.694	406.2616	289.1165	171.9205
2024	141.0999	1057.2	414.4643	297.9594	175.7725
2025	176.547	1305.17	511.9684	365.981	215.8993
2026	182.2369	1345.672	527.8671	377.2085	222.5415
2027	188.1166	1387.441	544.2629	388.7823	229.3908
2028	194.1929	1430.518	561.1718	400.7131	236.4536
2029	200.4729	1474.944	578.6102	413.012	243.7369
2030	206.9639	1520.764	596.5951	425.6908	251.2477
2031	213.6735	1568.021	615.1439	438.7612	258.9933
2032	220.6094	1616.762	634.2748	452.2357	266.9814
2033	227.7801	1667.035	654.0066	466.1268	275.2198
2034	235.1939	1718.89	674.3585	480.4478	283.7165
2035	242.8597	1772.377	695.3507	495.2122	292.4799
2036	274.6302	1971.27	773.3545	548.7043	324.8223
2037	280.7583	2012.696	789.6145	560.0438	331.5812
2038	301.0431	2146.086	844.7553	589.1356	345.49
2039	307.6028	2190.205	862.0995	601.1279	352.6094
2040	314.3153	2235.255	879.8085	613.3684	359.8795
2041	321.1844	2281.255	897.8903	625.8624	367.3038
2042	328.2142	2328.227	916.3532	638.6153	374.8855
2043	335.4089	2376.192	935.2056	651.6328	382.6284
2044	342.7726	2425.173	954.456	664.9204	390.5359
2045	365.2669	2508.429	986.5775	684.3006	404.4284
Savings Estimated (Tonnes)	5874.205	42201.2	16575.06	11700.31	6901.329

Source : HPC

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 which may affect the air quality. Measures are proposed which if implemented can minimize the impacts

Measures for Avoidance and Mitigation of Impacts

- Development of emission standards by concerned authorities for regulating the vessel emissions and development of process to ensure its compliance

- 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 4.2 in Volume 3C** for standards). Regular maintenance of vessels engine and propellers. IWAI should develop the stringent norms to be followed by vessel operators and should 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[37]
- The vessel should operate at partial power while docking at the terminal and achieve full power back again after leaving the port area.

4.11.4. *Impacts on Air Environment Due to Physical Interventions*

A. Pre-Construction/Design Stage

Site preparation, vegetation removal and construction material handling are the key air activities during this phase of project implementation which may generate the dust and other emissions which have potential to disturb the air quality of the area if left unadressed.

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 which may affect air quality if adequate mitigation measures are not taken. 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. Air quality will also be affected in case tree cutting is undertaken at site as the tree act as air purifiers.

As per baseline study, concentration of air pollutants in the influence area are within the prescribed limits as per NAAQS[38] (National Ambient Air Quality Standards., 2009) at all

[37] 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 Trieste37 to assess the feasibility of LNG usage as fuel in IWT. As per the study LNG usage is advantageous due to associated less SOx 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

[38] 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/m³ 24 hourly average
- Particulate matters of 2.5 micron Size ($PM_{2.5}$) : 60 μ/m³ 24 hourly average
- Oxides of Sulphur (SO2) : 80 μ/m³ 24 hourly average
- Oxides of Nitrogen (NOx) : 80 μ/m³ 24 hourly average

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. 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 Above mentioned activities will increase ambient pollutants level (dust or PM, SO_2, NO_x, & CO) but temporarily and will be localised. Further mitigation measures are proposed which can minimize the impacts.

Measures for Avoidance and Mitigation of Impacts

Provision should 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.

B. Construction Stage

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

- Carbon Mono Oxide (CO) : 2 mg/m^{3}8hourly Average 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. 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 4.13** below.

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 impacts could be significant if not addressed adequately. Thus a comprehensive mitigation planning is warranted. Mitigation measures recommended to minimize the ambient air pollution (not exceeding NAAQS).

Table 4.13 : 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

Measures for Avoidance and Mitigation of Impacts

- 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 should 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 should 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 should be carried out on monthly basis to check the level of pollutants and effectiveness of proposed mitigation and EMP.

C. Operation Stage

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 dust emissions if transported in open wagons or stored in open stock yards which is likely to affect the air quality if not mitigated properly. Air quality modelling study has been carried out for select two (Sahibganj & Haldia) Terminals to predict the concentration of the pollutants due to transportation activity of cargo material to & fro from the terminal/jetty site and is given at following se ction below. For management of these emissions, mitigation measures are proposed which will significantly reduce the anticipated impacts on air quality.

i. Air Modelling Study for Sahibganj terminal Site (Operation Stage Impact)

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 4.1.**

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.

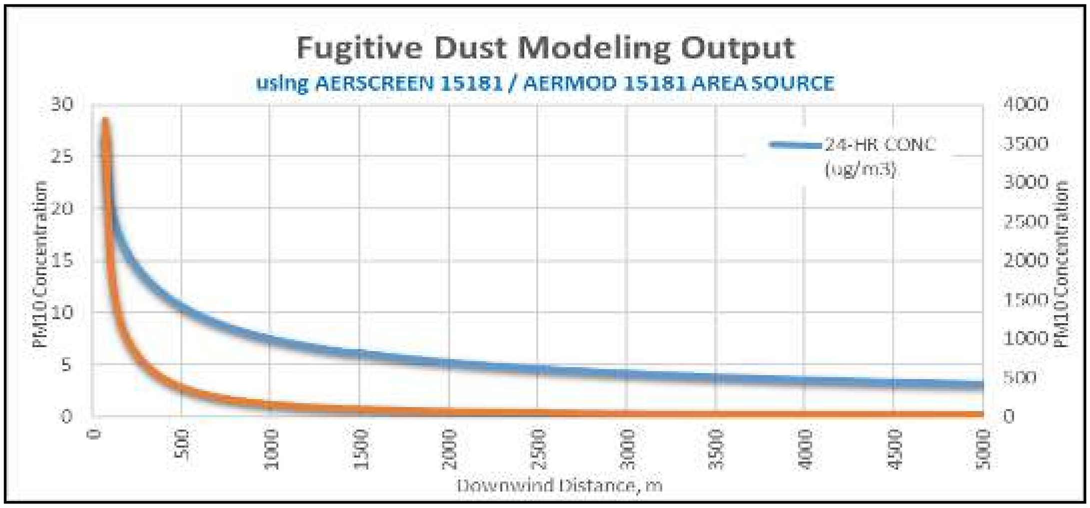


Figure 4.1 : Output of Air Dispersion Modelling-Sahibganj Terminal

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 waterspread 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.

ii. Air Modelling Study for Haldia terminal Site (Operation Stage Impact)

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 influence 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 4.2.**

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.

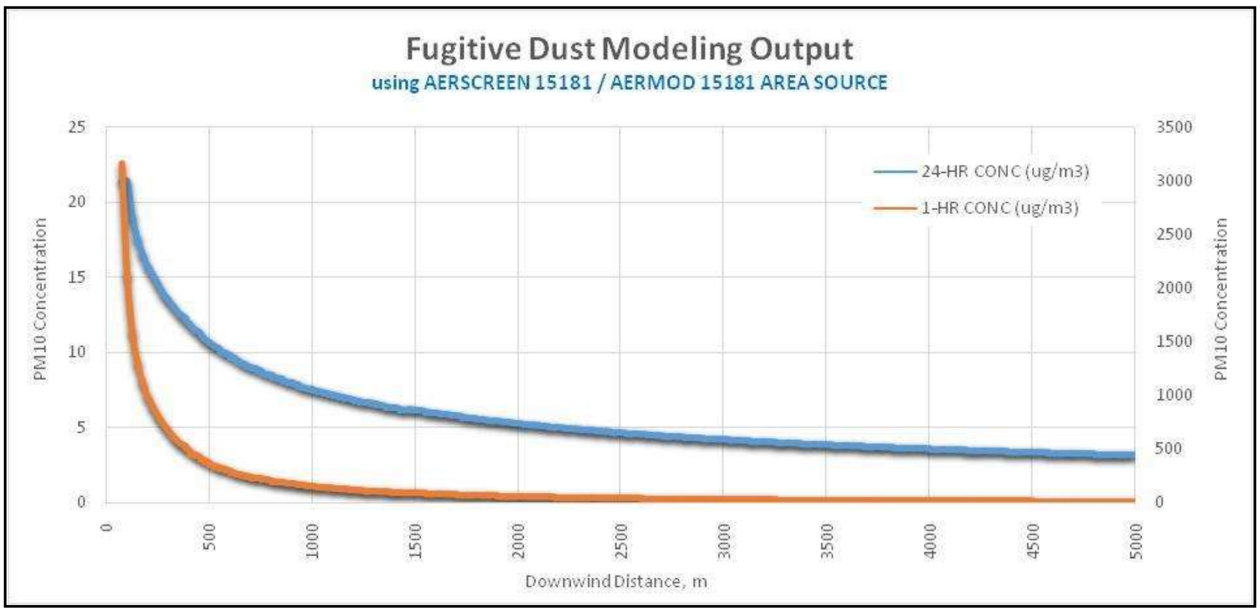


Figure 4.2 : Output of Air Dispersion Modelling-Haldia Terminal

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.

Measures for Avoidance and Mitigation of Impacts

- Material should be transported in covered vehicles
- Transportation vehicle should be properly serviced and maintain and should carry PUC certificate
- Material should be stored under cover sheds only especially coal, sand, aggregates etc.
- Thick green belt should be developed as per the provision already made in the design and maintained all along the periphery and along the roads. The green belt should be developed in canopy[39] 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[40].
- Water sprinkling should be carried out during all loading and unloading activities and storage period. Further dust suppression measures should be taken at the site like vaccum collectors at dust generation areas.
- More frequent water sprinkling should 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

[39] 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

[40] CPCB guidelines for green Belt development http://cpcb.nic.in/upload/Publications/Publication_513_GuidelinesForDevelopingGreenbelts.pdf

- It is recommended to provide mechanical conveying system with provision of dust collection system for loading/unloading material from barges. Pneumatic transfer only should be preferred for flyash transportation
- Minimizing free fall of materials to reduce the dust generation
- Minimizing dry cargo pile heights and containing piles with perimeter walls
- Removing materials from the bottom of piles to minimize dust re-suspension
- Regularly sweeping docks and handling areas, truck / rail storage areas, and paved roadway surfaces
- Monitoring of air quality should be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP
- Keeping transfer equipment (e.g. cranes, forklifts, and trucks) in good working condition[41]
- Upgrading the land vehicle fleet with less-polluting trucks and vehicles, and using alternative fuels and fuel mixtures
- Encouraging reduction in engine idling during on- and off-loading activities
- Encouraging storage planning to avoid or minimize restorage and reshuffling of cargo
- VOC emissions from fuel storage and transfer activities should be minimized by means of equipment selection, such as the use of floating top storage tanks or vapour recovery systems for fuel storage, loading / offloading, and fuelling activities (depending on the type of material to be stored), and adoption of management practices such as limiting or eliminating loading / unloading during poor air quality episodes or implementing tank and piping leak detection and repair programs
- Explore feasibility of using telescoping chutes to reduce the fugitive emissions and reduce the need for slingers for material loading & unloading.

4.11.5. *Conclusion (Air Environment)*

From the above discussion, it can be concluded that impacts are anticipated due to excavation, material transportation, storage of raw material and vehicular transportation majorly. The residential areas close to these civil interventions are likely to be affected majorly if the adequate mitigation measures are not taken. Also impacts are likely to be occur within 2 km radius of the intervention sites. With the above proposed mitigation measures impacts can be minimized to large extent.

4.12. Impact on Noise Environment

4.12.1. *Status of noise environmentalong NW-1 and influence area*

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.

[41] IFC Environmental, Health & Safety Guidelines-Ports, Harbors and Terminals

A. **Terminal/lock sites:**Ambient noise levels of the entire NW1 stretch are within the prescribed National Ambient Noise Quality Standard as well as standards prescribed in IFC general EHS guidelines for respective category for respective residential and commercial category at all the monitored locations.

B. **Sanctuary Area:**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.

4.12.2. *Impacts on Noise Environment due to Maintenance Dredging for maintaining minimum LAD in navigation channel*

Dredging operations generates noise levels of app. 85-90 dB(A). This noise level adds to the ambient noise levels of the area thereby exceeding the baseline noise levels. High noise level have serious impacts on human health and the flora & fauna residing in the area. But the noise significantly reduces and dissipates with distance. Dredging will be carried out within the river thus the noise levels due to dredging operation will reduce by the time it reaches the habitation area. Through noise modelling study as presented in **section 4.12.4.1 (Table 4.14)**, it is seen that noise levels reduce to 56 dB(A) at distance of 500 m from source which is equivalent to baseline noise levels of the area.Thus the impact is likely to be within 500 m distance from the dredging location. Noise level due to dredging and its impact on workers and resident population can be further minimized by undertaking the following mitigation measures.

Dredging also generates significant underwater noise. Impact on underwater noise generation due to dredgers is discussed in section of impact on aquatic ecology.

Measures for Avoidance and Mitigation of Impacts

- Dredgers should be regularly serviced and maintained so as to prevent noise due to friction
- Workers should be provided with ear plugs to prevent exposure to high noise levels
- A survey on sensitive noise receptors should be carried out for area within 500 m of dredging operations
- Provision of noise barrier in the impacted area if any sensitive receptor is located within 500 m distance
- No dredging activity should be carried out beyond 10:00 PM and before 6:00 Am
- Formulation of noise limit standards by concerned authorities for dredgers also similar to other construction machineries and vehicles

4.12.3. *Impact Due to Operations- Barge Movement*

Barge movement does not involve significant ambient noise generation, however significant underwater noise is generated. Impact due to underwater noise generation on aquatic ecology is discussed in depth in section impact on aquatic ecology. The details of Noise impact assessment and modelling are given under Impact on ecology under section 4.14.2.A(ii) and 4.14.3.D(i)

4.12.4. *Impacts Due to Physical Interventions*

D. Pre-Construction/Design and Construction Stage

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 4.14.**

Table 4.14 : 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 levels due to which it may affect the health of construction labour and nearby residents if the adequate mitigation measures are not taken. 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. But resultant noise level (ambient noise level + increase noise levels due to operation of equipment) can be higher than the prescribed limits of CPCB. However the noise associated with the construction activity will be restricted to construction period only and thus the impact is considered to be short term & temporary. Construction machinery & equipment will not be operated throughout the day thus noise generation from these equipment is considered to be of intermittent type. Further by undertaking the mitigation measures like 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 should not be more than 8 hours. OSHA guidelines should be followed for exposure to specific noise levels for workers and are listed in **Table 4.15.** Conducting hearing tests for workers may help in monitoring the impact of the higher noise level on workers' health.

Table 4.15 : 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

Thus the high noise levels are required to be managed by taking proper noise level reduction measures and preventive measures so as to minimize the impact on health due to exposure to high noise level.

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. Noise level assessed at varying distance due to dredging or piling operations are given in **Table 4.16** below.

Table 4.16 : 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.

Measures for Avoidance and Mitigation of Impacts

Provision should be made for:

- Barricading (Temporary noise barrier) the construction site to minimize the noise level outside the site boundary
- No piling and dredging activity should be carried out at night time.
- 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) should be provided to the workers operating near high noise generating machines. Construction equipment and machinery should 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 should 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.

E. Operation Stage

Noise generation sources during operation phase are primarily loading and unloading of material at site and vessel/barges, movement of dumpers & 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. The anticipated impact could be significant if left unadressed. Thus adequate avoidance and mitigation measures are required to mitigate the anticipated impacts.

A. 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 4.3.**

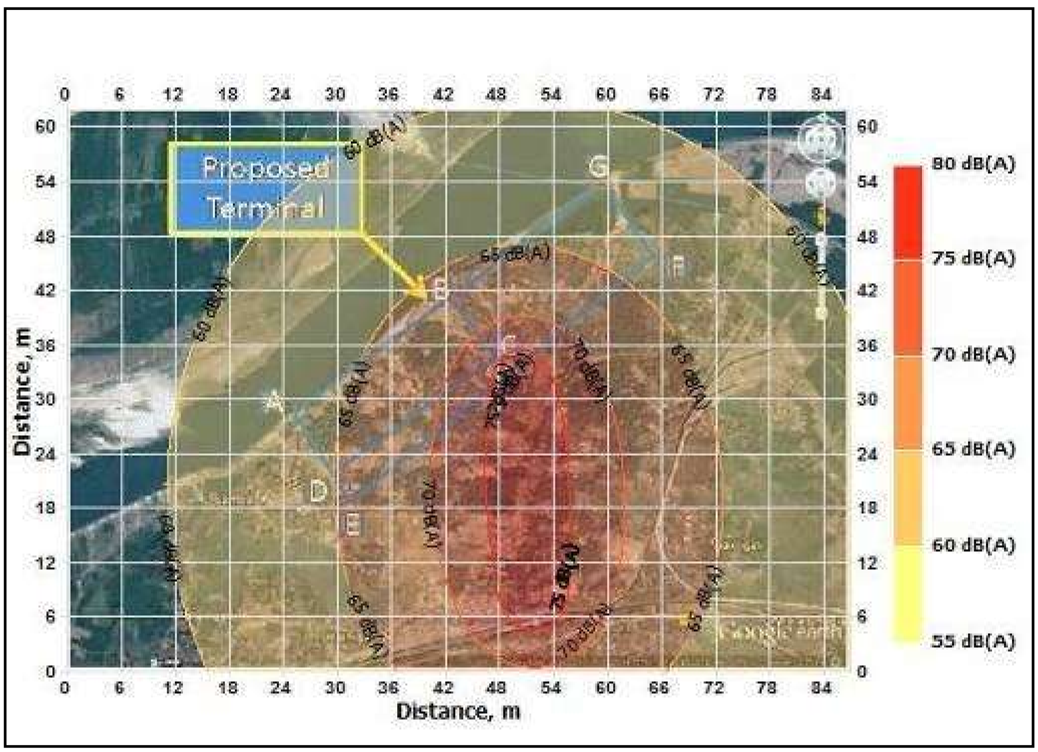


Figure 4.3 : Noise Modelling Output

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.

B. 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 4.4.**

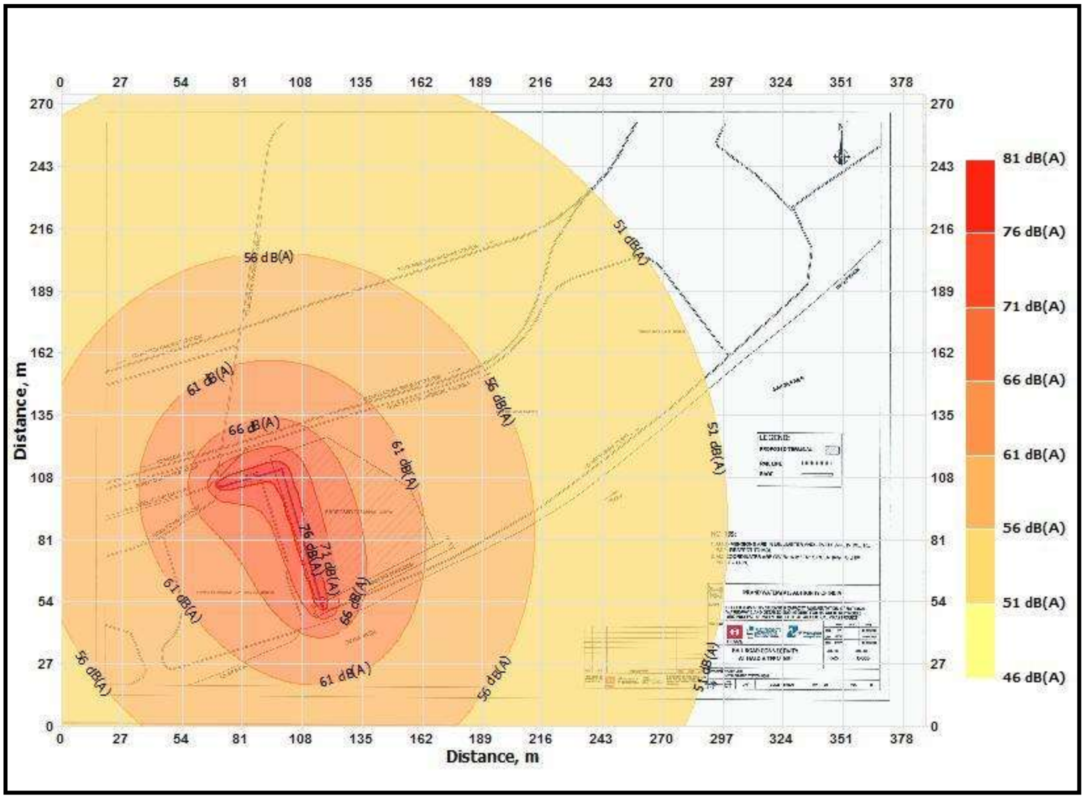


Figure 4.4 : Noise Modelling Output

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 4.13.** 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.

Measures for Avoidance and Mitigation of Impacts

- 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 should be prohibited at the project site
- Hearing test for the workers should be undertaken before employing them and thereafter should be done after every six months
- Job rotations should be practised for people, working in high noise level areas
- Noise generating activity should be undertaken between 6:00 am to 10:00 pm.
- DG sets should be provided with acoustic enclosure
- Monitoring of Noise levels should be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP

4.12.5. *Conclusion (Noise Environment)*

From the above discussion, it can be concluded that civil interventions are likely to affect the ambient noise levels of the area if the mitigation measures are not taken. The proposed mitigation measures can reduce the anticipated impacts to a large extent. Some of these measures are preventive which will prevent the damage due to increase in noise levels and some are mitigable which will help in reducing the noise levels.

4.13. Impact on Water Environment& Mitigation Measures

4.13.1. *Status of water environment along NW-1 and influence area*

A. Ground Water Quality:

Three ground water samples were collected from three locations around the proposed terminal site. 8 nos. of ground water sample were also collected from the stretches facing populated zones all along the NW-1. The Physico-chemical characteristics of the ground water samples were in good agreement with IS:10500 permissible limits. The TDS, Total Hardness and chloride values at Haldia and Sahibganj, Howrah and Kolkata are slightly above the desirable limit but were within the permissible limits specified under Drinking Water Standard (IS: 10500). Heavy metals, only Fe and Zn were found present but were quite lower in concentration. The arsenic content in ground water sample of Bhagalpur and Munger were found present in lower concentration. Other heavy metals were found in traces. Overall all the ground water quality at all sampling site is within the permissible limits specified under Drinking Water Standard (IS: 10500).

B. Surface Water Quality:

Surface water sample were collected from the upstream and downstream of the proposed and planned terminals/ lock and also at the river location of environmental sensitive receptors present all along the NW-1. One sample each were also collected from the other infrastructural interventions (existing ro-ro/jetty/floating terminals). Samples were collected as per the standard protocol mentioned earlier.

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 criteria. Metallic and pesticide level is within prescribed limit of Drinking water standard. The primary data results are similar to secondary data analyzed. The analysis concludes that the river water is good for propagation of Wild life and fisheries

C. River Water Quality at dredging locations:

IWAI undertakes dredging to maintain the LAD for effective navigation. To analyses 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 and analyses during study period. 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 normalized at a distance of 1000 m from the dredging location. In upstream side of the river there were no major changes has been 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.

D. Waste Water Generation from Major cities along NW-1:

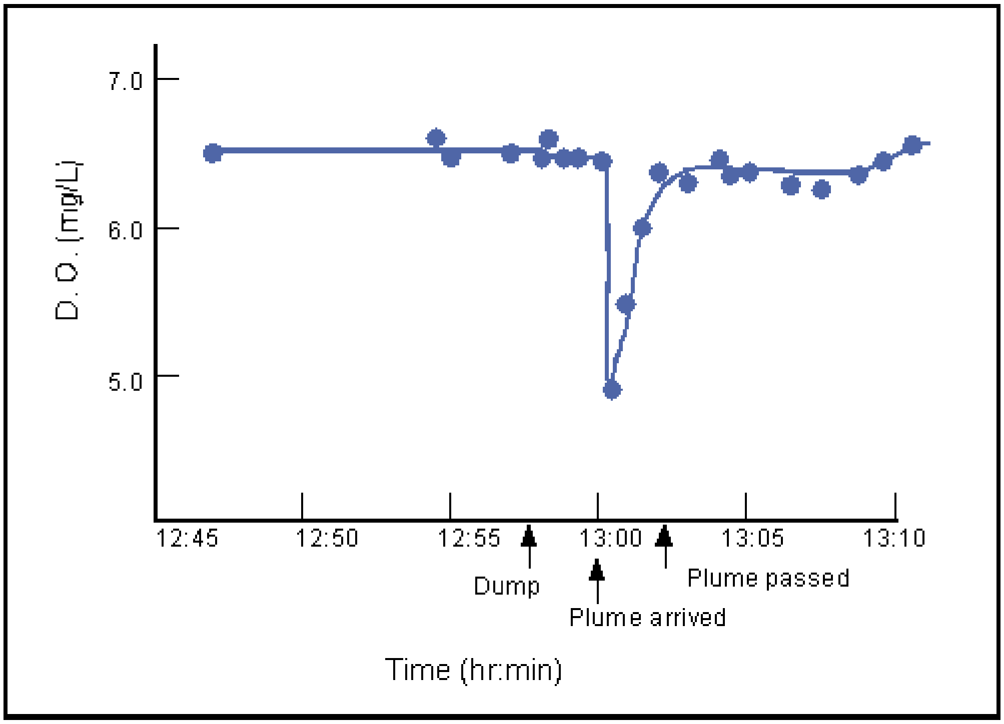
Waste water generation from cities and towns along NW-1 in Uttar Pradesh segment generated 422.6 MLD i.e. 26. % of total wastewater generation. Waste water generation from cities and towns along NW-1 in Bihar segments 376.5 MLD i.e. 14 % of total wastewater generation. The major city is Patna which generates 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 contributes 47% and Howrah generates 10% of the total waste water generation of west Bengal stretch.

4.13.2. *Impacts on Water Environment due to Maintenance Dredging for maintaining minimum LAD in navigation channel*

Impact of dredging on water environment is anticipated due to degradation of water quality during the dredging and off-shore dredge disposal operations. Impacts on water quality due to dredging activities & off-shore dredged disposal 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[42]during dredging & disposal resulting in changes in river water characteristics as mentioned above.

A. Change in 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 4.5**)



(Source: Water Quality Aspects of Dredging and Dredged Sediment Disposal byG. Fred Lee & Associates, California)

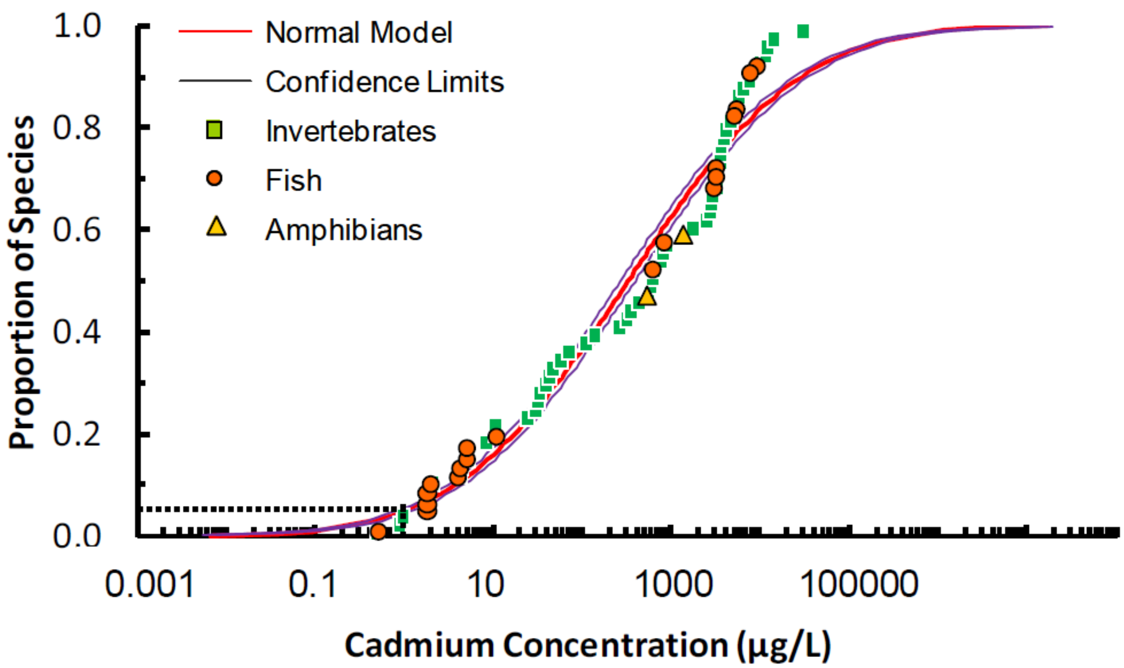
Figure 4.5 : Oxygen Depletion Rate vs Time for Dredge Disposal

B. Due to 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,

[42]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.

reveals that the river bed sediments are non-toxic except in Allahabad to Varanasi and Varanasi to Buxerstretches whereCadmium level is found marginally higher compared to US standard (refer **Figure 2.22 to 2.25 and Table 4.26 of Volueme 3A**). 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 4.6**



(source: Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, 2014)

Figure 4.6 : 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.

C. Due to Pesticides Presence:

The river bed sediment test results (refer Table 4.26 of Volueme 3A) 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.

D. Due to Turbidity and Ferrous Effect:

Hydraulic dredging involves slurring 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 2.23 of Volueme 3A.** 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 form43. 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

[43] 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.

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.

Measures for Avoidance and Mitigation of Impacts

Mitigation measures are proposed considering for the action required at design and operation stage of the project.

- Standards should be developed by concerned authorities for onshore and off-shore dredged material disposal and development of the process to ensure its compliance
- Attempt should 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 should 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 4.1 (Volume 3C).**
- 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 should 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 should 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.

- Dredgers should be selected so as there is minimal loss of sediments during dredging and disposal both. For inland waterways and off-shore disposal of the sediments, it is found that CSD is most feasible.
- 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.
- Sensitivity along NW-1 for dredge disposal is discussed in Table 4.4 above. Dredge material if disposed on river banks or on land caution should be exercised as per the Dredging and Disposal Management Plan is prepared for entire for NW-1 considering the sensitivities discussed in Table 4.4 and is this plan is given in volume 8. Table 6.1.

4.13.3. *Impact on Water Environment Due to Operations- Barge Movement*

Major impact on water environment is anticipated due to degradation of water quality due to discharge of liquid and solid waste from vessels into the river, dissolution of anti-fouling paints used for painting hull of the ships and oil spillages from the barges.

A. **Impact Due to Discharge of Liquid and Solid Waste in river:**

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, petroleum hydrocarbons, 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.

B. **Impact Due to Usage of Anti-fouling Paint:** Antifouling paints with toxic content can affect the aquatic life though to a very limited extent.

C. **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.

D. **Impact Due to Oil Spillage from barges/Vessels:** There could be oil spillage/leakage during the oil transportation due to leakage in oil tankers transported or due to accidents between the two vessels or due to leakages from engines of the barges and vessels. Oil spills severely affects the water quality as well the aquatic fauna. Oil forms the layer over the water and cut down the contact of atmosphere with the water lying below reducing the oxygen levels in the water. Due to generation of anoxic conditions, anaerobic digestion of organic matter starts taking place in water which leads to generation of foul smell and some acids which deteriorates the water quality. Further due to lack of oxygen, aquatic flora gets killed and add to the organic mass in the water, further reducing the dissolved oxygen levels and the water quality degradation

Measures for Avoidance and Mitigation of Impacts

- All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only. Till the time such facility is not developed, terminals should have arrangement for reception of the waste and wastewater from vessels so as to prevent its unauthorized disposal in river. A procedure should be developed by terminal facilities for reception of vessel waste, its storage and treatment and respective charges.
- Further a waste management plan is requisite to be formed indicating the entire process of waste segregation, collection, storage, handling over to be followed by vessels. This plan can also indicate the fee amount to be paid by waste generator as per the weight of the garbage.. Penalties should be imposed on the vessel operators in case the plan is not followed
- The wastewater from vessels can be sent to STP for treatment and the treated water can be used for landscaping and dust suppression at terminal sites
- Vessels alsomay have some facilities for treatment of the waste generated onboard like recycling/chemical toilets. Standards for discharge of wastewater & garbage from barges as per MARPOL is attached as **Annexure 4.3 & 4.4 (Volume 3C).**

- Vessel crew/captain should be aware about the waste handling and reception facilities and procedure at terminals and should be in line with above mentioned MARPOL standards.
- Further it is suggested that standards should be formulated for barges for disposal of waste and sewage as per Indian scenario w.r.t to NW-1 by concerned authorities
- 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 4.5 (Volume 3C).**
- Usage of non-toxic and non TBT containing anti-fouling paints for painting vessel
- Oil spill control and management plan should be prepared for each terminal facility and for barge operations inNW-1 as part of EHS management system of IWAI which should be duly communicated to vessel operator. Immediate/quick clean-up of oil/other spills to prevent damage on aquatic organisms should 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. An oil spill management plan proposed for the NW-1 by IWAI is attached as **Annexure 4.6 (Volume 3C).**
- 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 should 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. Washing should be undertaken only at the maintenance facility only. Standards for discharge of washing water from the vessels carrying noxious chemicals (vessel washing water) as per MARPOL is given in **Annexure 4.7 (Volume 3C).**
- Incase maintenance facility is not in place then washing can be done at terminal sites also but terminal sites should have proper system for handling the washing waste from barges. All washing water should be directed through closed drains to settling tank. Supernatant water should be tested and if suitable should be sent to STP for treatment. Sludge should be tested and disposed of to municipal waste disposal facility or hazardous waste disposal facility depending on thequality of sludge.

4.13.4. *Impacts on Water Environment Due to Physical Interventions*

A. Pre-Construction/Design and Construction Stage

Major impact on water environment associated with the design & construction of the physical intervention are degradation of quality and depletion of resources due to usage. 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 thus no significant impact is anticipated on the ground water resources. 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 4.1 in Volume 3C** 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 influence area during construction stage of project are given below.

Measures for Avoidance and Mitigation of Impacts

- Excavation should not be carried out during monsoon season. Excavated areas should be covered to the extent possible to prevent entry of rainfall run-off in case of rains. Excavation, filling and levelling should be carried out parallel so as to minimize the exposure of loose soil to wind/water. Levelled areas should be compacted.
- Garland drains should 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 should 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 should be provided in the parking areas also and these drains should be provided with oil & grease trap
- No waste should 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 should be made to prevent mixing of the waste in run-off and entering the water bodies.
- Washing of vehicle and equipment should 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 should 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 should be avoided at the site. Storage of debris and raw material should be carried out in paved and covered areas. This will minimize interface of run-off with raw material and debris.
- Septic tank/soak pit should 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 should be provided. Sewage should not be discharged into the River.
- Adequate number of toilets & bathrooms should be provided to prevent open defecation.
- Wastewater generated from the washing/cleaning area after passing through oil & grease trap & curing area should be re-used for water sprinkling and wheel washing
- Water use should 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 should 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 should be stored in leak proof containers and containers should be placed on paved surface.
- The piling work in river should be undertaken during low flow period.
- Turbidity traps/curtains or Geo-Textile synthetic sheet curtain should be placed around pilling and construction area to prevent movement of sediments and construction waste. Provision should be made for geo Synthetic Screen for arresting silt flowing down stream.
- Sedimentation tanks should be provided at the site so as run-off from site should 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 should 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 should 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 should be given to source water from rivers wherever feasible in the project area with due permission from authorities
- Permission should 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 should 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 should be made for collection and draining of water for the piling earth. It should be used for embankment protection or road construction depending on its suitability.

B. Operation Stage

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 should 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 Haldia to Barh, 2.5 m from Barh to Ghazipur and 2.2 m from Ghazipur to Varanasi and no dredging proposed at present beyond Varanasi. This will reduce dredging requirement from 31.08 million cum/year to 14.85 million cum which is more than half the volume there by cutting down impact to more than 50%. This dredging quantity includes the dredging to be carried out at terminal sites for maintaining navigability throughout year. 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:

Measures for Avoidance and Mitigation of Impacts

- Regular checks should be made for soil erosion and turfing conditions of river training structures for its effective maintenance
- Regular visual checks and cleaning of drains should 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 should 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 should be directed into a collection/dump pond. Storm water should 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 should be sent for disposal along with other municipal waste
- Storm water drains provided in parking & road areas should be provided with oil & grease traps
- Monitoring of water borne diseases due to stagnant water bodies
- Drains should be regularly cleaned and de-silted
- Water conservation fixtures should 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 should be received from vessels and vessels should not be allowed to discharge their wastewater and solid waste in river
- No waste/wastewater should be discharged in river or dumped into the ground
- Fuel should be stored in leak proof containers and containers should be placed on paved surfaces
- Dredged soil should be tested for toxicity, if toxic should 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 should not enter the storm water and sewage drains or storm water storage pits. Oil storage facility should be contained. Oil & grit separators should be provided in the storm water drains in these areas.
- Fuelling of vessels is not proposed at terminal facility but in case fuelling is carried out then Fuel dispensing equipment should be equipped with “breakaway” hose connections that provide emergency shutdown of flow.. Fuelling equipment should be inspected daily to ensure all components are in satisfactory condition.
- Ship design (of capacity > 5000 DWTat 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 should 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 should be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP

4.13.5. *Conclusion (Water Environment)*

Water environment is likely to be affected at all the stages and due to all proposed project activities. Impact are likely to be significant also if not mitigated. However the impacts can be minimized by taking above mentioned measures to a larger extent. Regular monitoring of water quality is essential to check the adequacy and effectiveness of the proposed measures.

4.14. Impact on Ecological Environment& Mitigation Measures

4.14.1. *Status of ecological environment along NW-1 and influence area*

A. Critical Environment Resources or VECs:

Biological VECs in NW-1 are located in ecologically fragile zones which need to be protected on account of their importance for providing suitable habitats for wildlife, humans, and their role in sustaining ecological functions.

There are two notified wild life sanctuaries (Kashi Turtle Sanctuary, Varanasi, UP, and Dolphin Sanctuary, Bihar and one Hilsa Sanctuary notified under Fisheries Act, WB located within the NW-1 stretch. RET (Rare, endangered and Threatened) species like Gangetic dolphin (Schedule-1) fresh water turtle species (frequently sighted), The smooth coated Otter and crocodile (very rarely sighted) are present in the river stretch of the NW-1.Hilsa fish is the another important species found in NW-1 stretch. Fishing of Hilsa is prohibited in the notified Hilsa sanctuary area. details of the Sanctuaries present in NW-1 stretch is given in **Table 4.17** below.

Table 4.17 Salient features of 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	VikramshilaGan	Officially protected	*Yes*	No	10

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)
		getic Dolphin, Sultanganj to Kahalgaon pahad	Under Wildlife Protection Act, 1972			
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)

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.

There are 6 nos. of important bird areas including Udhwa bird sanctuary. However, Udhwa bird sanctuary is located about 9.0 km away from the NW-1 stretch. Many migratory birds come to visit these IBA sites every winter from several parts of the world, including Siberia and Europe. Details of the IBAs located within 10 km area of the NW-1 are provided in **Table 4.18.**

Table 4.18 : 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	Winter	Close to NW-1

				Not protected		
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

B. Aquatic Flora and Fauna:

There are several aquatic floral species present in the riparian zone and in aquatic habitat along the whole 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 was Gabbia sp.Bellamya sp. Lymnaeasp, Belostomaindica and Cybister confuses.

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 mammalian fauna present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanistagangeticagangetica*) and the Smooth Coated Otter (*Lutrogale perspicillata*) which are categorized as endangered species (Schedule-I). Dolphin is found routinely moving between Allahabad to Farakka and post Farakka region of NW-1. However, these mammals are rarely sighted in Allahabad and Varanasi region. The Smooth Coated Otter is found throughout the length of the gangetic system but in very very poor numbers and it is one of the endangered category animal as per IUCN list. Though it is not sighted during our study period but fishermen at Bhagalpur and Sultanpur only has indicated its sighting. Its number has depleted fast due to one of the most hunted animal because of its precious skin. The reptile fauna found in Gangetic system are variety of fresh water turtle species, water snake (*Xenochrophispistator*), Mugger Crocodile (*Crocodilus Paluspris*), estuarine (East Coast) Crocodile (C. porosus) and Indian Gharial (*Gavilialis Gangeticus*). The Mugger, Crocodile and Indian Gharial are very rarely seen in NW-1 stretch. Its presence is more reported in tributaries (Chambal river) of Ganges. The turtle and water snake are found more commonly in the NW-1. Other than water snake, other reptile faunal species are classified as endangered species. Few researchers have indicated presence of Ganges Shark (Glyphis Gangeticus) in the last part of Ganga (Hoogly river region). However, there is no confirmed news or basis available yet for the presence of this critically endangered species in the gangetic system.

C. RET Species:

Gangetic dolphin and fresh water turtle species (endangered and vulnerable turtle species), Smooth Coated Otter and Crocodile areSchedule I species found in the river stretch of the NW-1. Some of the vulnerable and endangered species of migratory birds are also sighted in the IBAs located along the NW-1.

4.14.2. *Impacts on Ecological Environment due to Maintenance Dredging for maintaining minimum LAD in navigation channel*

A. Impact on Aquatic Ecology

Impacts due to maintenance dredging are anticipated largely on aquatic ecology. 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 Submerged Aquatic Vegetation (SAV). Impacts are assessed for different scenarios as given in the following section:

i. 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 45 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 dredger or barge movements[44].

ii. 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[45] . Noise sensitivity reference are not available for other crocodile and Smooth Coated Ottor but these animals are rarely sighted. It is assumed that these animals will also have similar sensitivity range. In any case these animals prefer to stay more on banks or on wet land near banks and are unlikely to be impacts due to dredging which is most likely to undertaken in the deep stream of river. 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.

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[44] 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

[45] As per Environmental Impact Statement of South of Embley Project.

iii. 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 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)[46]. 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 45 m 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.

iv. 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.

v. 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.

vi. 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

[46].As per UK Marine SACs Projects assessments

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.

Measures for Avoidance and Mitigation of Impacts

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, Turtle sanctuaryandconfluence zone of major rivers (100 m horizontally and 500m either side of major river confluence location).
- 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 presented in baseline volume (Sub volume 3A) of the report.
- No dredging should be carried out in winter season (November to February) along Mokama Taal to minimize impact on aquatic species and avifauna.
- 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.**

B. 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 may be affected 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 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.

Measures for Avoidance and Mitigation of Impacts

- Dredging operations should be undertaken 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 4.18**above 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.

4.14.3. *Impact on Ecological Environment (Aquatic Ecology) Due to Operations- Barge Movement*

A. Impact Due to Vessel Speed and Movement on Aquatic Organisms

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 VGDS 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. Smooth Coated Otter and Crocodile are rarely sighted speciesand prefers to rest on wet lands of river banks, noise impacts are anticipated negligible due to its fast attenuation. Accidental impact cannot be rules out however it will of similar nature as to Dolphin and same precautions will apply for these animals as well.

B. Impact Due to Ballast Water Discharges on Aquatic Organisms

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, andbacteria 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.

C. Impact Due to Spillage of Oil/Material in River on Aquatic Organisms

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 spill may also occur during material unloading and loading at terminal sites. 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 seawater & air (DO reaeration). This floating oil may 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 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.

Thus measures should be taken to prevent any oil spillage and also a plan is required to handle oil spills, if any occurs to minimize its affect on aquatic ecology.

D. Impact Due to High Noise Generation During Movement on Aquatic Organisms

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 significant on behavioural responses and audiometry of aquatic species, turtles and dolphins in particular. These impacts are analysed and presented in the following sections:

i. 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)[47] 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)[48] 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 4.19.** The vessels which will be diploid in the NW-1 passing through Sanctuary areas (VGDS

[47] Southall et al. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33(4).

[48] 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

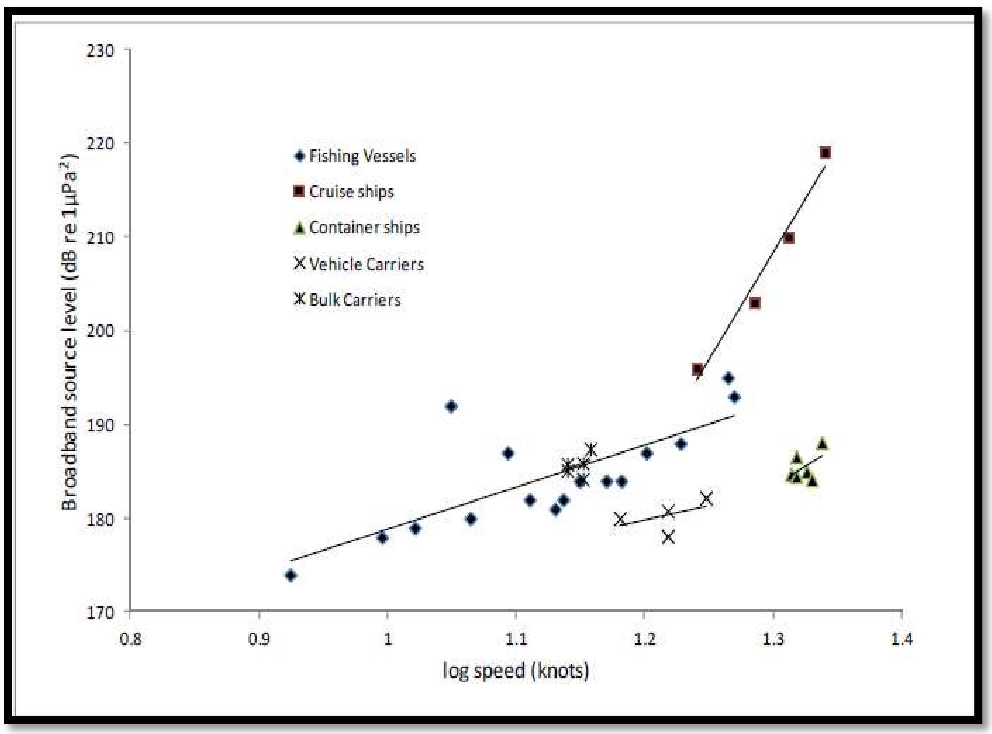
& Kashi turtle sanctuary will be 4 stroke engine vessels and propose to move with speed of 2.7 knots (5 kmph) within the sanctuary areas. *Thus as per this study one can conclude that from this source the noise level to be generated from the vessels will be in range of 110-139 d(B).*

Table 4.19 : 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
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 4.7.**



Source: Renilson M, Leaper R & Boisseau O, May, 2013

Note: 2.7 Knots or 5 Km/h = 0.43 log speed (knots)

Figure 4.7 : 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 4.20**. But no relation between the noise generated with the speed of vessel is highlighted in this study.

Table 4.20 : 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 4.21**

Table 4.21 : 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 4.22** 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 4.22 : 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

ii. 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)[49]. 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 damaged and the effect is called permanent threshold shift (PTS). **Table 4.23** 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 4.23 : 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.*

iii. 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

[49] NRC. (2005). Marine Mammal Populations and Ocean Noise - Determining When Noise Causes Biologically Significant Effects. National Research Council, National Academies Press

around 65 kHz (Sugimatsu et al., 2011)[50]. 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 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.

Measures for Avoidance and Mitigation of Noise Impacts on Aquatic Ecology

- Vessel speed should 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 should 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 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 should be discharged at vessel repair facility only. IWAI should develop the stringent norms to be followed by vessel operators and should 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 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.

[50] 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

- The proposed oil spill control and management plan (attached as Annexure 4.6 Volume 3C) should be effectively communicated for any emergency situations.
- 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 generation (specifically cavitation's 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.
- The navigation channel should maintain a minimum distance of 100m horizontally and 500m either side along the river at the confluence point of major tributaries with river Ganga.

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 should be made.

4.14.4. *Impacts on Terrestrial Ecology Due to Physical Interventions*

A. Pre-Construction/Design and Construction Stage

Development of the civil interventions may require clearing of the vegetation from the proposed site. No significant vegetation is present at Farakka lock, Haldia terminal and Varanasi terminal site thus no significant impact on terrestrial ecology is anticipated. But app. 500 trees are present at identified terminal site in Sahibganj. Mango orchards are present at the planned terminal site at Sahibganj thus tree cutting for terminal development is likely to affect the terrestrial ecology. This impact can be minimized by designing terminal to minimize tree cutting and to carry out adequate compensatory plantation. No wildlife is reported or observed during the visit at any of 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 confined 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.

Measures for Avoidance and Mitigation of Impacts

- Project layout design should be in a way to minimize tree cutting

- Permission should be obtained from forest department prior tree cutting and only the identified and permitted tree should be cut and remaining should be maintained properly
- Thick green belt should 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 should also be made green by growing grass and shrubs and herbs
- Caution sign should be placed to prevent hunting of animals
- Construction activities should be undertaken from 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 should be monitored regularly and measures should be taken so as to achieve minimum rate of 70%
- All efforts should 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 should 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 should 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 should 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 should 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

B. Operation Stage

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.

Measures for Avoidance and Mitigation of Impacts

- 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

4.14.5. *Impacts on Aquatic Ecology Due to Physical Interventions*

A. Pre-Construction/Design and Construction Stage

Eco-sensitive aquatic habitats identified within NW-1 are Vikramshila Dolphin sanctuary (Sultanpur-Kahalgaon) and Kashi Turtle Sanctuary at Varanasi. No civil interventions ae 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:

i. 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.

Measures for Avoidance and Mitigation of Impacts

- 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 should 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 should be fitted with the equipment as much as feasible. Noise barriers should also be installed

- Geo Textile synthetic sheet curtain & turbidity traps should 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.

ii. 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.

iii. Impact of Piling, dredging and other construction activities due to release of sediments

The riparian area soils 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.

Measures for Avoidance and Mitigation of Impacts

- To avoid the construction debris, wash or blown into the water the area should 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 should be connected to temporary sedimentation pit and collected water should 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 should 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 should be maintained in good condition should 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 should be maintained in good condition should be checked for oil & grease leakage
- Nesting grounds, breeding & spawning grounds should be identified and project activities should be minimized in those areas

B. Operation Stage

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

Measures for Avoidance and Mitigation of Impacts

- Dust generation during loading & unloading of barges should 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 should 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 should be identified and project activities should 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 should 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 should 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.

4.14.6. *Conclusion (Ecological Environment)*

From the above discussion, it is evident that physical interventions development can affect both the terrestrial and aquatic ecology however barge operations and maintenance dredging operations are likely to affect the aquatic ecology if the issues identified are not addressed and mitigated adequately. Significance of the impacts of physical interventions will be different in different phases of development on both the components however the impact on aquatic ecology due to dredging and barge operations is anticipated only during operation phase of the project. The impacts can affect the ecology of the area significantly if left unadressed. Mitigation measures as proposed are essentially required to be implemented to prevent the identified impact on the terrestrial and aquatic ecology. This measures will prevent the impacts as well as will reduce the intensity of the impact on the ecology.

4.15. Impact on Social Environment& Mitigation Measures

4.15.1. *Status of social environment along NW-1 and influence*

A. Demography:

NW-1 mainly passes through four Indian states namely Uttar Pradesh, Bihar, Jharkhand, and West Bengal. Each of the state has distinct socio-economic profile. 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 along 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 numbers of 'Households' was also recorded as 2562165 and 0-6-year age population was also recorded as 1308682.

B. Fishing and Livelihood along NW-1:

Ganga is the most important river and source of livelihood for countless fishers inhabiting on its bank. 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 catch of commercially important fish 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.

C. Culturally and religiously important places along NW-1:

Ganga river is worshipped in India and holds an important place as it is considered sacred and holy river in Hindu religion. Hindus also believes that that bathing in the river on certain special occasions and periods causes the forgiveness of sins and helps attain salvation. Various festivals are also 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 4.24.**

Table 4.24 : Culturally and Religiously Important Places with Fair and Festivals

S.No.	City	Place	Fairs & Festivals
1	Allahabad	Sangam	**Kumbh Mela: Kumbh mela is organised in Allahabad after every 12 years at** the confluence of the 3 rivers Ganga, Jamuna and the sacred and mythological river Saraswati at Allhabad Sangam. 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. Ardha Kumbh: **Ardha Kumbh mela is organised in Allahabad after every 6th years at** the confluence of the 3 rivers Ganga, Jamuna and the sacred and mythological river Saraswati at Allhabad Sangam. **Period of celebration:** January to February month **Magh Mela:** Apart from the Maha Kumbh and ardha Kumbh mela, Magh Mela is also organised in Allahabad city every year. **Period of celebration:** January to February month
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.
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. **Period of celebration:** 2 days in Oct or Nov
4	West Bengal and part of Jharkhand and Bihar	Durga Puja	**Durga Puja:** Durga Puja festival marks the victory of Goddess Durga over the evil buffalo demon MahishasuraThus, Durga Puja festival epitomizes the victory of Good over Evil. Durga puja celebrated every year. **Period of celebration:** 10 days in Sept or Oct

D. **Tourist Place along NW-1:**

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.

E. **Archaeological sites along 300 m of NW-1:**

The archeologically protected structures/monument[51] located within 300 m of NW-1 is listed at **Table 4.25.**

Table 4.25 : Archeologically Protected area around 300 m of NW-1

No.	Name	Latitude& Longitude	Place	Distance from NW-1 km	Direction from NW-1
1	KardmeshwarMahadeva Mandir	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

4.15.2. *Impacts on Socio-Economic and Cultural Aspects due to Maintenance Dredging*

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 and 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 confined to dredging locations

[51]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.

only. Dredging activity also pose threat to health & safety of the workers and other waterway users. No construction or interventions are planned within 300m of any of Archeologically protected monument. The Ramnagar fort is one of the protected monument. IWAI has undertaken a study with the help of Indian Institute of Technology (IIT) Roorkee to establish the effect of development of Varanasi terminal and NW-1 development. IIT in its study has establish that these developments will have no impact on these protected. 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.

Measures for Avoidance and Mitigation of Impacts

- Dredging should be prohibited in biological & social sensitive location and at time of religiously and culturally important festivals, during breeding & spawning season of fishes and during migratory bird season to minimise impact on socio-cultural aspects.
- A minimum of 100 m buffer zone from the religious Ghats at Varanasi and Patna (the cultural heritage locations) is proposed to be maintained as prohibited area for dredging for the protection of Ghats.
- Precautions followed for archeologically protected monument should also be followed for any intervention near any culturally important heritage structures.
- It is also proposed to report to IWAI and ASI for any chance finding during excavation and construction stage.
- Timely intimation to fishermen about dredging operation and location can minimize the disturbance to fishermen. As enhancement fishermen should 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 preventing accident risks during dredging and arrangement of all first-aid should be available at dredging locations all the time
- Dredging operations should be carried out 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 should 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 should 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.

4.15.3. *Impact on Socio-Economic and Cultural Aspects Due to Operations- Barge Operations*

A. 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. However, these accidents and accident intensity can be minimised with appropriate preventive measures.

A. 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.

B. 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.

Measures for Avoidance and Mitigation of Impacts

- 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.
- 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 should only be allowed to ply in the waterway. Each vessel should be thoroughly inspected by IWAI for compliance of require safetyand pollution control (Zero Discharge) measures before granting operational permit in NW-1.
- 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

B. 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.

Measures for Avoidance and Mitigation of Impacts

- 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/bank protection 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 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 should be made.

C. 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.

Measures for Avoidance and Mitigation of Impacts

- Vessel movement should be regularise in consultation with local bodies during the identified major festival period.
- No waste form barges should be discharged 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.

4.15.4. *Impacts Due to Physical Interventions*

A. Pre-Construction/Design and Construction Stage

Land is one of the major requirements for project development. At some of the proposed site it is also required to acquire private land.

Varanasi site (5.685 ha) is already under possession of IWAI. However additional land of 1.415 ha is required to be acquired to provide connectivity to terminal site with NH-7 which is agricultural land. For development of Sahibganj terminal, total 78.91 ha of land will be required including road & rail connectivity. For phase I, 23.98 ha of land will be required and remaining 54.93 ha will be required for phase II. Acquistion of 45.20 ha has been initiated by IWAI. There are few household and community temple located at Sahibganj 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. No private land acquisition is envisaged at present for Farakka lock & Haldia terminal site.

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.

Measures for Avoidance and Mitigation of Impacts

- 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 should 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

B. Operation Stage

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 may be 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

Measures for Avoidance and Mitigation of Impacts

- 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.

- Separation of people from vehicles and making vehicle passageways one-way, to the extent practical.
- 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.
- Spill prevention and control and emergency responsive system including spill control and management plan should be developed and effectively implemented at the terminal facilities & jetties
- Surface of terminal areas should be of adequate strength to support the heaviest expected loads; level, or with only a slight slope; free from holes, cracks, depressions, unnecessary curbs, or other raised objects; continuous; and skid resistant
- Providing safe access arrangements suitable for the sizes and types of vessels calling at their facilities. These access arrangements should include guard rails and / or properly secured safety nets to prevent workers from falling into the water between the vessel side and the adjacent quay.
- Provision should be made for inspection and approval all slings before use
- Clearly marking (indicating its own weight) all lifting beams and frames, vacuum lifting, or magnetic lifting device which does not form an integral part of a lifting appliance and every other item of loose gear weighing more than 100 kilograms (kg)
- Development of system to Inspectdisposable pallets and similar disposable devices before use and avoiding re-use of such disposable devices,equipping lifting appliances with means of emergency escape from the driver's cabin and a safe means for the removal of an injured or ill driver
- Risk of free fall of materials should be minimized by installing telescoping arm loaders and conveyors
- Materials handling operations should follow a simple, linear layout to reduce the need for multiple transfer points
- 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 should 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 stopped in the entire river. However docking of the boats by fishermen in zone of 100 m around the terminal facility/jetty should be prohibited so as their boats are not damaged due to arrival and wave action of ships approaching the terminals and jetties.

4.15.5. *Conclusion (Social Environment)*

From the above discussion, it is evident that all the three activities (physical interventions, barge movement and maintenance dredging) have potential to affect the various aspects of the social environment. River Ganga is considered sacred and lots of spiritual activities are associated with the River. Other than these many people depend on the River for livelihood. Also river is source of water in many villages located at its bank. Thus any interference with the river may affect the cultural and social activities associated with the river. These impacts may be significant and may lead to social issues if not mitigated at right stage of project development. To prevent these impacts, mitigation measures are proposed for each of the proposed activity and for each stage of project. These measures are to be implemented strictly to prevent the identified impacts.

4.16. 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 current planning NW-1 navigational channel width will be of 45 m and maximum LAD of 3m (range from 2.2 m to 3 m). 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 4.8**.

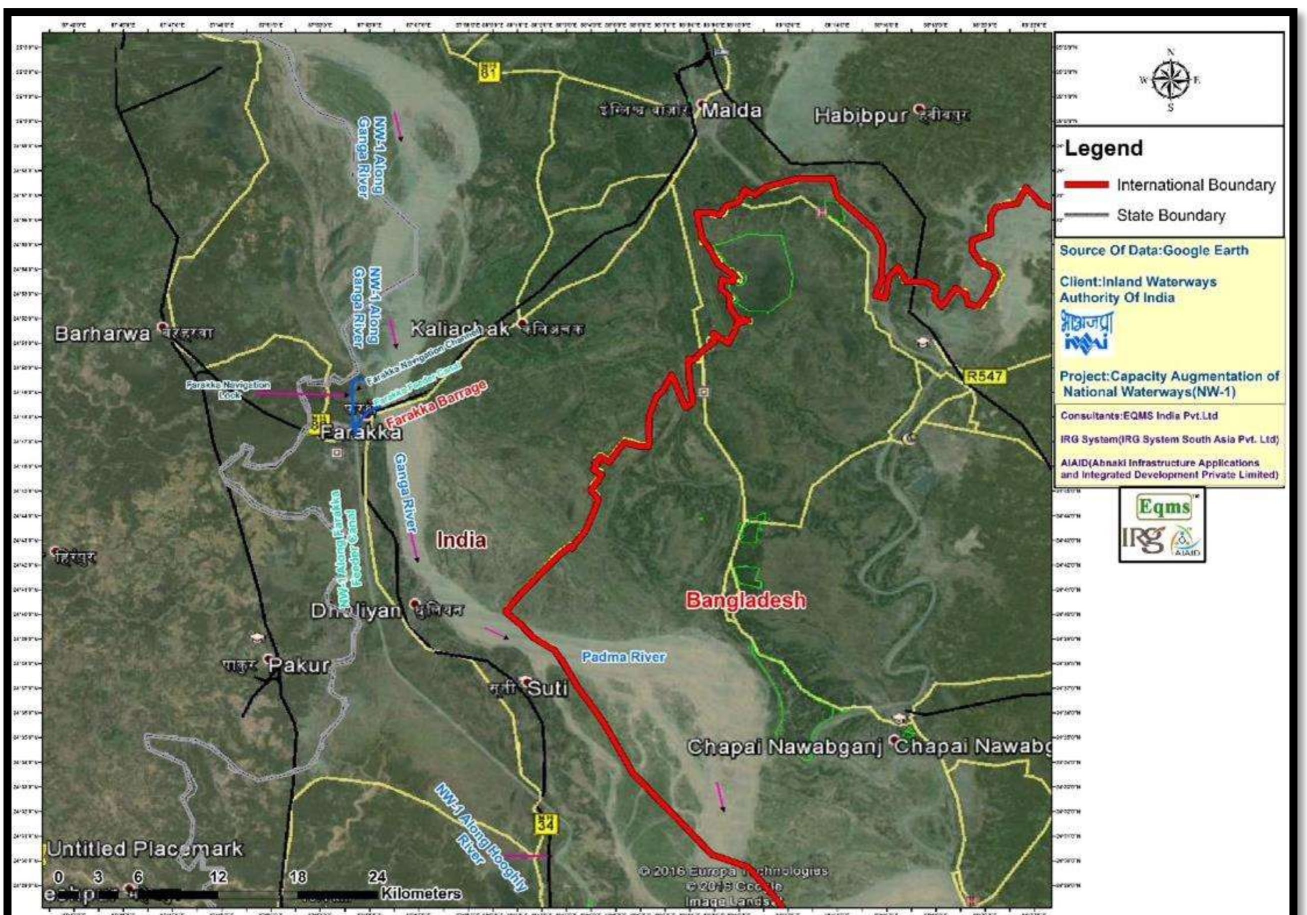


Figure 4.8 View of NW-1 route at Farakka and Control location for River Ganga Water flow to Bangladesh

An assessment of impact of Jal 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 4.26.**

Table 4.26 : 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.

4.16.1. *Conclusion (Indo -Bangladesh Water Sharing Treaty and Downstream water users in Bangladesh)*

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.

4.17. Impacts Due to Maintenance Facilities for Barge Repair and Maintenance

It is proposed to develop the maintenance facilities for barge/vessel repair and maintenance along the NW-1, however the location of same has not been finalized yet. Thus the location specific impact of the maintenance facilities could not be assessed. However, impacts due to such facilities in general are discussed in this section. Maintenance facilities use and store a wide range of chemicals and other materials, many of which may be hazardous. Examples include fuels, oils, alkaline and acidic solutions, cleaning solvents, disinfectants, detergents, degreasers, rust inhibitors and antifouling paints. These materials need to be used carefully and stored securely to prevent leakage and spills and pollution of soil in the area. There are fair possibilities of soil, water, noise and air pollution due to construction and operation of such facilities. Some of the activities undertaken at these facilities having potential to pollute environment arecleaning of the hulls scraping & sanding; water based pressure cleaning of hulls & exterior of boat; painting; Fiberglassing; welding& metal fabrication; engine maintenance & repair and generation of solid waste due to cleaning, repair & maintenance. All these activities may have significant impact on the environmental and social components, if not managed properly. Table below details out the activities and type of pollution resulting from it and the management required for the same.

Table 4.27 : Activities at Barge Maintenance & Repair Facilities, Their Impacts and Mitigation Measures

S. No.	Activities	Affect	Impact on Environment	Mitigation Measures
1	Hazardous Materials & Chemicals use and storage	Spillage and Leakage	• Soil quality deterioration • Surface and ground water quality deterioration • Contamination of land • Effect on flora and fauna in nearby areas • Air pollution due to odour • Impact on society due to	• Storage of these materials in contained facilities in isolated location • These storage facilities should have dedicated drainage system provided with oil interceptors • Training of the workers on handling of these materials and chemicals to prevent spillage and wastage • Availability of the emergency response plan for handling such spillage and leakage as soon as any such spillage or leakage happen • Quick clean up mechanism after

			environmental pollution and odour • Exposure of workers to the chemicals and hazardous materials • Fire accidents may happen in this area	such spillage and leakage • List and quantity of the hazardous materials and chemicals should be available at the site • MSDS for each chemical should be available at the site and all the workers should be trained and instructed about the possible hazard of each chemical stored or used in case of spillage and exposure. Material should be handled as per MSDS • Workers should be trained to handle situations after leakage, spillage and accidental exposure of workers due to spillage/leakage • Fire evacuation plan should be displayed everywhere in location so as it is legitimate and this plan should be explained and communicated to all workers. • Fire mock drills should be conducted every quarter and all the workers should know how to operate fire extinguishers • Fire alarm/hooter should be provided. Fire exits which are LED Lit should be provided • Emergency assembly area should be provided and it should be closed to the exit door and should be communicated to all the worker • Drivers transporting these materials should be given the induction on safe driving and vehicle should be maintained as per the Haz waste, 2016 rules • Combustible waste materials should not be stored in these areas • Material should be stored as per requirement and excess piling up of materials should be avoided • Store volatile and flammable solvents and other liquids in sealed containers away from heat, naked flames, direct sunlight, oil or other flammable liquids and fire hazards. • Store incompatible chemicals separately (e.g., the fibre glassing catalyst methyl ethyl ketone peroxide should not be stored anywhere near flammable liquids or other dangerous goods) • Seal and clearly label all storage

				containers and smaller decanting containers. • Where possible, fit containers with taps or pump the liquid to minimise the potential for spills • Place chemically compatible trays under container taps to catch spills or drips. • Replace the lids on containers of solvent, resin, fibreglassing initiator and accelerator promptly after use, to reduce evaporative loss and contamination by dust. • Keep and maintain spill clean-up equipment, such as absorbent materials, non-toxic dispersants boom (mechanical barriers for containing liquids). Sorbents can be made of peat, cotton, vermiculite, polypropylene fibre, wool or pine bark. • Train staff in the use of spill clean-up equipment • Contain and clean up spills or leaks immediately if it is safe to do so. Do not hose the substances onto soil or into any inland, estuarine or coastal waters • Do not use sawdust or other readily combustible absorbents to clean up flammable liquid spills • Dispose of contaminated clean-up materials in accordance with the Waste Management sections of these guidelines.
2	Removal of anti-fouling paint from vessels' hull-through scraping and scrubbing	Generation of paint debris, sludge, dust and other particles that may contribute to water, soil and air pollution and may be harmful to aquatic life.	• Spread of the removed antifouling paint particle & debris in air and soil deteriorating the soil quality • Contamination of the run-off with these debris and sludge • Contamination of the ground water due to leaching of the sludge generated during paint removal • Exposure of workers to the dust	• Usage of anti-fouling paints free from toxic material. Non-toxic paints which are silicon based should be used as antifoiling paints • Proper waste management plan should be prepared to handle & dispose the waste generated from this operation • Dust suppressers like water sprinklers should be provided in this area • Thick green belt should be developed all around the periphery to suppress dust and minimize direct exposure if people to the dust generated from these facilities • Workers should wear gloves while using the chemicals and cleaning agents and aprons and masks to

			generated	prevent inhalation of dust • Fit sanders, grinders and other power tools with dust extraction and collection systems. • Do not burn off antifouling coatings as this may generate highly toxic fumes, smoke and gases.
3	Cleaning of vessels' exterior	Generation of wastewater containing cleaning agents, solvents, chemical, detergents, grease, paints etc.	• Generation of large quantity of washing water containing the toxic material • Contamination of the soil with the wastewater generated due to washing operations • Contamination of river water bodies, if this wastewater is allowed to enter the water bodies and may lead to eutrophication • Biological particle stick to vessel's exterior may be present in this washing water which may become weed on land	• Cleaning area should be paved area provided with drains and oil interceptor • Use water-based or biodegradable strippers, cleaners and degreasers. • Use phosphate-free detergents wherever possible and scrub with a soft brush to absorb the detergent. Use biodegradable spray-type cleaners that do not require rinsing. • Wherever possible, use hot water, rags or a brush instead of chemicals • Dilute corrosion and rust removers to the correct concentration • Testing of the paint to be removed should be carried out at facility prior removal • If any removed underwater coating is contaminated with biocides or other hazardous chemicals and therefore must be handled and stored as controlled waste • Mechanical and manual cleaning should be undertaken in place of the blast cleaning to save water as well as spread of pollutants along with the spray particles • Prevent spray drift from escaping the work area by locating moveable waterproof screens alongside and behind the operator and avoiding pressure water blasting operations during windy conditions • If the surface of vessel to be cleaned contains paint with more than 0.5% lead content, then the area being cleaned should be totally encapsulated with a waterproof membrane and operators working inside the encapsulating membrane should be completely protected from contact with all wastewater. • If abrasive blast cleaning is undertaken, preferable wet and vaccum abrasive cleaning shall be

				undertaken • In case dry abrasive blast cleaning is carried out then it should not be carried out during windy days and abrasive blast chamber vented to atmosphere via an effective dust collector • Ensure that the screening material for outdoor/open-air blasting is tear-resistant, UVresistant, fire retardant and of suitable material and construction (preferably fully enclosed) to prevent the escape of fine dust • Avoid the use of silica sands (e.g. river sand, beach sand or quartz rock) and avoid using copper slag, zinc slag or any other abrasives that contain toxic heavy metals. • Use recyclable and more environmentally benign abrasives such as garnet, ilmenite, chilled iron grit, cast steel grit or cast iron shot. • ETP should be provided to treat the washing water generated • STP should be provided to treat the sewage generated due to domestic use • No-run-off from site should allow to get into rivers or accumulate at site or nearby areas • Proper waste management plan should be developed so as to handle, store, manage and dispose the waste generated • Treated water should be re-used for dust suppression, colling and landscaping and no treated water should be disposed off in river or in ground • Workers should wear gloves while using the chemicals and cleaning agents and aprons
4	Painting of Vessels	Spillage of paints and emissions of VOC while spray or manual painting	• Deterioration of soil quality and may be ground water due to leaching of the spillage paints • Emission of VOCs from paints and deterioration of air quality which may also have health	• Usage of Paints containing low VOCs • Spray painting should be minimized so as to minimize the spraying of tiny particles into the air while spray painting • Painting should be carry out on the paved surfaces which should have drains fitted with oil interceptors • Paint storage facilities should also

			impacts • Generation of fine particles while spray painting which may remain suspended in air leading to air pollution • Risk to workers due to exposure to VOCs and paints containing toxic chemicals	be paved surfaces and should have drains fitted with oil interceptors • Painting facility should be located in isolated location so as to minimize exposure of all workers to paint area and should be surrounded by thick tree belt all around • Mix paints in drip trays under cover and in a sealed, bunded and well ventilated paint bay. Do not mix or prepare antifouling paints in locations that are subject to floods • Spray paint large objects on a sealed and bunded surface that is either fully enclosed (sides and top) with screening material or fully screened (sides only) to a height two metres above the structure. Spray paint only in calm conditions. • Keep spray guns and lines clean and well maintained to reduce emissions; also spray perpendicular to the surface being sprayed and maintaining a uniform distance from the surface. • Use efficient spray equipment (transfer efficiency > 65%) such as high volume low pressure (HVLP) spray guns for all outdoor/open- air spraying. • Use corrosion inhibitors that are compatible with surface coating requirements, biodegradable and free from chromates, nitrates and nitrites. Corrosion inhibitors also commonly contain zinc that can contaminate stormwater and land. • Use a wash station for cleaning spray equipment and scrape the paint cup free of any residual paint with a spatula before cleaning the equipment with solvent • Workers should be provided with the masks to minimize inhalation of the VOCs and gloves to minimize exposure of paints to body • Deck paints and paints used in cabin areas of boats can usually be treated like normal household paints. • Clean up spilt paint (particularly water-based paint) and allow the remaining paint to dry rather than washing it into the wastewater

				collection system • After painting, wipe/squeeze as much paint as possible from the brushes, trays and rollers back into the paint tin for future use • Paint out excess paint onto an absorbent material such as an old rag or newspaper. Allow it to dry before disposal. Keep adequate supplies of rags and other absorbent materials for cleaning up small fuel and oil spills • Clean engine parts in a properly designated wash bath or over catch pans located in a covered, sealed and bunded area that is graded to a collection pit or sump • Where possible, clean engine parts with a brush rather than with solvents or aqueous degreasers such as alkaline or caustic soda • Use water-based or biodegradable strippers, cleaners or degreasers wherever possible. • Use a funnel when pouring fuel into drums or tanks or use hand pumps to remove fuel from drums. • Drain oil filters before disposal and never place any containers or boats containing residual oil, fuel or other fluids in industrial waste bins unless they have been drained and wiped clean • Use bilge pump/separation services at your facility. • When using containers filled with water to clean water-based paint from brushes and rollers, allow the paint solids to settle by leaving the container overnight. Pour the water out onto the garden or grassed area in the morning and use an old rag or newspaper to wipe out the solids from the bucket. • Do not rinse paint containers into storm water drains, gutters or sewers • Allow empty paint and thinner containers to air-dry before disposal.
5	Maintenance operations	Leakage or spillage of grease and	• Generation of large amount of hazardous and non-	• Consents from state under Air Act, 1981, Water Act, 1974 and Hazardous and Other Waste Rules should be obtained prior setting up

		solvents, generation of debris like metal wastes, greased cottons/clothes, empty containers of chemicals, used oil, leftover solvents, dry paint and other waste	hazardoussolid and liquid waste • Soil & water quality deterioration if this waste is allowed to mix with soil and run-off • Used oil, fuel and solvents used in cleaning may spill while maintenance operation and may lead to soil and water pollution • Generation of odour from these waste • Risk to workers using tools, chemicals, working on height, welding operations and other activities • This waste if not managed properly and dumped in open may be hazard to avifauna and other animal if ingested mistakenly by them • Odour from this waste may generate leading to air pollution and discomfort to the society • High noise levels may be generated in the maintenance and repair area	and operating such facilities • All conditions of consents should be followed and compliance of the same should be submitted as prescribed in consents to regulatory bodies and should be maintained monthly at site • Proper waste collection, segregation, storage, management and disposal plan for both hazardous and non-hazardous liquid and solid waste • Storage of hazardous waste in isolated location under covered shed and in covered containers separately from other non-hazardous solid & liquid waste • Inventory of the both hazardous and non-hazardous waste should be maintained. Records of hazardous waste should be maintained as per Haz. Waste Rules, 2016 • Tie-ups with vendors having hazardous waste authorization under haz. Waste rules, 2016 for transportation & disposal of hazardous waste • SOP should be prepared for each activity to be undertaken stating the equipment to be used for the activity, chemical required, safety measures to be taken, safety equipment to be used, PPE to be used, instruction for using the tools and keeping them back, procedures for keeping the tools incase work is to be left in middle. These SOPs should be communicated to workers at time of joining and prior starting the activity • Proper EHS cell should be established to take care of safety procedures and safety of workers at site. This cell should conduct safety meeting on monthly basis • Rest area for workers should be provided so as they should not have used floors of these facilities for lying down • Kitchen area and cafeteria should be provided in separate location so as there is no exposure of food and the chemicals used at site

				• Proper cleaning and washing facility should be provided at the site for cleaning up after working • First-aid room should be provided at the site with stretcher, first-aid box containing materials as per State's Factory law, ambulance facility and certified First Aid Trainers • List of contact nos. of safety officers and other emergency control services like hospital, fire brigade should be displayed everywhere in the plant and should be communicated tow worker • Proper lux levels should be maintained at site and working hours should be restricted to day time. If working in night time lux levels should be maintained as per IFC General EHS guidelines • Workers should be provided with air masks, ear plugs, safety shoes, googles as required as per EHS plan and SOP of each activity • Work zone noise levels should be maintained as per OSHAS norms and ambient noise levels should be as per standards given in Noise Rules 2000. No noise generation activity should be carried out during night time. • Incorporate acoustic barriers, damping and insulating materials in the facility's design and layout. Use the natural topography and consider landscaping improvements (fencing, mounds and structures) to serve as noise barriers • No facility should be established within 500 m of habitation area/forest area/sensitive areas like school, hospital & temple • Fit mechanical ventilation systems (e.g. air conditioners and fans) with noise-proof ducting and acoustically designed intake and exhaust openings • Enclose or acoustically screen potentially noisy equipment and undertake noisy activities in areas where noise can be muffled. • Fit silencers and/or exhaust

				mufflers to air compressors, pumps, fans, blowers and other noisy machinery. • Reduce structural-borne noise and vibration by mounting equipment on isolating platforms or rubber mats. • Specify noise-reduction options when purchasing new plant and equipment • Restrict internal work to similar hours unless there is effective sound-proofing of the building. • Minimise engine idling and testing. • Regularly maintain all equipment and vehicles by attending promptly to any loose parts, rattling covers, worn bearings and broken components. • Display signs indicating noise restrictions and requirements (where relevant). • Records for accidents and near-miss happened at site should be maintained. Detailed analysis for each incident should be carried out and report should be prepared detailing the reasons, causes, damages, loss and improvement to be taken • Emergency response plan should be available at site all the time. It should contain all the SOPs, waste management plans, emergency contact nos, list and nos. of PPEs, safety procedures at site, details of disaster management system like fire, earthquake, flood, cyclone etc. as applicable to the site. This ERP should be communicated to all the workers. • Visitors to the site should not be allowed to enter site without proper PPE and induction training • Records of training, mock drills, safety meetings, maintenance of the equipment, O & M works, quantity of material used, waste generated & disposed, PPE purchased & discarded should be maintained • Daily checklists should be maintained for carrying out cleaning and safety works at the site and it should be signed by the EHS head

				or authorized person on daily basis • Fresh water for workers should be tested on monthly basis to assure its compliance to IS:10500 • Signage should be displayed outside cautioning the presence of hazardous material at site. Signage should be provided in the entire facility for adoption and implementation of EMP and EHS system • Capacity building of EHS staff of the contractor and the client should be undertaken regularly through trainings and awareness programmes in regard to implementation of EMP, ERP and adoption of new waste management and safety techniques • Maintenance activities should be undertaken in the bunded and sealed areas to ensure that • Maintenance facility and work area should be minimum 1 m above the HFL of the River • Use a drip tray or groundsheet under the engine to collect oil, grease, solvents or detergents
6	Fiberglassing	Generation of VOCs during fiberglassing due to usage of solvents like acetone. Generation of dust during fibreglass trimming, grinding, sanding and drilling	• Generation of air pollution due to VOCs generation and dust generation during cleaning, trimming, grinding, sanding and drilling of fibreglass • Risk to safety of workers due to inhalation of excess dust, VOCs and during drilling, trimming, grinding and such similar works	• Contain and control all spray emissions. The recommended method is to work inside a building, keeping the doors closed while using mechanical ventilation equipment. • Where practical, hand lay-up methods are recommended over spray gun applications as hand lay-up releases less styrene. • For spraying, use airless, air-assisted, or HVLP spray guns. Internal mix, airless spray guns result in lower styrene emissions than other types of spray guns. • Ensure that the spray lay-up equipment is properly maintained and periodically cleaned. This will avoid glass jamming in the spray gun chopper mechanism and the generation of additional waste (resin and glass) when fixing it. • Use a gun wash station or similar for the cleaning of spraying equipment. • Reduce the amount of grinding and

				sanding as much as possible by trimming with a knife or mechanical cutter when articles have solidified but not yet hardened. • Securely wrap all sanding and grinding dusts prior to disposal. • Workers should be provided with the masks to minimize inhalation of the dust and gloves while using the chemicals like acetone to minimize exposure • Plantation should be developed all around the facility • Goggles and gloves should be provided to the workers involved in cutting, trimming, grinding, sanding and drilling operations of fibreglass
7	Welding and Metal fabrication	Generation of dust, small metal particles, smoke, fumes which may lead to soil, water and air pollution	• Generation of odour, smokes and fumes leading to air pollution • Direct exposure of workers to radiations during welding & metal fabrication and chances of blast during welding operations	• Pressure of the gas in cylinder should be checked so as to prevent explosion • Workers should wear face shield, googles, jackets, gloves and safety shoes to prevent exposure to UV radiations • Face masks should be provided to all workers working in the area to minimize smoke inhalation • Conduct all metal cutting operations on a sealed surface inside a screened area to minimise the horizontal dispersion of metal fragments and allow the sweeping or vacuuming of metal scraps and filings • Securely wrap all dusts and other grinding wastes prior to disposal in an industrial bin.

Source: Environment Guidelines for Boat Repair and Maintenance, Department of Environment, Parks, Heritage and the Arts Environment Division Tasmania

4.18. 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) analysing 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 environmentaland social external drivers on the chosen Valued Environmental Components (VECs)[52]/Critical Environmental Resources (CERs) over time, and (b) proposing concrete measures to avoid, reduce, or mitigatesuchcumulativeimpactsandrisktotheextentpossible 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 VECs. Further, overlay mapping and GIS have been extensive used for identifying the spatial distribution of VECs. Also indicators have been identified which can determine status/conditions of VECs. Baseline study has been conducted to assess the existing condition or status of the identified VECs based on these indicators in the influence area. Further VECs 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 VECs 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 PM_{10} 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

[52]VECs are environmental and social attributes that are considered to be important in assessing risks; they may be: • physical features, habitats, wildlife populations (e.g., biodiversity), • ecosystem services, • natural processes (e.g., water and nutrient cycles, microclimate), • social conditions (e.g., health, economics), or • cultural aspects (e.g., traditional spiritual ceremonies).

Critical Environmental Resource (CER) and Valued Environmental Components (VEC) are technically same referring to various key environmental resource or component like natural habitat. Critical Environment Resource word is used for Basin Level study as per terms of reference of these studies. However, for EIA studies VEC word is used.

activity on VECs 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.

4.18.1. *Cumulative Impact Assessment Vs Environmental Impact Assessment: Difference& Utility.*

CIA and EIA shares the same basic framework and analytical process for impact assessment but still the perspectives are different. EIA can be termed as project centred and CIA is always VECs centred. The CIA is prepared following preparation of Basin Level Critical Resource Study6 and takes into account the overall project perspective. The CIA is focused on VECs thus it considers the existing condition of VECs, conditions of VECs which may be changed due to intervention of project and the condition of VECs which may be changed due to other simultaneous developments taking place in the same influence area. The ecological and social impacts are determined considering, past, present, and natural drivers that effects the VECs in the influence area. The assessment reflects the geographical and temporal context in which the effect is aggregating and interacting with river landscape, catchment area, town, etc.53 . It defines the GHG assessment due to the project. The CIA provide the strategic consideration for project design and intervention proposed for example for Barge movement and operations. The influence area consideration for respective intervention is also derived based on CIA outcome.

In EIA the focus has been on project, its activities and the impacts its activities will have on the VECs. The ESIA is undertaken following CIA preparation and considering outcome CIA such as influence area recommendations for ESIA studies. In EIA study, impact on VECs is identified due to the project and mitigation measures proposed to avoid them, minimize them or eliminate them and if any of it is not possible then compensating the affected individual. It defines the environmental plan to mitigate the identified impacts.

[53] IFC Good Practice Handbook for Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets

Chapter 5. PUBLIC CONSULTATIONS AND DISCLOSURE

5.1. 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 influence 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.

5.2. Methods of Public Consultation

5.2.1. 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.

A. 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 are 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 5.1.**

Table 5.1 : 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.

B. 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 letters well in advance. Additionally, were also given in person to local bodies, Government officials & NGOs for attending the public consultation, much before the formal public consultation meeting. Locals were given invitation by personally visiting the villages. List of the stakeholders invited for the consultation meeting at Farakka Lock and Sahibganj Terminal are attached as **Annexure 5.1 (Volume 3C).** Copy of one invitation letter sent to stakeholder is attached as **Annexure 5.2 (Volume 3C)** for reference.

5.2.2. 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.

5.3. 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

Summary of consultation:

5.4. 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 5.3(Volume 3C)..** Main concerns raised during the consultation with redressal measures is given at **Table 5.2.** Photographs of informal public consultation are given in **Figure 5.1**

Table 5.2 : Summary of Key Concerns raised by Stakeholders and its redressal.

S. No.	Key Concerns	Redressal
Social Concerns		
1	Fishing community raised concern regarding effect on fish productivity and demanded support from project for the same.	Such impacts are unlikely from this project. However, mitigation, enhancement measures are proposed under EMP for reduction of impacts if any due to construction & operation of NW-1

		and its components. Some of the measures includes: Technical Support for enhancing fish productivity by setting up demonstration nurseries and training centre through institute of repute like CIFRI Regulated/slow speed of vessel at select locations and Zero Pollution approach from vessel and terminals Intimation of dredging/piling plan to fishermen community prior to carrying out any activity Provision of sirens and strong search lights in vessels/barges to pre-warn the fishermen
2	Provision should 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.
3	People desired to have the relocation site for the people likely to be displaced near river Ganga.	Relocation site is proposed to be selected by the concerned authorities responsible for land acquisition in consultation with people concerned.
4	People demanded support for the improvement in and around local immersion Ghat at Durga Chak (near Haldia terminal in West Bengal) to reduce congestion, especially during the local festival.	Budgetary provision is made under EMP for improvement of Ghats as an enhancement measures. Additional enhancement measure has been proposed for small enclosed areas dedicated for female bathing in every village along the NW-1 to allow female maintain their privacy while fulfilling their religious belief of bathing in river Ganga.
Environmental Concerns		
1	People raised concern that the terminal development may lead to increase of traffic on the connecting roads which are not suitable for such an increased load and needs to be upgraded.	Project design has considered this aspect and adequate provision is made for developing access road to the terminals to avoid any kind of congestion at each terminal sites.
2	Turtle will get impacted due to regular movement of vessels in river in Kashi Turtle Sanctuary.	Maximum of 1-2 vessels per hour are expected to move in the sanctuary area. Speed of vessels should be maintained to 5 kmph/2.7

		knots in turtle sanctuary area. Barge movement at this speed generates 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 anticipated to be insignificant. Other measures are also being proposed in the EMP to minimize impact of barge movement on turtle.
3	Dolphins will be affected due to barge movement during the operation phase of the project.	Adequate mitigative measures have been proposed in the project design which includes provision of propeller guards to prevent entangling of dolphins and other mammals, speed restriction in the sanctuary area and a restrictive buffer zone of 100m horizontally and 500m longitudinally either side of the river confluence areas for any dredging activity. Other measures are also proposed in management plan to reduce the impact on dolphins and other aquatic fauna.
4	Oil spillage from ships during accident may impact the aquatic flora, fauna, water quality and anti-bacterial properties of river Ganga.	Such situations are remote. Safety measures are proposed in the EMP for vessels as well. No vessels are proposed to discharge any of its liquid or oily waste in the river. Emergency response plan is proposed to deal with emergency situations to minimize the impact of emergency situations. It is also proposed to mandate that each vessel would have appropriate sewage treatment, treated sewage storage and waste management facilities to prevent water pollution.
5	People raised concerns regarding the likely impact on water quality due to construction and operation of terminal facility and cargo movement.	Environment management plan has incorporated the measures for prevention of water pollution from terminals, and barge operations. Zero discharge approach is proposed for terminals development and barge operations.
6	People raised concern about cutting of large no. of tree at	Compensatory tree plantation (1:7) basis at Sahibganj and additional

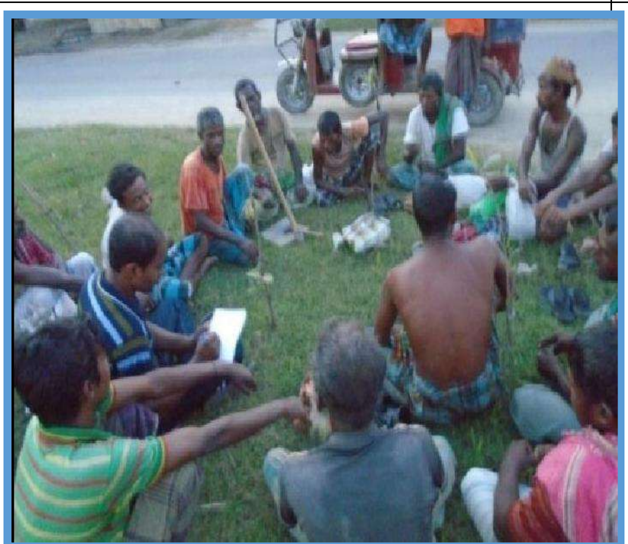
	Sahibganj site.	plantation is proposed to be undertaken. At all the terminal/jetty site green belt will be developed to the extent possible. This will help in minimizing the impact and will lead to reduced impact of CO2.
7	The varying LAD may lead to grounding of vessels.	LAD is proposed to be maintained in stretch between Haldia to Varanasi during entire lean period
8	Dredging may have significant impact on breeding and spawning season of fishes.	Dredging is proposed to be regulated during breeding and spawning season of the fishes.
9	People have raised the concern about existing erosion problem in the Farakka feeder canal and raised the apprehension that the NW-1 development and barge movement may escalate this problem.	Provision has been made in the project design for bank protection work of 9.438 km are proposed to be undertaken on banks of feeder canal to prevent the erosion.
10	People have suggested to make appropriate parking facilities inside the proposed terminals for better management of goods carriers and reduce traffic on existing road due to inappropriate parking on the public roads.	Adequate parking provisions is proposed in each terminal site design.
11	People have proposed to make adequate provisions of prevention of water logging in and around the terminals, and for firefighting.	Adequate drainage provision is made for channelizing the rain water at each terminal site. Fire-fighting facility is also proposed at each terminal 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.	**Socio-economic survey carried out by AIAID representative**
	
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.**

	
FGD with local residential at Durgachak,Haldia	**SC with Haldia Block Development Officials at Haldia**
	
KII with local fishermen at Durgachak,Haldia	**Photo from project location at Durgachak,Haldia**
	
BisarjaniGhat at Durgachak which located in	**Consultation with fisherman**

nearby proposed project site.	
	
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 5.1 : Photographs of Informal Consultations

5.4.2. *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.

A. 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 5.3**. Photographs of the formal public consultation meeting are given in **Figure 5.2.** Attendance sheet for the PCM is attached as **Annexure 5.4(Volume 3C).**

Table 5.3 : 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

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		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:** MrsMunni 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

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		villages 4. Fishing activity should not be prohibited in river 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 RajyaVidutVitran 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

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		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, **Address:** Ganga pump Canal Nahar Pariyojna (Irrigation Department, Sahibganj, Jharkhand	He supported the project and said that project is beneficial for overall development of area 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. Prashant 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	Villagers were highly concerned and raised

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
	of Samda Nala and Rampur village (Direct and Indirect Affected Persons)	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 prohibited 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 5.2 : Photographs of Formal Consultation at Samda Nala Village, Sahibganj

B. 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 5.4**. Photographs of the formal public consultation meeting are given in **Figure 5.3.**

Table 5.4 : Summary of formal Stakeholder Consultation, at Farakka

Sl. NO.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
1.	Kesang Dhendup Bhutia BDO & Block Executive Officer Farakka Block Development Office,Farakka,Murshidabad	• BDO,Farakka, welcomed the project development and assured his and local administration cooperation for the project 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. • 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. • 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 RedressalCommittees 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.	Kesang Dhendup Bhutia BDO & Block Executive Officer Farakka Block Development Office,Farakka,Murshidabad	• BDO,Farakka, welcomed the project development and assured his and local administration cooperation for the project 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. • 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. • 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 RedressalCommittees 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.
3.	Mr. Arnab Chakraborty Journalist(Malda&Murshidabad Division) UttarbangaSamgbad Farakka,Murshidabad	• 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.
4.	Mr.Jahid Hussain Arun Director, Mahadevnagar Rural Welfare Society, Farakka,Murshidabad	• 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.

Figure 5.3 : Photographs of Formal Consultation Meeting at Farakka

5.5. 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 5.5.** Photographs of the consultation are attached as **Figure 5.4.**List of invitee of the consultation is attached as **Annexure 5.5(Volume 3C)**.

Table 5.5 : Summary of the Second Stage Consultation at Patna

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.

S. No.	Person Consulted	Concerns Raised
		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, Urban Planning & Urban Development Specialist, Patna	Environment friendly waste disposal mechanism is required 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


भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण
INLAND WATERWAYS AUTHORITY OF INDIA


भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण
INLAND WATERWAYS AUTHORITY OF INDIA


(पोत परिवहन मंत्रालय, भारत सरकार)
(Ministry of Shipping, Govt. of India)

Figure 5.4 : Photographs of Formal Second Stage Consultation Meeting at Patna

5.6. 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 addressal 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 should 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 6. ENVIRONMENTAL MANAGEMENT PLAN

6.1. 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.

6.2. 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

6.3. 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,implementationplan covering monitoring, reporting and implementation and supervisory responsibility.

Consolidated EIA provides institutional mechanism, budgetary provisions and other systems and plans which are commonly applicable to all intervention and operations of NW-1. The EMPs prepared for dredging and barge operations are commonly applicable to the terminal development and operation and other intervention sites. Consolidated

EIA also provide generic EMP for the interventions such as Ro-Ro Jetties, embankment protection. Additionally, standalone EMPs prepared based on site specific terminal developments at Varanasi, Sahibganj and Haldia and Navigational Lock at Farakka.

6.3.1. *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. A sensitivity analysis was carried out of the entire NW-1 stretch from environmental biological and social sensitivity prospective v/s dredging and dredge disposal. This analysis is presentedat **Table 6.1**. Consideration dredging practices impact analysis and the above sensitivity the environmental management plan for dredging is given in **Volume 8.**

6.3.2. *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 in **Volume 9**.

6.3.3. *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 influence 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 (general) terminal, navigation locks & River Training Structures/Bank Protection measures for construction and operation phase and for Ro-Ro Jetties are given in **Annexure 6.1 & 6.2(Volume 3C).**

C. EMPs for Planned Civil Interventions

Standalone specific EMPsare prepared for each of proposed civil intervention i.e. Sahibganj, Varanasi& Haldia Terminal and Farakka NavigationLock based on these intervention specific EIA studies. These EMPs are included in **Volume 4, 5, 6 & 7**.

6.4. 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, Occupational Health & Safety and Social management cell (EHS) 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 EHS Cell. The major responsibilities of IWAI and of EHS cell would be:

- To develop the mechanism so as to ensure that proposed mitigation measures are discussed and integrated at policy level so as they become mandate for various stakeholders to be followed
- 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 should be made for setting up of common conservation cell consisting of one marine biologist, and ecologist, a sociologist and a fishery expert

The EHS cell 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 should also ensure availability of adequate resources. Institutional framework for the project is given in **Figure 6.1.**

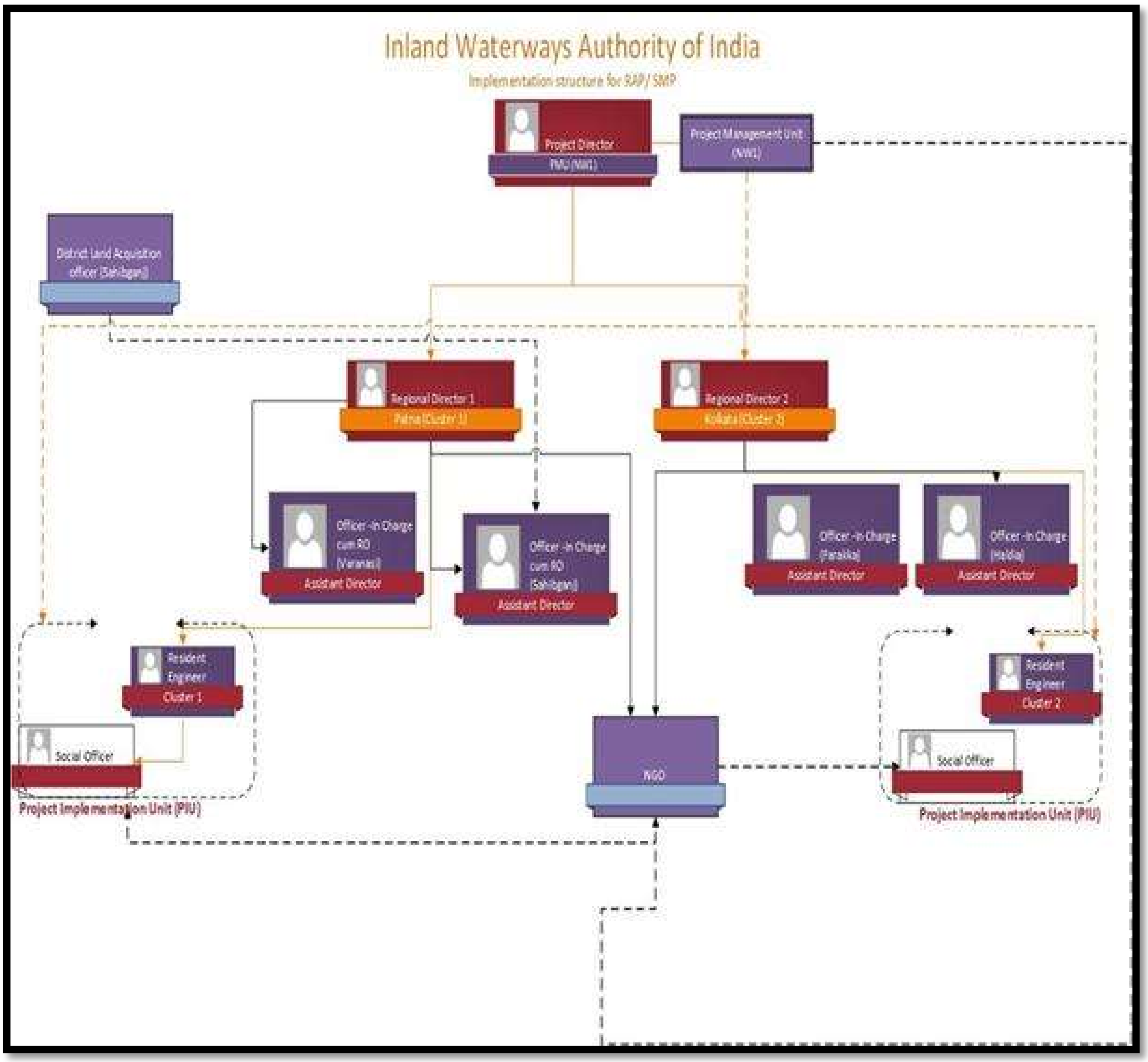


Figure 6.1 : Institutional Framework of IWAI

6.4.2. *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 health and safety management cell (EHS Cell) to ensure the implementation of the EMP and the SHE policy aiming at achieving the goals of safety, health and environmental management. The contractor EHS cell should have all the expertise in the field of Environment Health and Safety. The designated EHS officers should have adequate experience for implementing and monitoring the similar nature of EMPs. The contractor EHS cell should function in close coordinationwith PMU of IWAI and PMC to the project. The contractor EHS cell should submit the EMP compliance and applicable regulatory and IWAI EHS systems compliance on monthly basis.
- 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.

6.5. Environmental Health & Safety (EHS) Policy and EHS Management System

An effective environmental health and safety policy is essentially to demonstrate top management commitment for environmental protection and occupational health and safety. The policy should be communicated to all stakeholders including workers and should be freely available to them on demand. 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. Training and awareness will be an essential component of the EMP and EHS management system. It should include use of posters, bill boards/glow boards around project site an d barge NW-1 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.

6.6. 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.

No guidelines and standards are as of now available in India, which deals with the liquid and sewage waste management & disposal and air emissions from barges, terminal sites and at arrange maintenance facility during barge movement. Also no guidelines or standards on dredging and dredge disposal is available in India either for onshore or off-shore disposal. Guidelines are also not available on EHS management system to be followed by barges, terminal sites, dredging contractors, jetty sites, maintenance facilities. Such guidelines and standards should be developed by IWAI and other regulatory bodies in close association with IWAI. Further a monitoring mechanisms should also be developed so as to monitor the compliance of these guidelines and standards. Until the guidelines or standards are developed, IWAI can refer to the international guidelines and can make it mandatory to follow these guidelines by the stakeholders (terminal & jetty operators, barge operators, material transportation company, maintenance facility operators and other). until the new guidelines come up. Further IWAI is required to develop the infrastructure which is essential need as per these guidelines so as no violation of the guidelines happen.

Some of the international standards available in relation to dredge disposal, waste disposal, emissions management and some of national standards on water, air and construction standards are listed below. Details of 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 (Volume 3C) 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

6.7. 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 in **Table 6.2**. 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 should 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 should 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 should be planted and survival rate monitoring should be again taken up after 3 years. This cycle should continue until the 70% survival rate is achieved

Aquatic Ecology: Details about ecological aspect should 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 should 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 should 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 should be carried out. If any aspects of safety and emergency preparedness is found ineffective than appropriate corrective action should be taken.

6.8. Monitoring for Implementation of EMP

During project design and implementation stage the respective contractors should be liable for implementation of suggestive EMPs and IWAI will be responsible to monitor the contractor's performance and adequacy of implementation of EMPs directly or through third party (PMC). However, during operation stage, IWAI should be solely responsible for implementation of the EMP& Emergency Management. IWAI should be liable to ensure that suggestive mitigation measures are taken up by the shippers, dredgers and other stakeholders in time and adequately. IWAI should develop the mechanism so as to ensure the adherence and compliance of the EMP.

6.9. Reporting Requirement for EMP and EMoP

6.9.1. *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 compliance reports containing the status of environment, health & safety at site to PMC (Project Management Consultant) & PMU of IWAI. PMC/IWAI will be responsible for construction supervision and ensuring effective implementation of EMP by the contractor. PMC should 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.

6.9.2. *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

IWAI should be liable to ensure that suggestive mitigation measures are taken up by the shippers, dredgers and other stakeholders in time and adequately. IWAI should develop the mechanism so as to ensure the adherence and compliance of the EMP. It is proposed that IWAI will have dedicated department adequately staffed and equippedwithspeed monitoring, vessel positioning, and emergency response equipemnts(like oil spills control and remediation systems). IWAI may also adopt mechanism of involving Barge operators on the line of Responsible Carrier Programme of Americans Waterways Operators.

6.10. 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

6.11. Mechanism for Feedback and Adjustments

As part of the feedback mechanism, the EHS of PMU should monitor project compliance based on monitoring reports, audit and inspection reports with respect EMP, EMoP and applicable laws, rules and regulations. EHSwill report to PD quarterly. In case, any deviation from the contract requirements with respect to proposed EMP is observed, the same should be corrected within a fortnight through contractor and PMC and records maintained for the same. EHS will also verify the facts reports through periodic site visits.

Public involvement should be encouraged and ensured throughout the lifecycle of the project. The EHSshould 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 should be communicated back to PMC and contractor for correction and future implementation.

6.12. 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 6.3.**

6.13. 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 should evolve its environmental, Occupational health and safety guidelines and performance protocol. Budgetary provision has been made under environmental budget. The same should 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 6.3(Volume 3C).**

Responsible Carrier Programme of IWAI[54]**:** It is proposed that IWAI develops Indian Waterways Operations Responsible Carrier Programme which should be developed as part of its EHS Management Systems and Emergency Response Plan and Protocols Development. The programme should have the following components as well:

- Protocol for speed control, monitoring, and vessel tracking
- Protocol of waste management for barge operations and terminals management. (including zero discharges and waste disposal to river by barges and terminals. This protocol should also define about waste handling facilities at barges and waste disposal facilities at terminals for maintain zero discharge concept.
- Biodiversity protection including accident reporting with Aquatic mamals (dolphin)
- Oil spills reporting and control and remediation
- Near-miss reporting/lessons learned and corrective actions program
- Risk assessment procedures to assess and manage risks to personnel, vessels and the environment
- Identification of critical or essential equipment/systems
- Authority of the master, crew and shore side personnel
- Addition of document control procedures
- Tracking of number and volume of spills in performance measurement requirements
- Internal and external audit procedures and frequency

6.14. Authorities and their Responsibilities for Implementation of EMoP

The authorities and responsibilities for the implementation of the environmental management plans should 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 should be the responsibility of the IWAI (EA).

Projects should be implemented by Project Management Units (PMU). IWAI has set up Environmental, Occupational Health & Safety and Social Management Cell (EHS) within PMU. EHS will ensure that the environmental mitigation measures are being implemented effectively. The EHSshould, 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 EHScell at PMU. It is also proposed to appoint PMC who will supervise contractor and PMU to ensure effective implementation of management plan proposed. EHScell will be technically supported by independent subject experts who should be hired on need basis (Air, Noise, Water, and Aquatic).

[54] Reference is drawn to the successful similar programme of American Waterways Organisation's Responsible Carrier Programme. http://www.americanwaterways.com/rcp-2016.

The most essential component of the Environment Monitoring Plan is the execution of the Plan in accordance with the monitoring schedule provided therein. The EHScell andconcerned 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, EHS cell, PMC and contractor.

6.15. 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.

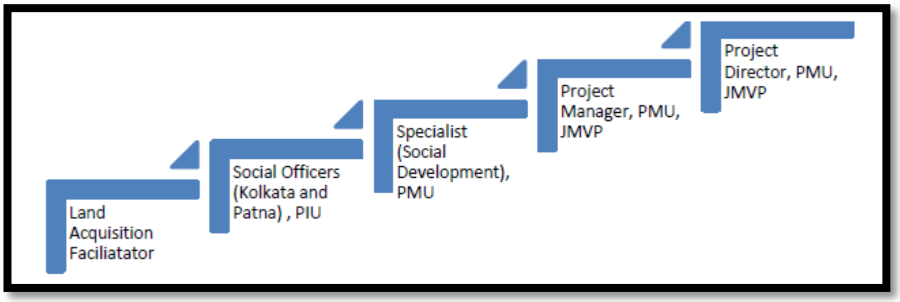
IWAI will be having prime responsibility for the same. Budgeting provision is made in the EMP for all the three enhancement proposal. EHS cell will obtain quotations and finalise implementation modalities, success indicators in consultation with proposed agency. The implementation plan will also be submitted to World Bank for information.

6.16. 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.

6.17. Grievance Redress Mechanism (GRM)

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 should also form part of quarterly report to World Bank. Hierarchy of escalation of complaint though GRM is presented below. GRM pocess flow diagram is given in Figure 6.2. Detailed GRM is given in RAP prepared for the project.



Hierarchy of escalation of Complaint

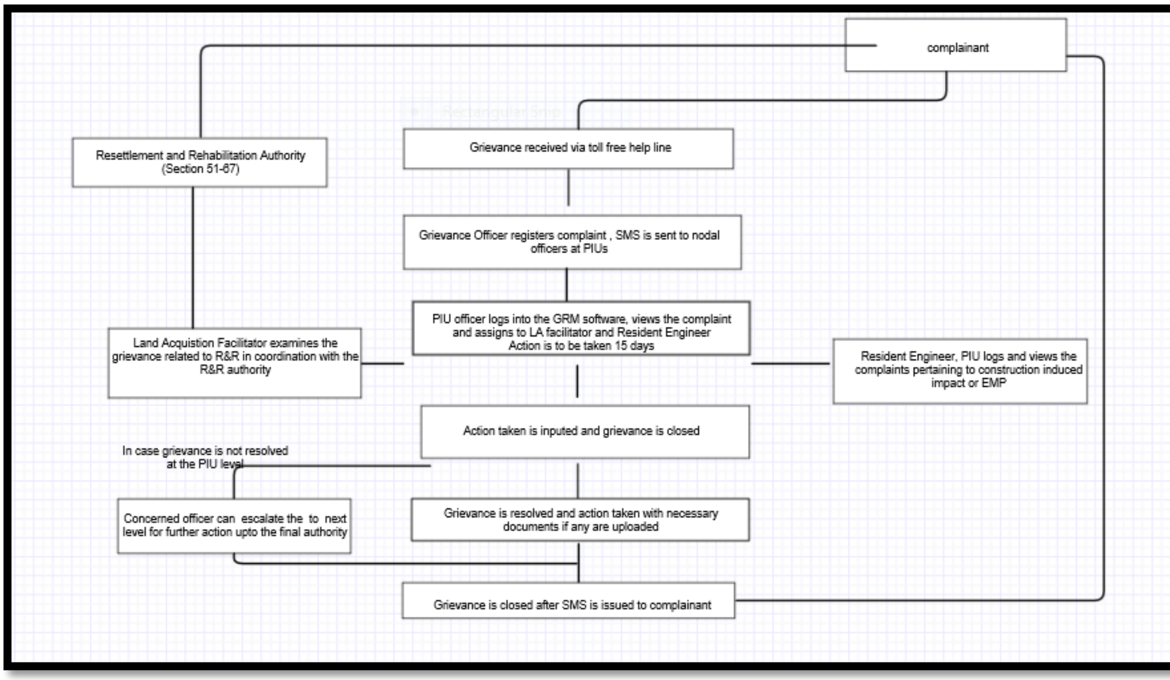


Figure 6.2 : Grievance Redressal Cell

6.18. 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 detailed break-up of costs is given at **Table 6.4**. Lump sum budget for each of the planned civil intervention area planned is given below in **Table 6.5** below. For detailed budget of each component the individual EIAs prepared for each of the proposed civil intervention can be referred.

Table 6.1 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: 3620000 cum between Tribeni to Farakka Dredged Quality: Not contaminated 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 Farakka55	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: 3960000 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 March56 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:16,00,000 cum Dredged Quality: Not contaminated Disposal Location: In river/shoals/scours	Fest & Festivals: Chat (Oct-Nov)	None	Peak spawning season for Indian Major Carps is May-August Breeding & Spawning grounds: Shallow waters and areas inundated during monsoon season57	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

[55] 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

[56] Ganges River Dolphins, WWF (http://wwf.panda.org/what_we_do/endangered_species/cetaceans/about/river_dolphins/ganges_river_dolphin/)

[57] Genetic Resources of Indian Major Carps, Their Distribution and Characterization, FAO (http://www.fao.org/docrep/006/x3850e/X3850E02.htm)

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: Patna to Buxar Dredged Qty:27,70,000 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: 29,00,000 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: Nil Dredged Quality: NA Disposal Location: NA	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 6.2 : 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 compounds	River bed near sites of terminals/locks /jetty Once in 6 months	Collection and analysis of samples as per IS 2720	Contractor	IWAI & PMC
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	---	Upstream & downstream of civil intervention sites and sites of river bank protection/river	Survey & observation; Extent and degree of erosion; Structures for controlling soil erosion	Contractor	IWAI & PMC

S. No.	Aspect	Parameters to be monitored	No of sampling locations & frequency	Standard methods for sampling and analysis	Role & Responsibility	
					Implementation	Supervision
	and sites of river training structures development		training works Six monthly			
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 Quality- terminal, lock & jetty sites	Physical, chemical and biological	River u/s & d/s of the proposed facility Once in quarter	Grab sampling and analysis by using standard methods	NABL accredited Lab to be contracted by IWAI	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 Management -terminals	Physical, chemical and biological of sewage and	Terminal site, testing of sewage and STP treated	--	NABL accredited Lab to be contracted	IWAI

S. No.	Aspect	Parameters to be monitored	No of sampling locations & frequency	Standard methods for sampling and analysis	Role & Responsibility	
					Implementation	Supervision
		STP treated water	water Once in quarter		by 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/river 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-terminal, lock, jetty sites	Physio-Chemical Parameters	River bed near sites of terminals/locks /jetty Once in 6 months	Depth Sampler	IWAI	IWAI
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 6.3 Training & Capacity Building

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 responsible for implementation of EMP, PMC & PMU	**Environmentally Sound Construction Practices:** Clean construction technology, alternatives materials and techniques for construction, Waste Management and minimization in construction, pollution control devices and	Workshops 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

		methods for construction sites and equipment, Environmental clauses in contract documents and their implications, protection of flora and fauna, Environmental monitoring during construction				
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, Evaluation and Review of results, Performance indicators and their applicability, possible corrective actions, reporting requirements and mechanisms	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
5	Health & Safe trainings, mock drills for fire & earthquake situation and handling other emergencies like floods, cyclones for contractor work force, environment	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

	al specialist, health & safety officers and environmental specialists of PMU & PMC					
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 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.	Workshops and trainings	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
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 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 **Rescue and rehabilitation of River Ganges Dolphin**	Workshops and seminars	Every six monthly during operation phase of project	1,00,000 per training 20 sites for 2 years	40,00,000
Total Cost for Training						**2,12,00,000**

Table 6.4 : 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
	• 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	--			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
	• 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 indicators	• 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
	• 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**
					Or say US$7.34 Mn (1US$ - INR 68)

Table 6.5 : Environmental Budget of Planned Civil Interventions

Civil Intervention	Amount (Rs in INR)-Crores
Varanasi Terminal	0.10029
Farakka Lock	1.37466
Haldia Terminal	1.20246
Sahibganj Terminal	1.64136

Chapter 7. SUMMARY, CONCLUSIONAND RECOMMENDATIONS

7.1. 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 Ghazipur and 2.2 m from Ghazipur to Varanasi), development of navigation infrastructure such as navigation aids, terminals (6 nos.), ro-ro crossings (5 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 3.18 MTPA respectively for phase I depending on available infrastructure. Navigation channel of 45 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. 14.85 million cum is estimated to be undertaken between Haldia and Varanasi to ensure year round navigation. This also includes the dredging quantity to be undertaken at the terminal sites. Major dredging requirement is anticipated at Haldia terminal only. For purpose of dredging, 12 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 24^0C 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.

IWAI should adopt the measures for reduction of dredging. Dredging management plan including compliance to defined restriction for dredging and disposal of dredged material close to cultural and aquatic sensitive locations shall be followed.

It should adopt the concept of green building and energy efficient terminals. The GRIHA guidelines shall be adopted for terminal design. All terminals shall be designed with zero waste discharge concept to prevent pollution to river Ganga. Similarly, all barges shall have integration of zero pollution concept. All consequent waste from the vessels shall be managed at terminals and barge maintenance facilities. All possible measures shall be adopted for GHG emission reduction including exploring the feasibility of fuel switch to LNG operated vessels.

It should take all measures for conservation of aquatic sanctuaries including reduction of impact on aquatic fauna. All possible efforts shall be made to minimize the impact considering the findings of CIA, Critical Resource Basin Study, Consolidated EIA Study and proposed conservation studies. IWAI should facilitate development of conservation plan for Dolphin, Turtle and sensitive species in NW-1 with the help of reputed institutions.

IWAI should develop all facilities for handling emergencies as part of emergency response plan.IWAI shall develop Indian Waterways Operations Responsible Carrier Programme on the line of American Waterways Operators Responsible Carrier Programme for accident and pollution free waterways operations

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.