

INLAND WATERWAYS AUTHORITY OF INDIA

Ministry of Shipping, Government of India

**ENVIRONMENTAL AND SOCIAL IMPACT
ASSESSMENT REPORT, ENVIRONMENTAL
MANAGEMENT PLAN AND RESETTLEMENT ACTION
PLAN FOR “CAPACITY AUGMENTATION OF
NATIONAL WATERWAY-1” BETWEEN HALDIA AND
ALLAHABAD
(JAL MARG VIKAS PROJECT)****(DRAFT)****EXECUTIVE SUMMARY
FOR
ENVIRONMENTAL IMPACT ASSESSMENT****MAY, 2016**

Since 1998



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EXECUTIVE SUMMARY

1.0 Background

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

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

feasibility report of Jal Marg Vikas Project being funded by World Bank. The following summarises the outcome of above studies.

2.0 Project Need and Location

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

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

Project area under Jal Marg Vikas Project includes entire reach of the River Ganga from Haldia to Allahabad including the areas proposed for development of project related

facilities & infrastructure, i.e. terminal sites, lock site, Ro-Ro jetty sites and sites for other planned development. Stretch from Allahabad to Haldia covers four states namely Jharkhand, Bihar, Uttar Pradesh & West Bengal. Map showing location of NW-1 stretch from Haldia to Allahabad is shown in **Figure 1** below.



Figure 1: Location Map of NW-1

3.0 Project Description

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

- Maintenance dredging to provide LAD in waterway/channel and the terminal facility
- Improved Navigation Infrastructure & Navigation Aids
 - Construction of 10 Ro-Ro jetties & ferry passenger jetties. Locations of these jetties are yet to be identified.
 - Construction of 6 terminals: Site identification and planning for 3 terminals sites at Sahibganj, Varanasi and Haldia is completed. 2 more potential sites for development of terminals are identified at Ghazipur and Kalughat. These two sites

are still under consideration for finalization and planning of design at initial stage only. One more terminal site along NW-1 is being identified.

- Construction of one Navigation Lock at Farakka, West Bengal.
- Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment. Development of low draught cargos.
- Development of navigation aids along NW-1 for facilitation of day & night time navigation.
- Development of efficient River Information System with all hardware & software.
- Provision for bank protection / slope protection and river training works for critical locations.

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

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

Table 1: Traffic Forecast for Planned Navigational Infrastructural Facilities

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

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

There are various challenges for Jal Marg Vikas Project development which includes typical characteristics alluvial river Ganga his braiding, meandering large water fluctuations between summer and monsoon months and annual silt loads of 1600 million tonnes. The maintenance dredging requirements, planned infrastructures facilities, and

other facilities are planned keeping these challenges and transportation requirements in consideration. The salient features of the Jal Marg Vikas Project with the details of planned and proposed developments are given at **Table 2**.

Table 2: Salient Features of Jal Marg Vikas Project

Salient Features	Capacity/Quantity/Nos.			
Facilities Planned	<ul style="list-style-type: none"> 3 terminal sites (Sahibganj, Varanasi & Haldia) 1 new Navigation lock- Farakka River bank protection works at planned terminal sites and along Feeder canal 			
Facilities under Planning Stage	<ul style="list-style-type: none"> 3 additional terminal sites 10 ro-ro jetties Barge repair and maintenance facility River training works River bank protection works at the proposed civil intervention sites 			
Designed capacity of Terminals	Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
	Sahibganj Terminal	2.24	4.39	9.00
	Varanasi Terminal (with current land)	0.54	1.22	1.22
	Haldia Terminal	4.07 MTPA (1.57 other cargo & 2.5 MTPA coal transshipment)		
Navigation Channel	Width-45 m LAD – from Haldia to Barh 3 m, from Barh to Ghazipur 2.5 m, from Ghazipur to Varanasi 2.2 m.			
Design Vessel Specifications	Vessels of maximum length 85 m, beam 14 m, draught 2.5 m- and air draught of 9 m will ply in the waterway			
Size of Vessels	1500-2000 dWT			
Maintenance Dredging	Navigation Channel-10.8 million 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			

3.1 Project Implementation Schedule, Cost and Implementation Responsibilities

The project being of large spatial extent, will be developed in phases. The implementation period of 3 years is anticipated for completion of phase 1 components of the Jal Marg Vikas Project (6 terminal sites, maintenance dredging, vessel management system, shore protection works and river training works). Overall cost of the Jal Marg Vikas Project will depend on finalization of various components proposed under the project. However, fund

allotted by World Bank to GOI for development of Jal Marg Vikas is about 650 million USD (~4200 Cr). The project director and officer of the rank of vice chairman of IWAI will be in charge of the implementation programme who will be assisted by Project Management Unit and Regional Directors.

4.0 Environmental Impact Assessment Process

This project is classified as Category 'A' operations under the World Bank environmental screening procedures specified under its operation policy 4.01. The project triggers 7 of the World Bank safeguard policy¹ and requires comprehensive environmental assessment. This project does not require any environmental impact assessment as per the existing provisions of Indian Laws. The environmental impact assessment was carried out by a consortium led by EQMS India Pvt. Ltd. Initially a basin level critical environmental resource study was carried out to identify "NOGO" and "Restricted areas". The baseline survey planning was carried out considering the output of this study as well. In addition to assessing the air, water, noise soil quality and biological environment (aquatic and terrestrial ecological aspects), sampling and testing of riverbed sediments at different locations in the entire stretch of NW-1 was also carried out. The baseline survey was carried out between: 15thSeptember, 2015 to 28thFebruary 2016 for different period and frequency at different locations covering the entire stretch of NW-1, finalised intervention areas, likely intervention areas, likely maintenance dredging areas, existing select RO-RO jetty locations, existing passenger select ferry locations and environmental sensitive areas. Being a liner project, the 500m radius on either side of the bank is considered as core influence zone, 2 Km radius as extended influence area. The terminal site will have influence area beyond 2 km. As per Indian standard practice, influence area is considered as 10 km along the NW-1 stretch and intervention areas for study purposes. The studies were carried out in tandem with preparation of detailed engineering feasibility report. Initially separate environmental impact assessment was carried out for each terminal / lock, maintenance dredging and barge operations. This was followed by carrying out environmental impact assessment for all components in the form of environmental impact assessment report for NW-1. The formal informal consultation was undertaken as part of impact assessment process. The impact assessment covers all three stages of the project viz. design, construction and operation stages. The impacts are identified from all

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

components and activities of the project on physical, biological (terrestrial and aquatic ecology) and socio – economic environment. Environmental management and monitoring programme are suggested to minimize the identified impacts and sustain the benefits. Institutional Mechanism is also proposed for effective implementation of environmental management and monitoring plan.

5.0 Project, Legal and Administrative Framework

The project has been evaluated for applicability of all National, State Laws, Rules and Regulations. The Acts, rules and guidelines applicable for the project are critically analysed to list out the permits/NOC required to be obtained by IWAI/contractor prior and during the development of the project. Environmental legislations applicable for the project are (i) Environmental Protection Act, 1986 (ii) EIA Notification, 2006 as amended till date (iii) Forest Conservation Act, 1980 (iv) Wildlife Life Protection Act, 1972 (v) CRZ Notification, 2011 (vi) Air (Prevention and Control) of Pollution Act 1981/1987 (vii) Water (Prevention and Control of Pollution) Act, 1974/1988 (viii) Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016 (ix) Other waste management & safety rules, regulations and guidelines; Construction and Demolition Waste Management Rules 2016, E-Waste Management Rules, 2016; Plastic Waste Management Rules, 2016; The Battery Management and Handling Rules, 2001; Ancient Monument and Archaeological Site and Remains Act, 1958.

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

Permission under CRZ Notification, 2011 is required for establishing Haldia Terminal from West Bengal Coastal Zone Management Authority. The process for this permission has

already been initiated. Permission for movement of vessel through Kashi Turtle sanctuary & Vikramshila Gangetic Dolphin Sanctuary located under Wild Life Protection Act, 1972². Process has already been initiated for obtaining these permissions. There are nine archaeological sites located within 300m area of river bank on NW-1. No construction activities are proposed closed to these sites. Permissions shall be obtained from archaeological department if any construction is planned in near future within 300 m of these sites.

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

6.0 Key safeguard documents

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

² As per notification, restrictions are imposed for fishing (larvae of Hilsa & during breeding & spawning season) only in Hilsa Sanctuary

during the course of the study. Stakeholders were informed about the project components and likely environmental impacts before seeking their views. In each consultation all efforts were made to have adequate participation from women as well. Consultations has been carried out for the project in two stages. First stage consultation was undertaken during impact assessment process to identify the concerns of people which were duly addressed through appropriate mitigation measures. Second stage consultation was undertaken after preparation of EIA report so as to assess the adequacy and acceptability of the proposed mitigation measures and management plan. Public consultations ensured involvement of public, NGO, experts in the project's pre-planning stage itself and addressal of their concerns and expectation from the project.

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

An executive summary of EIA report for NW-1 is available for public view in local language (Hindi and Bengali) versions at IWAI website. EIA report for entire Jal Marg Vikas Project and its executive summary is also disclosed at IWAI website and as per provisions of World Bank disclosure policies.

8.0 Alternative Analysis

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

8.1 Strategic Consideration

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

8.2 Planning Consideration:

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

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

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

To maintain the river navigability, maintenance dredging is required to be planned so as to maintain the length and width of the channel and maintain LAD near the berths/jetty. IWAI proposed either maintaining 3m LAD throughout the NW-1 stretch or maintained different LAD in different stretches (from Haldia to Barh 3 m, from Barh to Ghazipur 2.5 m, from Ghazipur to Varanasi 2.2 m.). Width of 45 m will be maintained throughout the navigation channel. Alternative analysis was carried out for both these options considering environmental (dredge quality, impact on aquatic ecology and water quality), social (cultural and aesthetic value, employment and socio-economic consideration) and technical feasibility (dredge quantity, navigation feasibility, economic aspects, dredgers and other infrastructure requirements). As per analysis option of maintaining different LAD at different stretch was found most preferred option.

8.3 Technological Consideration:

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

9.0 Salient Environmental Features of NW-1

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

Table 3: Salient Environmental Features along NW-1 Alignment

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

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

10.0 Anticipated Environmental Impacts and Mitigation Measures

Environmental impacts have been assessed considering present environmental setting of the project area, nature, and extent of the proposed activities. Suitable qualitative and

quantitative approach was followed for identification of likely impact on each value components of environment for design construction and operation stage. The impacts were analysed under three broad categories namely (i) Impacts due to dredging operations (ii) Impacts due to barge operations (iii) Impacts due to civil interventions. Additionally, impact was analysed for climate change and riparian issues. Impacts due to land acquisition are covered under separate Social impact assessment and Rehabilitation Action Plan report and not included under this summary.

Maintenance dredging & dredge disposal will be carried out during the operational phase of the project to maintain continued navigability throughout the year from Haldia to Varanasi in NW-1. Dredging of 10.8 million cubic meter will be undertaken, LAD – from Haldia to Barh 3 m, from Barh to Ghazipur 2.5 m, from Ghazipur to Varanasi 2.2 m. will be maintained. Impacts of the dredging are analysed for Physical Environment: on water quality and land, Ecological Environment: on aquatic ecology and avi-fauna (6 Important bird areas, VGDS, Kashi turtle sanctuary & Hilsa sanctuary), and Socio-Economic Environment: cultural (Ghats at Patna & Varanasi), archaeological (9 nos.) and livelihood of fishing community

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

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

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

10.1 Impacts due to maintenance dredging and barge operations

10.1.1 Impact on land and water quality

A. Baseline conditions

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

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

Ground and Surface Water Quality: Ground water quality monitoring is carried out along NW-1 and within the critical impact zones considered for planned civil interventions as per CPCB guidelines. TDS, Total Hardness and chloride values at Haldia and Sahibganj, Howrah and Kolkata are slightly above the desirable limit but are within the permissible limits specified of IS: 10500. Fe and Zn were detected in water samples but in lower concentration. Arsenic was detected in samples collected from Bhagalpur and Munger but in lower concentration.

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

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

Impacts: Impact of dredging on water quality are increase in turbidity; reduced light transmittance; reduced DO; changes in salinity, temperature, pH & concentration of nutrients and release of heavy metals/chemicals. As per a study, DO level comes down suddenly by 2 to 2.5 mg/l for maximum of 2 minutes only at the dredge plume arrival point which is regained within 3-4 minutes as plume passes. As per baseline study, river bed sediments are non-toxic except in Allahabad to Buxar stretch where Cadmium level is found marginally higher compared to US standard for off-shore sediment disposal. However, this higher level is unlikely to have toxic effect on aquatic life considering the sensitivity level to cadmium exposure (short terms at LC_{50} level) to aquatic life as per

Canadian Guidelines³. Pesticides are present in traces but much below the safe limit for off-shore disposal. Turbidity of water also increases substantially close to dredging point but it reduces with distance and almost get normalise at a distance of 700 m from dredging point. Coarser sediments settle much faster and at shorter distance. Presence of iron in sediments enhances settling of fine sediments as it acts as coagulant. Land disposal of sediments is anticipated only when sediments are contaminated and in case of Haldia terminal dredging. When the dredged material is disposed on land in form of slurry, excess water drains back to the water body which can affect the water quality.

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

C. Impact on water quality due to barge operations:

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

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

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

³As per Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment, 2014

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°C at Patna and daily mean maximum temperature of around 26.9°C at Kolkata. April and May are the hottest months with daily mean minimum temperature of 24°C at Malda and daily mean maximum temperature of 40.4°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}, PM₁₀, SO₂, NO₂ and CO) was carried out along NW-1 and within the critical impact zones considered for planned civil interventions as per CPCB guidelines. PM₁₀ level varies from 39 to 145 µg/m³. PM₁₀ levels are within 100 µg/m³ at all the locations except Varanasi (near bridge), Patna and Howrah. PM_{2.5} levels ranges from 16 to 58µg/m³ and are within the CPCB limit of 60 µg/m³. Level of SO₂& NO_x ranges from 4.4 to 35.6µg/m³ and 9.0 to 48µg/m³ 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/m³ and are within limits of NAAQs, 2009.

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

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

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

Table 4: Comparative Analysis for Air Pollutants by Different Modes

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

Source: Analysis done using emission factors⁴

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

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

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

⁴ The Environmental Effects of Freight, Organization for Economic Co-operation and Development, Paris and Air Quality Monitoring Research Association of India "Air Quality Monitoring Project-India Clean Air Programme (ICAP), CPCB/MoEF & EPA emission factors for rail locomotives, commercial

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

10.1.3 Impact on terrestrial and aquatic ecology

A. Baseline Conditions

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

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

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

Aquatic Flora & Fauna: The aquatic floral and faunal diversity of NW-1 stretch comprise phytoplankton, zooplankton, zoo-benthos, fish and higher vertebrates. Phytoplankton is represented by Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, Xanthophyceae and Rhodophyceae groups. Dominance of Bacillariophyceae members followed by Chrophyceae and Cyanophyceae was observed in NW-1 stretch. Zooplankton comprises of Protozoans, Rotifers and Crustaceans. Phytoplankton and zooplankton diversity is little higher in Farakka to Haldia stretch in comparison of Allahabad to Farakka stretch. Macro benthos and Macro-invertebrates constitute Annelida, Arthropoda insects

and Mollusca. Fish in the NW-1 stretch is represented by total of 106 species. The higher aquatic vertebrates present in NW-1 stretch (Allahabad to Haldia area) are Gangetic dolphin (*Platanistagangeticagangetica*) which is categorized as endangered species (Schedule-I) and few endangered and vulnerable species of fresh water turtle.

B. Impact on Aquatic Ecology due to maintenance dredging:

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

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

C. Impact on aquatic ecology due to barge operations:

Impact: Impact of barge movement on aquatic ecology can be due to speeding vessels, spillage of material transported (oil majorly) and generation of high level underwater noise. Vessels if moving in high speed can collide with aquatic organisms leading to mortality and injury to aquatic organisms. Spillage of material transported can impact the habitat of the aquatic species. Oil spills are most significant among all spills as oil can form a layer breaking contact between water & air and reducing DO level, block gills and skin pores of aquatic organisms leading to mortality. Barge of size 1500-2000 dWT are expected to move in the waterways which generate noise levels of 110-180 dB as per speed. Speed is however restricted in sanctuary area to 5 kmph and noise levels will be maximum 140

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

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

D. Impact on Avifauna due to maintenance dredging:

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

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

10.1.4 Impact on Socio economic and cultural aspects

A. Baseline Conditions

NW-1 traverses through four states: Uttar Pradesh, Bihar, Jharkhand, and West Bengal. There are various densely populated areas located along NW-1 such as Allahabad, Farakka, Sahibganj, Berhampur etc. As per the Census, 2011, population of the major cities & towns along NW-1 is 1,28,75,343 (67,82,150 male & 60,93,193 females) and the total numbers of Households are 2562165, population between 0-6-year age is recorded

as 13,08,682. Being project of such large spatial extent, NW-1 interfaces with various archaeological, social and cultural sensitive and important locations. There are 9 archaeological important sites along NW-1 but no activity at present is proposed to be undertaken within 300 m of these sites. Ghats at Patna and Varanasi are another socially important features which will be impacted due to project. However, measures are proposed to minimize such impacts. There are several festivals such as Kumbh at Allahabad (Jan-Feb), Ganga Mahotsav at Varanasi (Oct-Nov), Dhruvad Mela at Tulsi Ghat of Varanasi (Feb to March), Chatt at Bihar & Jharkhand (Oct-Nov) and Ganga Sagar Mela at Sagar (January) are being celebrated at NW-1. Due to barge operation and dredging activities there could be interference in these celebrations. Mitigation measures are proposed to be undertaken to minimize such impacts.

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

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

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

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

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

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

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

10.2 Impact & Mitigation Due to Civil Interventions

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

Impact during design phase:

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

Key Mitigation Measures

Tree cutting should be minimized by efficient planning of the interventions. Permission from forest department is essential prior to cutting of trees besides, compensatory plantation to be carried out as per respective state forest policy. Restoration and rehabilitation of locations occupied or used for construction purposes immediately after the given task(s) is over. Dedicated approach roads and improvement of haul roads should be considered to minimize the traffic congestion and air emissions. Traffic management should be undertaken to avoid peak hours. Utility shifting should be carried out during or prior construction phase but without disrupting service to public. Necessary permissions

from the area development authorities and local bodies should be obtained prior development of proposed interventions. Natural drainage pattern should be maintained by provision of adequate drainage. Compensation should be given to affected households as per R & R Act, 2013.

Impact during construction phase

Activities to be carried out during design phase which can impact the physical, biological and social environment are construction activities, material transportation and operation of machinery & construction equipment. Major impacts due to these activities are Loss of top soil, Soil contamination due to spillage of material, Bank Erosion/bed scouring, Surface water contamination due to increased run-off from construction site, High noise levels and disturbance to nearby habitation, Traffic jams, wear & tear of existing roads, increased accidents and air pollution, Unpleasant view due to construction activities, construction material storage and waste storage, Health & safety of Workers and people in nearby areas, Quality of Life, Mortality, disturbance to habitat and change in behavioural response and Tree cutting & vegetation removal

Key Mitigation Measures

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

mixing with contaminant, provision of storm water management system, provision of sediment traps, oil interceptors with storm water drains in parking areas. Impact of piling & construction dredging should be managed by adoption of vibratory piling and usage of bubble curtains to disperse the fauna and reduce the noise level.

Impact during operation phase at intervention sites

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

Key Mitigation Measures

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

10.3 Impact on Climate Change

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

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

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

10.5 Cumulative Impact Assessment

Cumulative Impact Assessment (CIA) of NW-1 from Allahabad to Haldia has been carried out for (a) analyzing the potential impacts and risks of proposed, indirect & induced developments in the context of water flow, water availability and water quality, considering human activities and natural environmental and social external drivers on the chosen Critical Environmental Resources (CERs) over time, and (b) proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible in the influence area (10 km) 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 EIA report for NW-1 & basin critical resources study of the proposed project has been carried out to identify the CERs. Further, overlay mapping and GIS have been extensive used for identifying the spatial distribution of CERs. Also indicators have been identified which can determine status/conditions of CERs. Baseline study has been conducted to assess the existing condition or status of the identified CERs based on these indicators in the study area. Further CERs under stress have been identified and are termed as hotspots. Also nature of the impacts due to proposed/planned & anticipated development on these hotspots has been assessed. It has been found that cumulative impacts due to proposed development of NW-1 on the hotspots will not be significant. Further, impacts triggered due to induced & indirect development can be mitigated & monitored.

11.0 Environmental Management Plan

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

requirements, training awareness and capacity building programme, grievance redress mechanism and environmental budget.

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

Reporting Requirements: Contractor would be required to submit monthly and six monthly reports containing the status of environment, health & safety at site to PMC (Project management consultant) & PMU of IWAI. PMC will be responsible for construction supervision and ensuring effective implementation of EMP by the contractor. PMC shall report to PMU monthly about the performance and effectiveness of the EMP implemented by contractor on site and coordinate with field units and PMU for necessary corrective actions as may be required. IWAI will also organise an independent Environment Audit which will be submitted to Bank within 3 months of completion of the second and fourth year of implementation period.

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

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

Table 5: Environmental Budget



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

S.No.	Description	Amount
5.	CONTINGENCIES @ 5 % on total Environmental Costs	2,37,66,000 2.38 Cr
6.	GRAND TOTAL (in Rs)	499086000 Or say 49.91 Cr

12.0 Conclusion & Recommendations

The development of project “Jal Marg Vikas” is beneficial for the economic development of country and environment due to expected modal 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.